

March 29, 1966

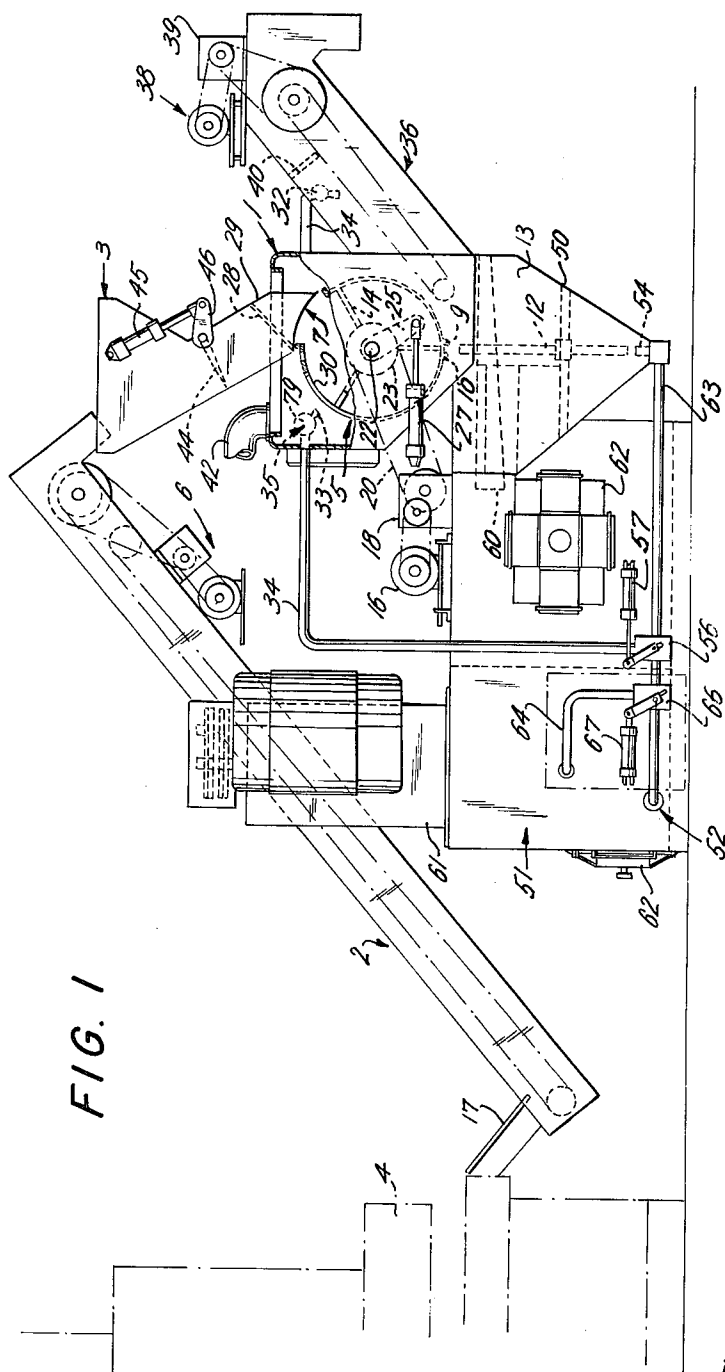
P. KOSAR

3,242,618

METHOD FOR SURFACE TREATING ARTICLES

Filed Nov. 7, 1961

3 Sheets-Sheet 1



INVENTOR.
PETER KOSAR

BY

Curtis, Morris & Safford
ATTORNEYS

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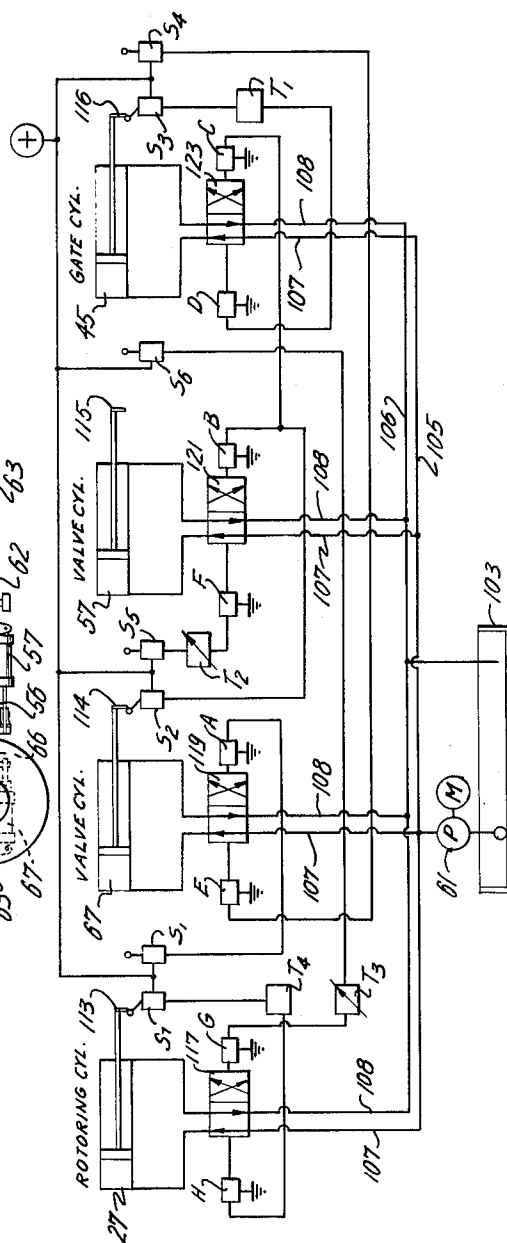
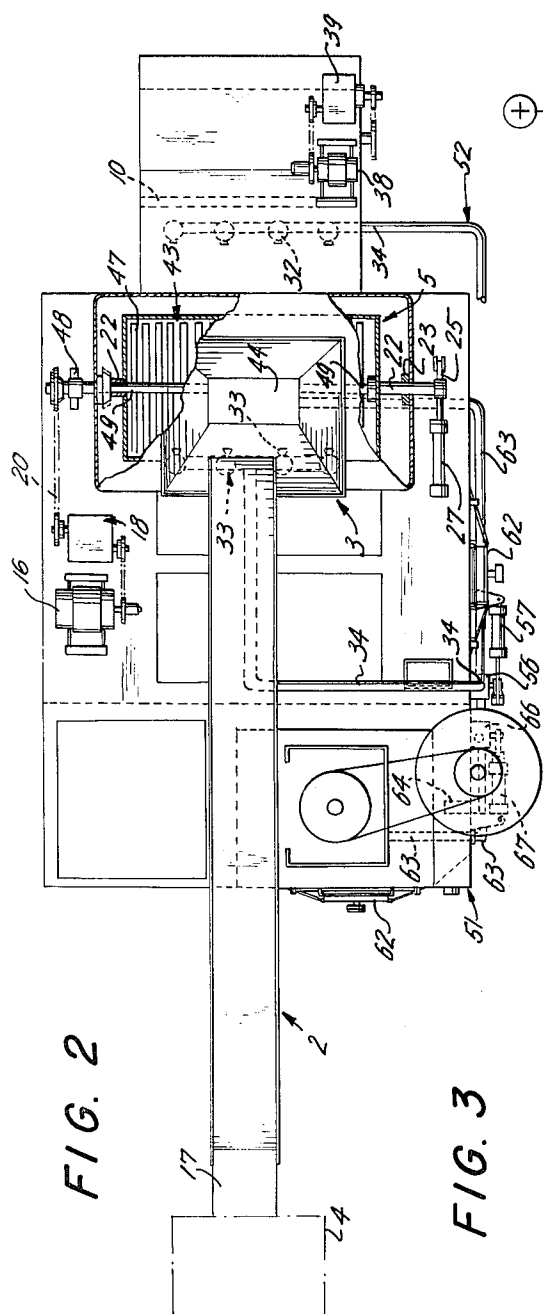
P. KOSAR

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METHOD FOR SURFACE TREATING ARTICLES

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INVENTOR.
PETER KOSAR

BY

Curtis, Morris & Safford
ATTORNEYS

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FIG. 4

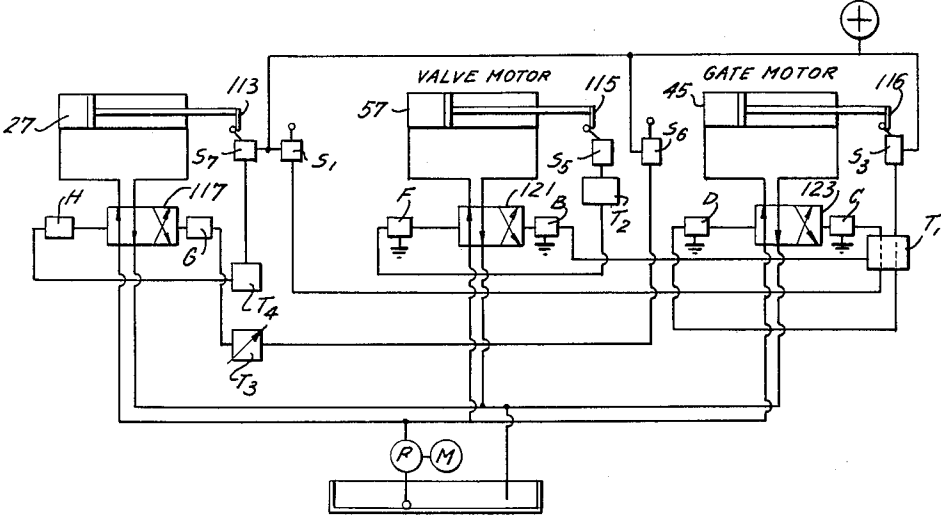


FIG. 5

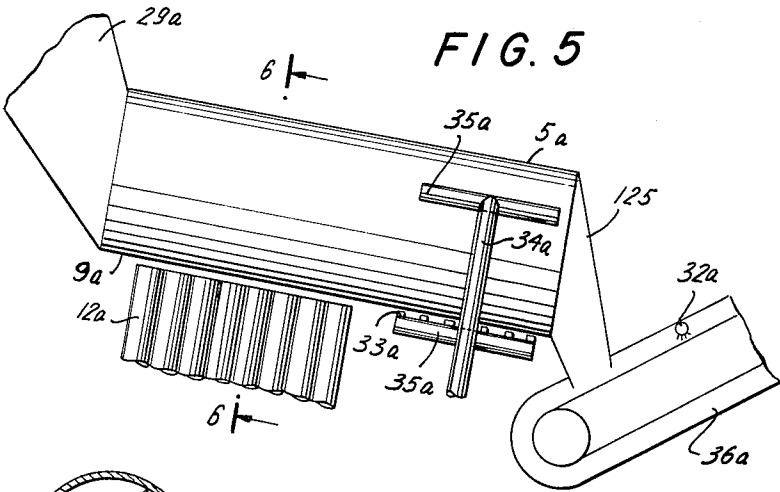
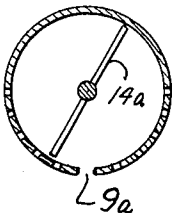


FIG. 6



INVENTOR.
PETER KOSAR

BY
Curtis, Morris & Safford
ATTORNEYS

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3,242,618

METHOD FOR SURFACE TREATING ARTICLES

Peter Kosar, Garden City, Mich., assignor to Ajem

Laboratories, Inc., Livonia, Mich.

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7 Claims. (Cl. 51—321)

This invention relates to surface treating manufactured parts, etc., more particularly, to liquid grit blasting methods, wherein the grit is driven at high velocity by a liquid.

The invention utilizes high energy imparted to grit particles for surface re-forming of metal hereinafter described as embodied parts, especially for rearranging or altering the surface molecules of the surface material. Thus the grit particles abrade,peen, or otherwise remove or deform the surface and thus form a new surface, alone or by cooperation with chemical action of the liquid. The liquid also takes active part in the process by cushioning the impacts of the grit particles, covering the freshly exposed surface material, and catching and carrying off the debris of the process.

Surface treating by liquid suspended abrasive impingement techniques is effected by entraining grit, for example, steel shot, chopped wire fragments, or machining chips, aluminum oxide, corundum, or other hard grains, etc., in a high velocity liquid and impinging it upon surfaces of parts to be treated. In many instances, chemical solutions are used as the entraining medium to simultaneously clean or passivate, or plate or protect the surfaces of these parts, at the instant fresh metal is exposed, by the abrasive or peening action. Apparatus employing these techniques have been previously disclosed in Patent No. 3,150,467, applied for February 19, 1960, by Umbricht and Johnson, and Patent No. 3,146,550, applied for July 7, 1961, by Millhiser, Panzica, Umbricht, and Evans. In the present invention I am more particularly concerned with facilitating the blasting and flush-off treatment of smaller manufactured parts and in treating a larger number of parts more rapidly and economically and especially with automatic production practices not requiring accurate location or clamping, etc. of each part.

In carrying out my invention, one may take manufactured parts randomly from a production line, or temporary storage, to grit blasting apparatus used in carrying out this invention because the apparatus moves and turns the parts during blasting, and moves them alternately into the blast and into the lee of other parts or obstructions in the treating chamber, e.g., a perforated drum wherein they are continuously shifted and tumbled, until all areas of their entire surfaces have been exposed to the processing; the treatment is most effective and uniform, yet requires no handling or manual control.

Liquid-grit blasts for surface treating the manufactured parts are introduced into the treating chamber for a predetermined timed interval, here designated "the active treating phase" of the processing cycle. Subsequently, jets, or flushing streams, of wash liquid are introduced into the same treating chamber to remove all dirt and debris released from the treated parts. After being thus washed, the fully treated parts are ejected from the common treating chamber and dried, and are carried off for further processing in the production line, or for delivery to users, etc.

The active treating phase of the cycle in the apparatus is advantageously controlled by automatic timer mechanisms so that the manufactured parts which have been blasted, shifted and tumbled in the treating chamber receive uniform treatment of their entire surfaces and then are discharged and replaced by a new batch.

In this specification and the accompanying drawings, a preferred embodiment of this invention is described and

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shown; and in addition, certain alternatives and modifications have been suggested. These are selected and set forth for purpose of illustration in order that others skilled in the art can fully understand the invention and the principles thereof and will thus be enabled to further modify it and embody it in a variety of forms, as may best be suited to the conditions of each particular use.

In the drawings:

FIGURE 1 is a diagrammatic side elevation, partly in phantom, of a surface-treating apparatus used in carrying out this invention.

FIGURE 2 is a top plan view, part in phantom, and with parts of the housing and paddles broken away, of the apparatus of FIGURE 1.

FIGURE 3 is a schematic diagram of a hydraulic control system for the apparatus of FIGURES 1 and 2.

FIGURE 4 is a view similar to FIGURE 3 but simplified by omission of one valve and its operating solenoids valve etc.

FIGURE 5 is a fragmentary diagrammatic detail view showing a modification upon the structures of FIGURE 1; and

FIGURE 6 is a cross-sectional detail taken on line 6 of FIGURE 5.

As shown in FIGURES 1 and 2, the apparatus used in carrying out this invention is positioned to receive parts from a conveyor 2, a temporary storage station 3 or directly from a production line or machine, etc., 4, for example, a press. The parts ejected from this press, as shown, are carried to the treating chamber of the surface treating apparatus 1, with or without intermediate accumulation in the temporary accumulating hopper 3. Conveyor 2, as shown, is driven by an electric motor and speed reducer unit 6. When these parts have been fully treated in chamber 5 and washed, they are discharged to another manufacturing stage, not shown, or are discharged for sale and shipment.

The treating chamber 5 as shown here is a cylindrical perforate drum having an upper opening 7 for receiving from the hopper 3 the articles to be treated, and at its bottom slot or slots 9, which, when aligned over blast tubes 12, provide entry for the liquid-grit blast. Flanges 10 are shown at the sides of the slot 9, but are not essential to the effective blasting.

Arcuate slots 30 are provided in an upper part of the drum for entry of flushing jets as set forth below.

Within the chamber 5 is rotatably mounted a paddle wheel 14 driven counterclockwise, as seen in FIGURE 1, by motor 16 through speed reducer 18 and V-belt and drive pulleys, or sprockets and chains 20.

The treating chamber 5 is rotatably supported within a housing 1 by hollow trunnions 22—22' mounted on opposite ends coaxial with the chamber. Trunnions 22 operate in bearings 23 supported in an opposite walls of housing 1. At one end of the chamber 5 is driving arm 25 connected thereto. This driving arm 25 is connected by a clevis to a hydraulic cylinder motor 27 which, when extended and retracted, rocks the treating chamber 5 back and forth through a limited arc about its longitudinal axis.

When cylinder 27 is extended to normally position chamber 5, the feed opening 7 is aligned under chute 28 to receive articles from hopper 3; and ingress vents 9 for the surface treating blast from tube 12 are bottomed in alignment with blast tubes 12. The treating chamber 5 is also provided with a number of transverse arcuate slots 30 aligned with jets 33 for washing liquid generated by washing system 34, hereinafter described.

The circumferential width of slot 9 is smaller than the width of the articles being treated, so as to prevent their falling out from chamber 5, for example, 4 inches when the articles have a width of 5 inches. This allows ingress to the liquid grit blast while preventing the escape of the

articles from chamber 5. The pair of flanges 10 protect the edges of slot 9 from abrasive and can be easily replaced if they are objectionably abraded.

Opening 7, on the other hand, extends over an arc, for example of 40°, sufficient to pass the articles when loaded into and discharged from chamber 5. When cylinder 27 is retracted to rock chamber 5 in a clockwise direction, opening 7 is sided (moved to a position at one side) over an enclosed discharge conveyor 36 operated by motor 38 through gear reducer 39.

A resilient curtain 40, e.g., of neoprene, serves as a partition within the housing of conveyor 36 to contain any splash or spray or vagrant grit particles and ducts 42 leading to a continuous exhaust fan or blower draws off such vagrant particles to prevent contamination of the surrounding atmosphere.

A feed conveyor 2 continuously driven by a motor and gear reducer unit 6, elevates and feeds into a hopper 3 the articles to be treated. This feeding from hopper 3 is controlled by gate 44 to accumulate parts for loading into treating chamber 5. The gate 44 is actuated by a hydraulic motor 45 acting on crank arm 46. A resilient curtain 28, e.g., of neoprene, may be used in chute 29 to further block escape of spray and grit from the apparatus. This curtain is sufficiently flexible to pass, be pushed aside by the articles being fed to chamber 5 from the hopper 3, and sufficiently resilient to snap back into place across chute 29 when such articles have passed by.

While opening 7 is thus sided, the paddle wheel 14 continues to rotate, pushing the treated articles up to and over the lower edge of opening 7. In addition to the aforesaid discharge function, the paddle wheel 14 is operative during blasting and washing to push and tumble the articles over the slot 9 and over each other to give intermittent blasting of all surfaces of said articles.

The paddle wheel 14, as shown in FIGURE 1 has longitudinal paddles to push the articles along. In FIGURE 2 is shown an alternative paddle wheel in which long spaced fingers are secured to shaft 49. These fingers extend close to the inner wall of chamber 5.

One end of shaft 49 is journaled at the inner face of one end of chamber 5; the other end of shaft 49 is journaled coaxially in the hollow trunnion 22 and is further supported in an external bearing 48.

The clarification system comprising sump 50 and tank 51 and overflow trough 60, and the high pressure liquid system 52 for supplying the liquid to grit blast 54 and the washing and flush down jets 32-33, are not new with this invention, but are advantageously of the types described in the above-identified patent applications. The sump system shown includes a sump 50 with downwardly converging sides, which also serves as a separator and reservoir for surface-treating grit. The particles of grit gravitate to the bottom of sump 50, and together with some of the liquid in the sump are entrained by high-velocity jets of aqueous liquid, for example chemical solution, forcefully ejected through jet nozzles 54 on a liquid pressure manifold 63 in the pressure liquid system 52. The pressure liquid is directed to this manifold from a pump 61 by a diverting valve 56 in the system 52, so that the velocity and inertia of the liquid flow is maintained, while the blast is cut off, the flow then being diverted into the washing portion 34 of system 52, or if desired back into sump 50.

Blast tubes 12 are supported in alignment with and spaced slightly above the nozzles 54, respectively, and are directed to the slots 9 by horizontal braces, shown in phantom lines on FIGURE 1.

These blast tubes 12 are open at their lower ends near the bottom of sump 50 and just above jets 54 so that the jets drive into the tubes settled grit and ambient liquid as well as the liquid of the jets themselves. All this passes upwardly at high velocity through the tubes 12 and the slot 9 to impinge with high energy upon the articles in chamber 5 as they are continuously shifted and tumbled over the slot 9 by the rotating paddle wheel 14.

The diverting valve 56 is controlled by a hydraulic cylinder motor 57 to alternately direct the liquid to the manifold for the jets 54 and to liquid pressure manifolds for the washing jets 32 and 33. The liquid directed into the washing part 34 of system is forcefully ejected as flat jet streams (or a long series of narrow jets side by side) through a number of jet nozzles 32, e.g. of the type set forth in Patent Nos. 2,778,685 and 2,760,825, each aligned with one of the washing slots 30 and passes through them into the chamber 5.

The liquids, together with used grit particles and dirt and debris removed from the parts during both the active treating and washing phases, drain from the chamber 5 into sump 50. The chamber 5 is provided with holes adapted to facilitate this drainage but too small to allow the articles being treated to fall through. The material which drains back into sump 50 through these holes is separated to recover for reuse at least some of the liquid and solids thereof. As shown, some of the solid matter gravitates into the vicinity of the nozzles 54 where it is taken into blast tubes 12, as already described, and some of the liquid overflow is collected in trough 60, e.g., after settling, in a clarification tank 51 or filtration, and is then pumped at 61 into the high pressure liquid system 52. The clarification tank 51 is shown as having a pair of water-tight doors 62 for cleaning and maintenance purposes.

Liquid from this clarification tank 51 is driven through the system 52 by a motor driven, high pressure, high capacity, liquid pump 61. The impeller of this pump extends into the liquid in tank 51.

As shown in FIGURE 1, the output of pump 61 through pipe 63 is controlled by a second diverting valve 66, operated by a hydraulic motor 67 to divert liquid away from the blast system 54, 12 etc., along a by-pass pipe 64 to the tank 51 or along the washing part of the system 34 when the apparatus 1 is not operating. This diversion of the liquid flow by valves 56 or 66 is very advantageous, as it avoids "water hammer" effects which would result from suddenly turning off the flow from a high-pressure line.

One system of hydraulic control for such a machine is shown in FIGURE 3, as exemplary of various control systems including pneumatic, electrical, etc., which may be employed. In the interest of simplification, the components and connections of the system are shown diagrammatically. Solenoid-operated control valves are shown at 117, 119, 121 and 123 associated with the rocking cylinder 27, diverting valve cylinders 57 and 67 and gate cylinder 45, respectively; the arrows included within each of the control valves indicate the cross connections for flow of fluid pressure to the motor cylinders through the slide valves represented, when operated by their respective solenoids A, B, C, D etc.

The hydraulic system, as shown, includes a liquid reservoir 103 from which liquid is drawn and raised to effective operating pressure by the motor-operated pump 61. The pressure fluid is distributed by a pressure manifold 105 and, after use in the various control cylinders, is returned to the reservoir through a return manifold 106. The pressure manifold 105 and the return manifold 106 are connected to the respective control cylinders by connections 107 and 108. The control valves 117 through 123 are interposed to reverse the hydraulic fluid flow so as to either extend or retract the respective control cylinders.

Assuming for purposes of description that a previous processing cycle has been completed and rocking motor 27 is fully extended to put cylinder 5 in its normal position for grit blasting, whereby the opening 7 is disposed beneath chute 29 to receive the accumulated parts from hopper 3, a flange 113 carried on its piston rod engages and operates a switch S1 to complete an energizing circuit for solenoid A.

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Solenoid A, when energized, operates control valve 119 to retract the valve motor 67 to draw the control arm of valve 66 and divert liquid from the liquid conduit system 63 to the clarification tank 51 through the by-pass 64. At this time, therefore, the sump system 63 and the washing system 34 are both cut off and no spray or mist is generated within housing 1, and any remaining in the housing is rapidly exhausted by the exhaust ducts 42 before the gate 44 is opened.

This retraction of valve motor 67 causes flange 114 carried on its piston rod to engage and close switch S2. Switch S2, when closed, completes energizing circuits for solenoids B and C concurrently.

Solenoid B operates the control valve 121 to retract valve motor 57 and swing to the right arm of diverting valve 56, which thereby is disposed to direct pressure liquid along pipe 63 to jets 54 for the grit-blasting phase of the processing cycle (but for the moment no liquid passes, as it is diverted at 66).

At the same time the retraction of valve motor 67 energizes solenoid C to operate the control valve 123 to retract gate cylinder 45 so as to draw back arm 46 and open gate 44, whereby the accumulated parts are discharged from hopper 3 along chute 29 and into chamber 5 through opening 7.

A flange 116 carried on the piston rod of the gate operating motor 45 engages and operates switch S3. This switch, when operated, starts timer unit T1 which interposes a delay sufficient to insure that hopper 3 has been fully discharged and then completes an energizing circuit for solenoid D. Solenoid D, when energized, operates control valve 123 to the position shown in FIGURE 3 in which pressure on the piston extends the piston rod to close gate 44, whereby subsequent parts directed along the continuous conveyor 2 are accumulated.

The loading of parts into chamber 5 is complete when this extension of gate operating motor 45 occurs; therefore, when extended, the flange 116 carried on the piston rod engages and operates switch S4 to complete an energizing circuit for solenoid E. Solenoid E, when energized, operates control valve 119 to extend the valve motor 67 to swing the control arm of diverting valve 66.

This diverts the pressure liquid from the by-pass 64 through the valve 56 to the pressure liquid manifold 63 whereby the jet streams are established at 54 to generate the grit blast in tubes 12. The surfaces of each of the parts as it is tumbled into a position over the slot 9 by the revolving paddles 14 then receive the full impact of the grit blast to effect the desired treatment.

The duration of the blasting phase of the cycle is accurately controlled by a timer unit T2. This timer is started by valve motor 67 extending its flange 114 so that it operates switch S5. When timer T2 has run to the end of its prescribed delay, it closes the circuit of solenoid F, to operate control valve 121 to the position shown in FIGURE 3, which extends the valve motor 57 and thus cuts off the blast jet 54. Timer T2 is preferably adjustable (as indicated by the diagonal arrow) so as to control conveniently the degree of surface treatment effected.

When motor 57 is thus extended, it initiates the washing phase of the cycle by diverting into the pipes 34 and to the washing jet nozzles 32 and 33 the liquid flow from pump 61. The jets 33 pass through the arcuate slots 30 into chamber 5 and thoroughly wash the treated parts. Jets 32 likewise wash the parts as they pass up on the conveyor 36.

Flange 115 carried on the piston rod of motor 57, at the end of its stroke, engages and closes switch S6 to start timer unit T3 which controls the duration of the washing and parts discharge. At the end of its delay period, timer T3 completes an energizing circuit for solenoid G.

Solenoid G, when thus energized, initiates the discharge phase of the cycle by moving control valve 117 to the left, as seen in FIGURE 3, which connects the pressure

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supply so as to retract cylinder 27, thus drawing the arm 25 to the left and rotating chamber 5, for example approximately 90°, in a clockwise direction about its longitudinal axis. The washing phase and the discharge phase of the cycle may be concurrent or overlapping in time.

So long as the cylinder 57 remains extended, the washing liquid stream for the washing jets continue to flow through valve 56.

The washing slots 30 extend over an arc, e.g., of approximately 90°, so as to allow ingress to the clarified jet streams while chamber 5 is rocked position to the discharged position.

While the rotating cylinder 27 is retracted, the paddles 14 continuously revolve in a counterclockwise direction to spill the treated parts over the lower edge of the slot 7 and onto the second conveyor system 36, which carries them up under the washing jets 32 to complete the removal of surface contaminants. Washing jets 32 may be supplied, e.g. with clarified liquid, to the extent desired.

The used liquid and surface contaminants drain back along the base of conveyor system 36 to the sump 50.

As suggested above, valve 66 and its motor 67 can be omitted and the flow of pressure liquid be switched between 34 and 63 with no idle flow period. If this is done, the operation of the control system is altered to some extent, and certain of the connections must be altered as shown in FIGURE 4. Comparing this FIGURE 4 with FIGURE 3, it will be evident that valve cylinder 67 and its operating valve 119 with solenoids A and E, its pressure fluid connections 107 and 108 and its switch S-2 and the switch S-4 associated with the gate motor 45 are omitted. A switch S-1 instead of being connected to solenoid A is now connected to solenoids B and C and through switches in timer T-1 (thus taking over functions of S-2). The switch S-5 and its timer T-2 are positioned to be operated by the finger 115 on retraction of valve motor 57, instead of upon extension of motor 67 as shown in FIGURE 3.

The operation of this modified control system is in most respects the same as that shown in FIGURE 3, but is significantly altered, being as follows:

Starting once more with the discharge of articles from a previous cycle of operation, the motor 27 is extended by shifting valve 117 to the right. This motor swings the arm 25 to rotate chamber 5 so that the feed opening 7 is aligned under chute 29. At the end of the stroke, the finger 113 closes switch S-1, in the circuits to solenoids B and C, respectively. These circuits both go through switches on timer T-1; of which that for C has been left closed at the end of the previous cycle, while that for B is still open.

When solenoid C is energized by closing of switch S-1, it shifts valve 123 to the left and thereby retracts motor 45 to open the gate 44 and allow articles to feed down chute 29 into chamber 5.

The finger 116 on the piston rod of motor 45 closes switch S-3 to start timer T-1 operating. After this timer has metered a substantial delay for at least partial feeding of the articles to be treated (but advantageously less than the full delay period of the timer) it closes the circuit to solenoid B. The valve 121 is thus moved to the left and the valve motor 57 is retracted, diverting to the blast jet 54 the flow of liquid from the pump 61.

At the end of a further delay period metered by the timer T-1, to the end of the blasting treatment, the circuit to solenoids B and C will again be opened by T-1. This causes extension of motor 45 and the circuit to solenoid D will thus be closed at the switch S-3 and through timer T-1 to extend motor 45 and close gate 44, terminating the feed of articles to chamber 5.

When the valve motor 57 is retracted to start the blasting phase of the cycle, a switch S-5 is closed by finger 115. This starts a timer T-2 to determine the period for active treatment of the articles in the chamber 5. At the end of such period a switch in timer T-2 is

closed and a circuit is thus completed through switch S-5 and timer T-2 to solenoid F, which thereupon shifts valve 121 to extend motor 57 and divert the flow of pressure fluid away from the blasting jet 54 and through pipe 34 to the washing jets 32 and 33. Prior to the expiration of the blasting period, the timer T-1 will have opened the circuits of solenoids B and C but it continues to run for a short time after the end of the treating period, until the motor 27 has been retracted and the circuits of solenoids B and C are again opened at switch S-1. At this time the switches of these circuits within timer T-1 are again closed preparatory to another cycle and timer T-1 is at the end of its operation.

In the meantime, with the motor 27 retracted, the feed opening 7 is sided over the conveyor 36, and the treated articles are being pushed out through the opening 7 onto the conveyor. As the piston rod of motor 27 nears the end of its retraction, the finger 113 closes switch S-7, which starts timer T-4; and, after a delay sufficient for discharging all of the treated articles, it closes a circuit to solenoid H, thereby shifting valve 117 to the right and extending the motor 27 to start another cycle.

With this control, the liquid from the pump 61 is always flowing either through the blast jet 54 or through the washing jets 32 and 33. This, therefore, does not have the advantage of preventing a mist from flowing back into the feed chute during the feeding period of the cycle when the gate 44 is open. This, however, is not so serious that it cannot be tolerated.

The discharge of the cycle is advantageously controlled by a timer unit T-4 which is started on the engagement and operation of switch S-7 by flange 113 carried on the piston rod of motor 27. Thus the timer starts when the chamber 5 is moved to its discharge position with the slot 9 sided, and it is set for a sufficient time delay to allow all of the treated parts to be spilled from chamber 5. At the end of its time delay, timer T-4 energizes solenoid H to move control valve 117 to the right and thus supply pressure fluid for rotating motor 27 to return chamber 5 to its normal position for blasting. When motor 27 has been extended, flange 113 carried on its piston rod again engages and operates switch S-1 to complete the present processing cycle and initiate a subsequent processing cycle, as hereinabove described.

In FIGURES 5 and 6, I have shown in diagrammatic fragmentary views another modification from the embodiment shown in FIGURES 1 to 3. In this case, instead of batch operation with the chamber 5 filling and discharging at regular intervals and the pumped liquid being diverted from blast tubes 12 to wash jets 32 and 33 and back, I provide continuous operation in the chamber 5a. This chamber slopes from the loading end to the discharge end. Chute 29a feeds into the higher end of the chamber 5a and then the articles discharged from the opposite end fall into a discharge chute 125 which guides onto the conveyor 36a.

In the higher end near the feed chute 29a a series of blast tubes 12a are aligned with slot 9a in the bottom of the chamber 5a so that the parts are blasted through this slot in the same manner as during the blasting part of the cycle with the apparatus of FIGURE 1.

Beyond this the lower part of the chamber 5a a series of wash jets 33a on manifolds 35a are aligned with openings in the side of chamber 5a so that jets of washing liquid are projected into the chamber and onto the articles being treated as they are moved and tumbled around so as to present their various surfaces in different orientation to the grit blast and the washing jets.

In this modification, as shown in FIGURE 6, I have also used a diametric scraper adapted to move the articles being treated over the slot 9a and up on its side until its paddle blade causes them to slide or tumble down along the blade 14a to the opposite side, and then again is moved over the slot 9a on through the blasts from the tubes 12a, each time falling a little farther along the axial length

of the chamber 5a until they reach the washing area where they pass across the washing tubes 33a at the bottom and exposed to the downwardly directed jets from the manifolds 35a higher on the sides and finally to the washing jets 32a on the exit conveyor.

These embodiments hereinabove set forth, therefore, are particularly well suited for continuous in line production to effectively and uniformly surface treat the entire surface of a plurality of parts simultaneously at low unit cost, and does not require for its proper operation the intercession of human labor. However, this invention is adaptable to numerous applications as will be obvious to persons skilled in the art.

I claim:

1. A method of surface treatment of articles manufactured of malleable materials which comprises feeding the articles to the vicinity of a treating zone, accumulating the articles above said zone, intermittently releasing accumulated articles into said zone in successive batches, directing upwardly into each batch a blast of grit entrained in a liquid jet of sufficiently high velocity to effect surface reforming on said articles, randomly moving said articles into and beyond said blast and in randomly varying orientations thereto, whereby to effect said surface reforming, diverting the liquid flow from said high-velocity grit blast to washing jets directed into said batch of articles, and onto an exit path of said articles beyond a position in which they are blasted with said grit, dumping said articles from said position of exposure to said grit blast and conveying them along said exit path, stopping the discharge and again releasing a batch of articles into the chamber, diverting the liquid flow back to said high-velocity grit blasts and repeating the process.

2. A method of surface treatment of articles manufactured of malleable materials such as metal, which comprises conveying articles to the vicinity of a treating zone, directing upwardly into the bulk of said articles a blast of grit entrained in liquid of sufficiently high velocity to effect surface reforming on said articles and to repeatedly and randomly move said articles into and beyond said blast and in randomly varying orientations thereto, whereby to effect said surface reforming, thereafter cleaning said articles by directing thereagainst a jet of washing liquid, discharging said articles in successive batches from said chamber and conveying them away from said treating zone and continuing said treatment with a succession of batches of such articles, the grit blasting and washing being continuous and adjacent and the articles being continuously moved along a path which passes through both, whereby the surfaces of each article are randomly exposed to said grit blasting and then to thorough washing.

3. A method of surface treatment of manufactured articles which comprises accelerating and confining liquid into a high velocity jet, supplying to said jet and entraining therein a flow of grit, thereby imparting to the grit high energy for surface reforming of said articles and establishing a concentrated unidirectional blast of said grit and said liquid directed into a bulk of said articles, moving said articles in continuous succession along a path which brings their surfaces successively into and out of said concentrated blast while it continues uninterrupted, whereby they are subjected to reforming by said blast, whereby the force and abrasive action of said blast is exerted on said articles for re-forming their surfaces, and moving the articles to successively different orientations while shielding any adjacent apparatus and personnel from direct action of the blast by interposed articles of said batch.

4. The method as defined in claim 3 in which the blast is directed into a central part of a restricted treating space and a bulk of said articles is maintained in said space over said blast, whereby their combined mass opposes the force of the blast, and the force of the blast is sufficient

to cause the lowermost articles in the pile to be moved up and rotated.

5. The method as defined in claim 3 in which the blast is directed upward into a bulk of said articles in a confined space; the articles are continually pushed across the blast and along a surface which curves upward from said blast, whereby said articles are raised above the bottom of the chamber and tumbled back into said blast.

6. The method as defined in claim 3 in which the blast is directed at an oblique angle toward the direction of movement of said articles through said blast, whereby the articles are impelled along their path and tend to be rolled.

7. The method of treating articles for surface reforming which comprises entraining a flow of grit in a high velocity liquid jet whereby to impart to the grit high energy for said surface reforming and establish a concentrated liquid grit blast directed at an oblique angle toward the direction of movement of said articles through

said blast, moving said articles in continuous succession along a path counter current to, but at an angle to the axis of said blast, whereby they are subjected to reforming first by ricochet and peripheral portions of the blast escaping past another article, and then by direct impact of the blast.

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LESTER M. SWINGLE, *Primary Examiner*.

JOHN C. CHRISTIE, *Examiner*.