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SHOT PEENING APPARATUS

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4 Claims. (Cl. 29—90)

This invention relates generally to shot peening apparatus of the type in which small shot particles are forcibly impacted against surfaces of parts for cold working purposes, and more particularly has to do with improvements in such apparatus directed to more efficient handling and transportation of the shot particles and better arrangement and movement control of both the peening nozzles from which the shot is thrown and the carrying means for the part to be peened, ultimately favoring higher outputs, lower cumulative shot loss and better quality peened surfaces.

In general, shot peening operations of this type are characterized by continuous entrainment of shot particles into a stream of compressed air being jetted through one or more nozzles at a part to be treated, the entrained shot being impacted against the part surface. Normally the peening operation is carried out inside a closed chamber to prevent loss of bouncing shot particles, and means are provided for collecting spent shot particles for subsequent recycling to the nozzles for reuse. Such shot peening operations are further characterized by a number of problems having to do with difficulties in keeping closely spaced or mating moving parts of the mechanism free of shot accumulation to prevent scoring thereof, shot loss during shot handling and transportation and during the insertion or removal of a part from the peening chamber, non-uniformity of effective peening on the part surface due to the absence of or poor nozzle control, the tendency of a certain amount of shot to remain on the part surface especially if the surface is large and extends horizontally, and inefficient shot handling during recycling.

To overcome these and other problems, the present invention contemplates mounting the shot nozzles for pivotal movement within the peening chamber, and providing a carrier for the part to be peened mounted outside the entrance to the peening chamber for access thereto through the entrance, the carrier being movable in a plane facing the nozzles to carry the part frontally past the nozzles to subject successive frontal surface portions of the part to the peening action of the shot carrying air streams. With the part surfaces to be peened extending upwardly instead of horizontally, spent shot particles tend to fall off the part and downwardly for collection and recycling, minimizing shot loss since no shot remains on the part upon its removal from the chamber.

Furthermore, the invention includes the provision of a rotatable carrier for the part, and preferably several such carriers mounted within a pivoted turret adapted to be swung to present alternate carriers and parts carried thereby to the peening chamber, so that while one part is being peened a previously treated part may be removed from the turret and an untreated part may be loaded for subsequent peening. For this purpose, a flexible border seal may extend around the entrance to the chamber to seal off between the turret and the chamber housing preventing loss of bouncing shot particles during peening.

Quality control of surface peening may be had by

mounting a number of nozzles in vertically spaced relation for oscillatory movement at a substantially fixed distance from the upwardly extending plane within which the part is oriented. The nozzles are separately supplied with shot through conduits which may be selectively controlled so that only certain of the nozzles are in operation, corresponding to the configuration of the part surface to be peened.

Improved handling of the small shot particles is obtained by recycling them entirely within an enclosed system to prevent shot loss. For this purpose, the spent shot falling to the bottom of the peening chamber is collected and blown in an air stream through a duct to a hopper at the top of the peening chamber for subsequent gravity flow to the nozzles below. Separation of the shot from the air stream is achieved by venting the hopper and baffling the vent to separate any shot particles from the outflowing air stream.

Other features and objects of the invention, as well as the details of an illustrative embodiment will be more fully understood from the following description of the drawings, in which:

Fig. 1 is a front elevation showing the complete peening apparatus;

Fig. 2 is an enlarged fragmentary view of the peening nozzle assembly taken on line 2—2 of Fig. 1;

Fig. 3 is a fragmentary view taken on line 3—3 of Fig. 1 and showing the actuator for the nozzle assembly;

Fig. 4 is an enlarged detail taken on line 4—4 of Fig. 2;

Fig. 4*a* is a fragmentary section taken on line 4*a*—4*a* of Fig. 2;

Fig. 5 is an enlarged section taken through the shot hopper shown in Fig. 1;

Fig. 6 is a transverse section taken on line 6—6 of Fig. 1;

Fig. 7 is a view showing the method of closing off a shot conduit;

Fig. 8 is an enlarged perspective view showing the method for mounting a nozzle;

Fig. 9 is an enlarged fragmentary section taken in elevation on line 9—9 of Fig. 1 showing the part carrying turret, and

Fig. 10 is a section taken on line 10—10 of Fig. 9.

Referring to Figs. 1, 9 and 10, the shot peening apparatus is shown to include an upright container or cabinet 10 enclosing a shot peening chamber 11 within which one or more laterally extending nozzles 12 are supported in spaced directional relation to cabinet side entrances 13 and 14. As indicated in Fig. 1, side entrance 13 is considerably larger than entrance 14 in order to accommodate entrance of a large part such as the wing section 15 into the peening chamber, whereas entrance 14 is considerably smaller to accommodate the smaller part carrying turret assembly 16 shown in Fig. 9 to be in communication with the peening chamber through the entrance 14.

The turret assembly illustrated in detail in Figs. 9 and 10 includes a frame structure 17 mounting an oppositely directed pair of receptacles 18 having closed inner ends 19 and sized at their open ends for accommodation within entrance 14 in sealing engagement with the elastomer seal 20 bordering the entrance. The receptacles are co-axially aligned to receive and mount a central rotatable shaft 21, opposite ends of which project respectively into the two receptacles and are circumferentially grooved and dimpled at 22. A pair of carriers 23 are mounted respectively on the opposite ends of the shaft 21, the carriers including sleeves 24 fitting closely on the shaft ends and mounting spring urged detents 25 engageable with the dimples 22 to removably couple the carriers to the shaft. The particular design of the carrier may vary in accordance with the size and shape

of the part to be mounted and rotated thereby, and merely for purposes of illustration each carrier is shown in Fig. 10 to comprise a cupped body having a clamping flange 26 extending within the peening chamber and mounting a part generally indicated at 27. Referring back to Fig. 9, it will be seen that rotation of the carrier by the shaft effects rotation of the part in a vertical plane facing the nozzle 12 so that the part is rotatably carried frontally past the nozzle in laterally spaced rotation thereto to subject successive frontal surface portions of the part to the peaning action of the shot carrying stream jetted from the nozzle.

The turret assembly 16 is pivotally mounted about a vertical axis exterior to the cabinet 10 between laterally extending vertically spaced supports 28, the pivots 29 being connected to the frame structure of the turret. From the foregoing, it is clear that the turret may be pivoted to bring either receptacle 18 into communication with the interior of the peening chamber 11 so as to subject a rotating part to the peening action of the shot carrying stream, while the alternate carrier faces outwardly away from the cabinet. In this position, the alternate carrier may be slipped off the rotating shaft by manually overcoming the resistance of the detent mechanism, and a new part may be mounted on the carrier which may then be returned to the rotating shaft and the turret swung around through 180° to subject the new part to peening. The shaft 21 may be continually rotated by any convenient means, as for example the motor 30 mounted on the frame 17 and driving the shaft 21 through a belt driven gear box 31 driving a chain 32 rotating the sprocket 33 on the shaft. Finally, Fig. 9 shows the bottom wall 34 of each receptacle 18 to be slanted downwardly and toward the open end of the receptacle, this configuration assuring that shot particles will not collect in the receptacle but will tumble downward toward and into the peening chamber. Also, since the surface of the part subjected to peening is rotated in a vertical plane, the shot particles will tend naturally to fall downward off the part within the peening chamber for collection at the bottom thereof.

Referring back to Fig. 1, the carrier 35 for the wing section 15 comprises a wheeled cart movable along a rail 36 extending through the opposite entrances 13 to the peening chamber, the cart being movable by a chain conveyor 37. Suitable arms 38 carried by the cart support the wing section in an upwardly extending plane, designated by the side of the wing section facing the nozzles 21 as shown in Fig. 2, with the result that shot particles do not collect on the surface of the wing section but tend naturally to tumble downward within the peening chamber for collection at the bottom thereof.

The nozzle assembly 39 indicated in broken lines in Fig. 1 is shown in detail in Fig. 2 to comprise a series of spaced nozzles 12 rigidly mounted by support 40 in a vertically extending plane at a fixed distance from the upwardly extending plane of the wing section 15 which faces the nozzles. The support 40 is in turn carried by parallel swingable arms 41 having equal lengths to form a parallalogram linkage with the support 40. A specific pivotal connection between lower arm 41 and the support 40 is shown in Fig. 4 to comprise a pin 42 rigidly connected to arm 41 through the offset member 43, the pin being rotatably received within a metal bushing 44 mounted by the support 40. The connection between the upper arm 41 and support 40 is the same except for the use of a flexible bushing 144 typically of rubber construction to receive upper pin 42, as shown in Fig. 4a, the purpose of this bushing being to accommodate relative misalignment between movable members 40 and 41, such as by any slightly out of parallel mounting of shafts 141, and thereby freeing the linkage for pivotal movement controlled by lower arm 41. The pivoted end of the lower arm 41 is keyed to lower shaft 141, the end of which projects from the cabinet and is conveniently rotatably mounted in cabinet-supported lower pillow block 45 shown in Fig. 3. The projecting end of lower shaft 141 is rigidly connected to the pivot lever 46, which is in turn connected to linear actuator 47 through a take-up link 48 for angular reciprocation by the actuator.

Such reciprocation is communicated by the shaft 141 to the lower arm 41 which therefore pivots along an arc 49 indicated on Fig. 2, the support or links 40 being connected in such angular relation to the arms or links 41 that the latter extend substantially normal to the support when the arms are at their median positions in their oscillatory travel along arcs 49. This configuration assures that the support 40 and nozzles 12 will be reciprocated at a substantially fixed distance from the part surface to be peened and will remain angularly oriented in space so as to maintain uniform peening action over the surface of the part. Also, the transmission of reciprocation to the support 30 through the lower rotatable shaft 141 minimizes the risk of malfunctioning of the oscillatory mechanism resulting from the effects of shot particles scoring the mechanism, since shaft 141 does not reciprocate through the bearing but rotates back and forth therein.

Coming now to a description of the systems utilized for handling and recycling the shot, Fig. 1 shows a catch bin 50 convergent downward toward receptacle 51 into which the shot falls under the influence of gravity. A compressed air line 52 is also connected into the receptacle and directed toward the entrance to duct 53 extending upward from the receptacle to the shot hopper 54 mounted at the top of the cabinet 10. Compressed air entrains the shot falling into the receptacle 51 and lifts it through the duct 53 for discharge into the hopper 54, wherein the shot ultimately settles as shown in Fig. 5. Separation of the air from the shot within the hopper is effected by directing the entering shot carrying air stream into the upper portion of the hopper at an angle to its axis as shown in Fig. 6, wherein two ducts 53 are shown connected into the hopper, and the interior of the hopper may be lined with thin sheets of rubber 55 to prevent erosion of the metal hopper walls by the impact of shot thereagainst. Shot entering the hopper tends to bounce around the inner walls of the hopper and ultimately to settle within the convergent lower portion 56 of the hopper, whereas the air led into the hopper through the ducts 53 is vented to the exterior at 57 through the hopper top.

Due to the peculiar tendency of the shot to rebound within the hopper, it has been found that a considerable amount of shot is lost by escape through a vent such as 57, and to prevent such loss elements forming a labyrinth passageway system may be inserted within the hopper below the vent 57. As illustrated in Fig. 5, a baffle ring 58 considerably larger than the vent opening is provided immediately below the vent to enclose and form an enlarged passageway 59, a restricted tubular opening 60 being provided within the larger baffle opening 61 formed at its base. Finally, a deflector plate 62 is positioned between the restricted opening 60 and the vent 57. In operation, most of the air delivered to the interior of the hopper through ducts 53 exhausts through the restricted opening 60 into the enlarged passageway 59 where its velocity is substantially reduced. Any random shot particles carried into the chamber 59 are deflected by plate 62 and drop downwardly through bottom opening 61 in the baffle due to the lower upward velocity of air within passageway 59. The air, of course, exhausts from that passageway around the deflector plate and through the vent 57 to the exterior.

As shown in Figs. 1, 2, 5, 7 and 8, shot particles are delivered from the hopper 54 to the nozzles through individual flexible conduits 63 depending from the base of udder 64 formed under the hopper and delivering to individual sub-hoppers 65, and individual conduits 66 depending from the hub-hoppers and connected with the

nozzles, the shot flowing to the nozzles under the influence of gravity and being entrained by compressed air delivered to the nozzles through other conduits 67. Normally, the lower open ends of hanging conduits 63 are held squarely against the downwardly angled sides of sub-hoppers 65, so as to prevent egress of shot from the conduits, by laterally extending tension springs 68 and by pivoted hangers 69 both of which are connected to collars 70 carried at the lower portions of the conduits. The upper ends of the hangers hang from suitably supported pivots 71 positioned alongside the upper portions of the conduits and below their upper ends so that when swung laterally by springs 68 the lower ends of the hangers will carry the discharge ends of the conduits along curved paths and into squarely engaging contact with the sub-hopper sides. Under these conditions the conduits themselves cannot form sharp bends or kinks, such as would allow escape of shot from their discharge ends, but will hang approximately along circular arcs.

Selective use of particular nozzles may be accomplished by pulling on one or more cables 72 connected with hangers 69 so as to displace the discharge ends of the conduits from the angled sides of the sub-hoppers, against the forces exerted by springs 68. As a result, the conduits 63 may be displaced to hang vertically over the open upper ends of conduits 66, as indicated by the broken lines in Fig. 7, permitting free flow of shot particles to the nozzles.

I claim:

1. For combination with a chamber having an entrance through which a part to be peened is insertible into the chamber, improved shot peening apparatus comprising a nozzle directed within said chamber in spaced relation to said entrance for continuously jetting a shot carrying gas stream at the part during relative movement between the part and nozzle within the chamber, and movable means for reciprocating the nozzle including a frame having three members two of which are angularly reciprocable along separate circular arcs and the third of which supports the nozzle and joints interconnecting said two members with said third member so that the latter and said nozzle remain angularly oriented in space during said nozzle reciprocation to subject successive frontal surface portions of the part to the peening action of said shot carrying stream, said frame members being reciprocable in planes entirely within the chamber, said movable means including an actuator outside the chamber and a shaft extending into said chamber from the exterior thereof and operatively connected with said frame for transmitting angular reciprocation to the frame in response to actuator operation, said shaft being restrained against endwise axial sliding movement whereby the entirety of said means within the chamber is angularly reciprocable only and said nozzle is substantially linearly reciprocable.

2. For combination with an upright chamber and having a side entrance through which a part to be peened is insertible into the chamber, improved shot peening apparatus comprising a nozzle directed substantially laterally within said chamber in spaced relation to said entrance for continuously jetting a shot carrying air stream at the part during relative movement between the part and nozzle within the chamber, and movable means for reciprocating the nozzle including a frame having three links two of which are of substantially equal length and are angularly reciprocable along vertically spaced apart circular arcs and the third of which supports the nozzle and joints interconnecting said two links with said third link so that the latter and said nozzle remain angularly oriented in space during said nozzle reciprocation to subject successive frontal surface portions of the part to the peening action of said shot carrying stream, said frame links extending in an upright plane entirely within the chamber, said movable means including an actuator outside the chamber and a shaft extending into said chamber from the exterior thereof and operatively connected with said frame for transmitting angular reciprocation to the frame in the plane thereof in response to actuator operation, said shaft being restrained against endwise axial sliding movement whereby the entirety of said means within the chamber is angularly reciprocable only and said nozzle is substantially linearly reciprocable.

3. The invention as defined in claim 2 in which a plurality of vertically spaced substantially parallel directed nozzles are carried by said third link.

4. The invention as defined in claim 3 in which said third link remains inclined slightly from the vertical during said reciprocation and is substantially longer than each of said two equal length links.

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FIG. 1.

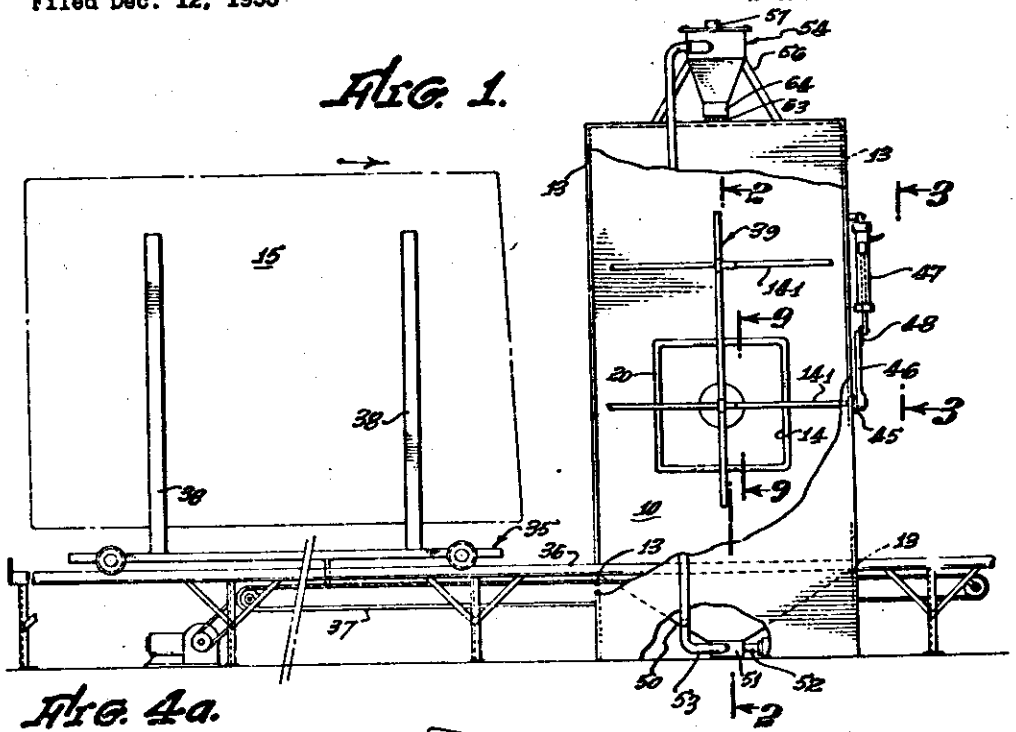


FIG. 4a.

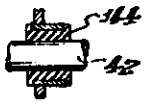


FIG. 2.

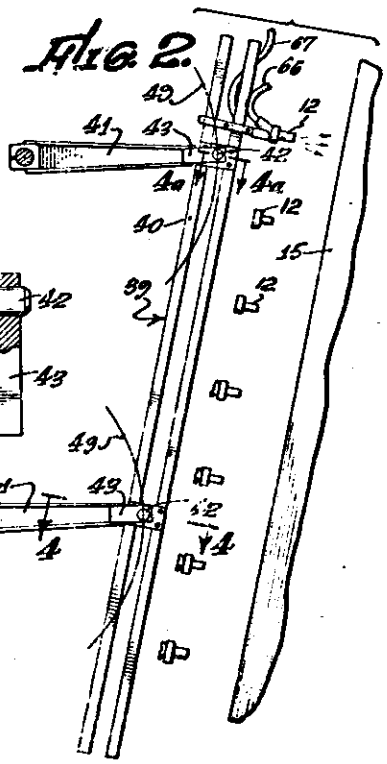
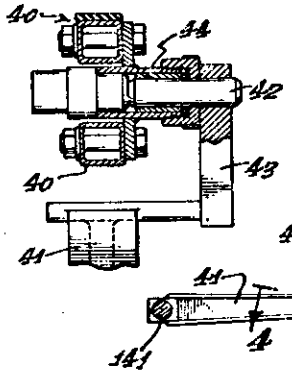


FIG. 4.



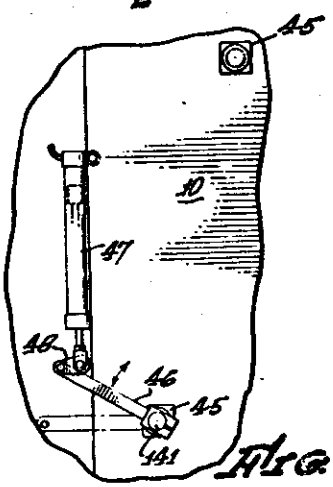


FIG. 3.

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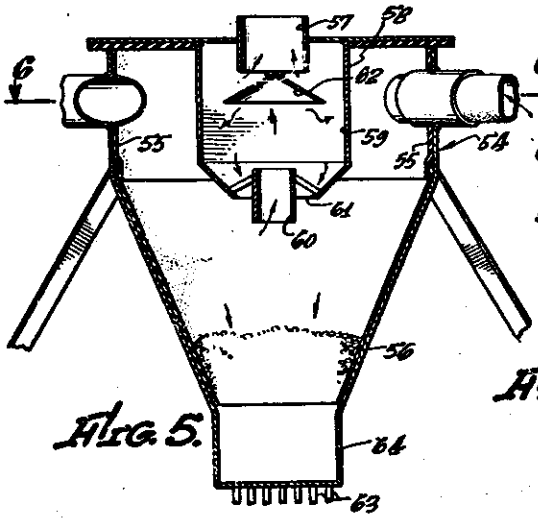

FIG. 5.

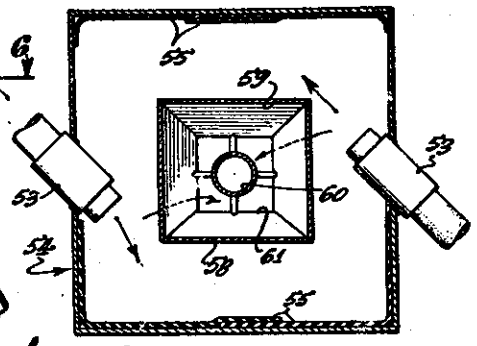

FIG. 6.

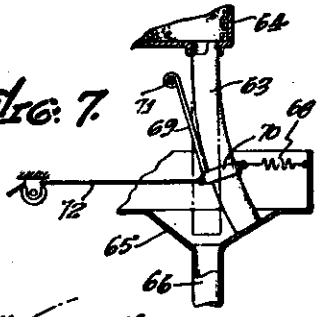

FIG. 7.

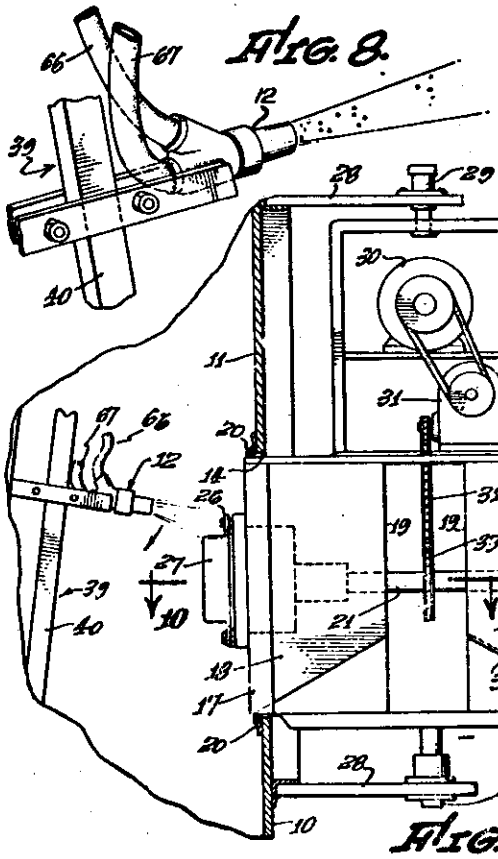

FIG. 9.

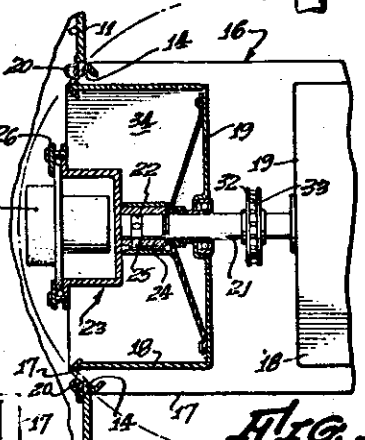

FIG. 10.

FIG. 8.

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