United States Patent Office

3,485,073
Patented Dec. 23, 1969

3,485,073

INTERNAL PEENING APPARATUS

Harold W. Burney, Hackensack, N.J., assignor to Metal Improvement Company, Carlstadt, N.J., a corporation of New Jersey

Filed May 10, 1966, Ser. No. 548,976
Int. Cl. B24c 3/16
U.S. Cl. 72—53 12 Claims

ABSTRACT OF THE DISCLOSURE

The disclosure relates to apparatus particularly suited and arranged for treating and peening the interior surface of a workpiece. A tubular lance device from which peening shot are ejected is extended along an axial path relative to the workpiece for both reciprocatory and rotary motion. The shot are ejected under fluid pressure from a nozzle located at one end of the lance so that the path of ejection is normal to the surface of the workpiece being treated.

This invention relates to peening apparatus. It is particularly adapted for peening the internal surfaces of various components where access is very difficult, but where it is important to strengthen the internal surfaces. The peening effect of shot impacting the treated surface at relatively high velocity gives an effect similar to cold working of the metal.

It has been extremely difficult in the past to provide a convenient and logical procedure for reaching internally of small tubular, cylindrical or hollow elements, because of the difficulties of space limitations in the type of article worked upon, and the necessity of accurately controlling both the volume or density of the shot used, as well as the velocity at which the shot strikes the surface to be worked. Further than this, because of the non-planar character of the impacted surface to be worked upon, it has, in the past, been difficult to obtain adequate uniformity of working over the entire range, particularly where the ejected shot often travels over substantially different path lengths prior to the actual impact. Further, in the past, such surfaces were often peened by rotating the work about the peening nozzle. This operation often required excessive working space and became completely uneconomical, particularly where only a small portion of a large article required peening.

The apparatus here to be described and claimed will set forth particularly its use for peening the internal surfaces of tubular elements or hollow generally cylindrical elements, such as cylinders, tubing, connectors, ducts, pipes or the like. In its preferred form, the peening apparatus here to be described embodies a tubular lance element having a peening head or nozzle attached at one end thereof. The peening head and the end of the lance to which it is attached are positioned internally of the surface region which is to be worked upon. The work is preferably carried upon and clamped to a support surface or plate within which numerous openings are provided and about one large opening of which the work is generally centered, with the lance being adapted to be moved in both a rotary and a reciprocating path through this large opening. The lance may be supported relative to the work-support plate so that when it protrudes through the large opening therein, it will be held in a substantially fixed relationship laterally relative to the work. The lance, with the peening nozzle secured thereto, is rotated internally of the work at a selected rotational sped and simultaneously reciprocated through a selected number of cycles or strokes per unit time period. The rotation and reciprocation is achieved by supporting the end portion of the lance remote from the

nozzle from a platform, a suitable drive mechanism for providing rotation, as desired, being included. Normally, the lance is capable of being rotated in either a clockwise or a counterclockwise direction, as conditions demand. This is because in many peening operations it is often desirable that the peening nozzle and the lance shall each make some selected number of rotations within a selected time period following which the direction of drive and rotation may be changed, with the peening head and the lance turned in the opposite direction.

The support platform is motor driven and mounted upon or within a standard for slidable up and down reciprocation concurrently with lance rotation. Suitable limit controls of the up and down reciprocatory motion are provided so that the length of the reciprocating stroke may be selectively controlled.

In some forms of the apparatus, the lance-drive motor may be supported directly upon the platform which is reciprocated. The motor shaft may be hollow, where desired, so that the tubular lance may be fitted tightly therein. In this connection the peening shot and fluid are passed directly through the motor shaft from one side of the motor shaft from one side of the motor to the other. Alternatively, the motor shaft, if hollow, may connect to the tubular lance on one side and on the other side, may connect to a flexible feed connection by way of a swivel bearing. The feed connection is adapted to supply peening shot and fluid (such as air under a selected pressure) through the unit thereby eventually to discharge the shot and fluid outwardly through the nozzle to impact the work.

The apparatus usually comprises also a suitable means for gathering the shot ejected from the nozzle at a time subsequent to its ejection and impact upon the work to be treated. The used shot is thereby recovered and returned through a suitable cleaning component for recirculation. Following this plan, the cleaned shot is discharged to be mixed with the applied fluid, such as air, through a suitable mixing valve in order to be reused.

Normally, the connection from the mixing valve to the lower end of the lance is by way of a flexible cable so that the drive and reciprocating units for turning and reciprocating the lance may be driven freely in any desired fashion. The swivel bearing connection already described between the flexible supply element and the end of the lance permits the lance to rotate freely relative to the supply connection irrespective of the precise rate of rotation. Various modifications, of course, may be made within the spirit of what is herein described without departing from the spirit and scope of what is considered new and novel and which is defined by the claims later appended.

The invention has been illustrated in one of its preferred forms by the accompanying drawings wherein:

FIG. 1 is a top plan view of one preferred form of the invention;

FIG. 2 is a side elevational view taken approximately on the line 2—2 of FIG. 1 looking in the direction of the arrows;

FIG. 3 is a front elevational view looking at FIG. 1 approximately on the line 3—3 with the side closure door in open position;

FIG. 4 is an isometric view showing particularly the drive and lance movement;

FIG. 5 is an elevational view to show the work holder means secured to the top closure member through which the rotary and reciprocating lance is moved; and

FIG. 6 is a view in section showing the peening nozzle tip and the connection of the lance tube thereto.

Referring now to the drawings, and considering first the combination of FIGS. 1, 2 and 3, the lance tube 11 is positioned generally centrally of a framework compris-

ing pairs of side upright members 12 and 13 which connect to each other by a series of cross members 14, 15, 16 and 17. The upright side members and cross members form collectively an open frame member within which the lance is supported. A platform 20 is shown approximately in a mid-position along the upright frame. It is held by side members 21 and 22 for movement up and down along a pair of vertically positioned angle brackets 23 and 24.

The platform 20 is secured to a pair of bracket members 27 and 28 by suitably secured cross-members 25. Roller members 29, 30, 31 and 32 form end support elements adapted to rest and roll on the guide elements 27, thereby to move the platform, as a whole, up and down. A bracket 37 extends outwardly from the corner upright support 13 and is apertured to provide one guide or bearing point(not shown) for the control rod 38. The control rod extends upwardly adjacent to the side of the frame. At its upper end 39, the rod is secured by a suitable link attachment to a switch element 40 adapted to connect into a switching unit 41.

A second bracket 43 extends outwardly from the platform 20 and has an aperture at its outer end through which the limit switch rod 38 is passed. Collars 45 and 46 are secured about the limit switch rod 38 and spaced apart appropriate to establish, as will later become apparent, the stroke length of reciprocation of the lance member 11 which is carried from the platform.

The platform 20 is adapted to be held to and moved up and down by the connection thereto of suitable drive cables or V-belts 51 and 52. The drive cables attach to one end to the platform and then pass downwardly and around idler pulleys 53 and 54 which are carried by an idler shaft 55 whose ends are suitably supported in bearings 57 at opposite frame upright members. The drive cable 52 also wraps over a pair of drive pulleys 58 and 59 held on a shaft 60 carried in the upper portion of the frame. The shaft 60, on one side, protrudes outwardly from the frame and a pulley 62 is secured thereto for driving purposes through a cable 64. The cable also wraps about a pulley 65 secured at the end of the shaft 66 to the motor mount and assembly schematically represented at 67. The motor 67 drives into a gear box assembly 68 which determines the speed of rotation of the driving shaft 66 for the drive pulley 65.

The motor 67 is capable of being driven either forward or backward. For this purpose, the already mentioned switch element 40 and switch box 41 provide a control (not shown in the drawings). The cable 64 drives the pulley 63 attached to shaft 60 at a speed proportional to the rotational speed of the drive pulley 65. This, in turn, with the shaft 60 being secured in bearings 69 on the frame, establishes an up and down drive for the platform 20.

Reversal of the platform is established through the reversal of position of the switch 40 of the switch box 41, as determined by the position of the collars 45 and 46 on the rod 38 which are contacted by slider 72 which is secured to the V-belt 51. Cushioning of the movement of the limit switch rod 38 is provided by spring members 70 and 71 whose position is established by the locating collar 46 and a second collar 73. So arranged, the platform 20 and the motor 91 carried thereby for turning the lance element 11 is adapted to be moved up and down in a reciprocating path of selectively fixed stroke lengths, the path length being determined, as above noted, by the spacing between the collars 45 and 46 to bring about a reversal of drive of the belts 51 and 52, as described.

At the same time that the assembly is being moved up and down, the motor 91 is permitted to rotate thereby to drive the lance in either a clockwise or counterclockwise direction determined by the direction of motor rotation. The motor 91 is preferably of the worm-geared type to drive the lance at any desired rate. For one satisfactory operation this was at 86 r.p.m., although this valve is purely illustrative and not limiting. Peening shot moved forward under the influence of a supplied fluid pressure (such as compressed air) are supplied by way of the flexible hose-like connection 97 which connects with an extension 98 of the motor shaft through the swivel joint 99. The lance 11 may extend directly through the hollow rotor shaft (not shown) of the motor 91 or the interior of the hollow rotor shaft may be formed of hardened material so that the shaft itself forms a passageway for peening shot and fluid to pass therethrough to the lance 11. In either instance, a swivel connection, such as 99, is desirable to preclude all possibility of the connection twisting and accidental shut-off. At the same time the swivel provides an easy connection of a very satisfactory type.

The peening shot which are supplied through the connection 97, are made available from a supply 101 fed down through a valve 102 of any desired character to be mixed in the mixing chamber 103 into which fluid under pressure is also supplied by way of the indicated connection 104. Depending upon the pressure adopted and the opening within the valve 102, the amount of peening shot fed outwardly from the supply 101 may be determined.

It is often desirable in a peening operation of the character here set forth that the lance tube and the nozzle carried thereby shall make a fixed number of revolutions in one direction during the course of movement up and down along the reciprocating path taken by the lance rod 11. A counting mechanism, conventionally shown at 105, provides this index. It also provides that after a count of some selected number, current will be fed into the counting mechanism to provide a reversal of current into the drive motor thereby to reverse it. Normally, controls may also be applied directly electrically by means of a panel box 106 having a series of buttons for the on and off control, as well as the forward and reverse in known fashion.

So far, in this description, only indirect mention has been made of the peening mechanism per se. The particular peening nozzle is shown in more detail by FIG. 6. This component in its preferred form is essentially cylindrical in shape and has its ejection portion or throat 108 shaped to follow an optimum shot ejection path. The nozzle per se is formed of extremely hard metal, usually a tungsten carbide composition. The nozzle is attached at the upper end of the lance in approximately the location indicated by FIG. 5 and shown further by FIG. 4. The diameter of this nozzle, considering the fact that the unit is particularly adapted for use on internal cylindrical surfaces, is just slightly greater than that of the lance tube so that when shot are forced upwardly through the lance tube 11 under the influence of pressure applied from a source (not shown), the shot which are within the lance tube 11 will be ejected first upwardly and then, upon striking the curved portion 109 of the internal wall of the nozzle, will be redirected along a path (usually substantially at a right angle) which is angular relative to the axis of the lance element. With this occurring, shot moving upwardly through the lance tube 11 reach the nozzle 107 with reasonably high velocity and are forced outwardly from the nozzle opening 111 in well known fashion.

It is important that the internal diameter of the lance tube be just slightly greater than the internal diameter of the base of the nozzle in order that the shot ejected from the lance and into the nozzle shall have a generally free path of movement except as that movement is charged by the nozzle shaping.

With the type of work adapted to peening, shown as the internal surface 115 of an assumed generally cylindrical or tubular inner surface characteristics (see FIGS. 5 and 6) the work is held securely to the top member 118 and arranged generally to surround an enlarged opening 119 in the top plate through which the lance protrudes.

As can be seen particularly from FIG. 5, the diameter of the opening 119 is substantially greater than that of the lance although, of course, less than the interior of the work piece 115 to be handled. For these conditions obtaining, shot ejected from the upper end of the lance tube into the nozzle first strike the interior of the work piece. There, the surface toughening occurs. The projected steel balls after impact on the surface to be treated then drop gravitationally onto the upper surface of the top member 118.

Some of the shot, after having been ejected to impact the internal surface of the work piece 115, return to the supply hopper or bin 101 by falling through the openings 120 in the top member 118. However, some shot, if quite small, may fall through the opening 119, provided this opening is sufficiently larger than the lance which extends therethrough. In the supply hopper, the used shot are cleaned prior to recirculation. The return to the supply hopper is schematically indicated by the gravitational drop provided by way of the path 123.

Various ways and means may be provided for holding the work to the top member 118 for action by the peening jet. One form of work-holder has been schematically represented particularly in FIGS. 1, 3 and 5 where the work 115 is rested upon and held to the top plate. Clamping members 125 and 126 are rested upon the top plate 118 to extend outwardly from each side of the work. The clamp members have foot sections 127, 128 which are slotted (as indicated) and adapted to receive suitable fastening bolts 129. The upright sections of the clamping elements 125, 126 extend upwardly from the support and bend in a substantially L-shaped pattern to turn inwardly at 130 and 131. Each inwardly turned section has an internal edge which is adapted to fit over and clamp to the work. These inwardly turned sections 130, 131 have laterally and outwardly extending arms 132, 133 which are adapted to be bolted together by suitable fastening bolts 135, 136 (see particularly FIGS. 1 and 5).

With the work 115 being placed within the holder to rest upon the upper plate 118, and the holder also held thereto in loosened position by the bolts 129, the support members are then moved inwardly along the slotted portions 127 or 128. Then, with the inwardly turned sections 130 or 131 brought into engagement with the work, the bolts 129 are suitably tightened thereby to hold the support member fixedly to the upper plate. At this time, the bolts 135 and 136 are also tightened thereby to hold the upper section of the work tightly to the clamp.

At times, it is desirable to provide an additional tightening element adjacent to the work and to fit between the work and the support on the top member 118. This is provided by a suitable shim or wedge-like structure conventionally represented at 137. This shim may be rigid or resilient. Its main function is to fill the space between the support and the work. The foregoing is merely illustrative of various ways and means that may be adopted to hold the work but the above described component is easily used and equally reusable thereby adequate for time saving in introducing new component parts.

The entire assembly may be housed or closed in by closure doors, as desired. One such closure door is represented particularly by the door 141 (see FIG. 1 for closed position) which is adapted to turn about hinges 142 on a support rod 143 thereby to move from the closed position of FIG. 1 to the open position of FIG. 3. The other sides of the casing likewise may be enclosed as desired. Further, by reason of the peening action, it is often desirable also to close off the upper section of the casing wherein the work is supported as indicated by FIG. 5.

Various other and further modifications may be made as will appear evident from what has been disclosed and as may be fully within the scope and spirit of the claims hereafter appended.

Having now described the invention what is claimed is:

1. Peening apparatus for peening the interior surfaces of a workpiece, said apparatus comprising

platform means for supporting the workpiece, said platform means having an opening so located as to be substantially centrally positioned relative to the interior of the workpiece supported thereby,

a tubular lance member,

means for supporting the lance member in substantially cantilever fashion so that the lance extends substantially along an axial path relative to the workpiece interior and is projectable interiorly of the workpiece along the axial path through the platform opening so as to make it movable to controllable positions interiorly of the workpiece,

a nozzle element having its inlet secured to the end of the lance member which is movable within the workpiece through said opening and having its outlet directed substantially normal to each of the axial paths of the lance member movement and to the interior of the workpiece supported by the platform,

motor means carried upon the lance support member and connected for rotationally driving the lance member and for providing substantially continuous power thereto, thereby to establish its rotation relative to a supported workpiece and to turn the secured nozzle at the free end of the cantilever lance member with lance member rotation,

motor means for also controlling the reciprocatory movement of all of the lance support means, the motor support, the lance and the nozzle movement along the axial path and the stroke length of movement of the lance and nozzle within the workpiece through the platform opening, and

means to supply peening shot under fluid pressure within the lance member for discharge through the nozzle during rotation and reciprocation, thereby to peen the workpiece interior.

2. The apparatus claimed in claim 1 wherein the work support for the workpiece is apertured to an extent more than that required for the movement of the tubular lance member therethrough to permit the return of shot ejected from the nozzle for reuse.

3. The apparatus as claimed in claim 1 comprising, in addition, means for controlling the reciprocatory movement of the lance support within adjustable limits.

4. The apparatus as claimed in claim 3 comprising, in addition, means to reverse the direction of drive of the motor at the end of each reciprocatory path of movement of its support means.

5. The apparatus claimed in claim 1 comprising, in addition, a flexible means and swivel joint means connected to the supported end of the cantilever lance member to supply peening shot and fluid under pressure therethrough for final ejection through the nozzle.

6. The apparatus as claimed in claim 2 comprising, in addition, shot gathering means positioned beneath the work support platform and its apertured region for gathering used shot for reuse subsequent to the shot ejection from the nozzle toward the supported workpiece.

7. The apparatus as claimed in claim 5 comprising, in addition, a rotatable coupling connection between the flexible supply means for peening shot and fluid under pressure to the supported end of the cantilever type lance element.

8. The apparatus as claimed in claim 1 wherein the lance rotating motor means is provided with a hollow shaft member and wherein the supported end of the lance member extends through the hollow motor shaft for making its connection with the flexible supply means.

9. The apparatus as claimed in claim 8 comprising, in addition, a plurality of upright frame members,

means associated with the lance support member and

also driven from the motor means for controlling the movement of the lance support means and the elements carried thereby in reciprocating fashion, and

means for reversing the motor direction together with the direction of rotation of the lance member and the nozzle carried thereby at the end of each controlled length stroke movement of the lance and nozzle.

10. The apparatus claimed in claim 9 comprising, in addition,

a slidable platform carried for up and down movement within the framework for guiding the same,

means carried by the platform for rotationally moving the lance member,

means carried by the platform for guiding the said platform in its up and down movement along the guide means, and

means for determining the length of reciprocating stroke of the lance movement.

11. The apparatus claimed in claim 10 comprising, in addition, a supply container,

means for supplying used shot to the container, and means for feeding cleaned used shot to the lance member.

12. The peening apparatus claimed in claim 1 wherein

the peening nozzle carried on the free end of the cantilever lance member comprises

a communicating passage between the entrance and exit ports having a curvature covering an arc of the order of 90°, the said curvature varying from a nominal curvature at the point of connection of the nozzle to the free end of the lance member and progressively increasing in curvature in the direction toward the exit port whereby peening shot forced through the lance member have minimal velocity reduction in the curved area of the nozzle and are projected outwardly from the nozzle in a direction substantially 90° from the lance axis.

References Cited

UNITED STATES PATENTS

2,041,209	5/1936	Ridley	72—56 X
2,041,355	5/1936	Koether	72—53
2,439,032	4/1948	Almen	29—90.80
2,900,765	8/1959	Blackburn	29—90.80

FOREIGN PATENTS

13,808	6/1925	Australia.

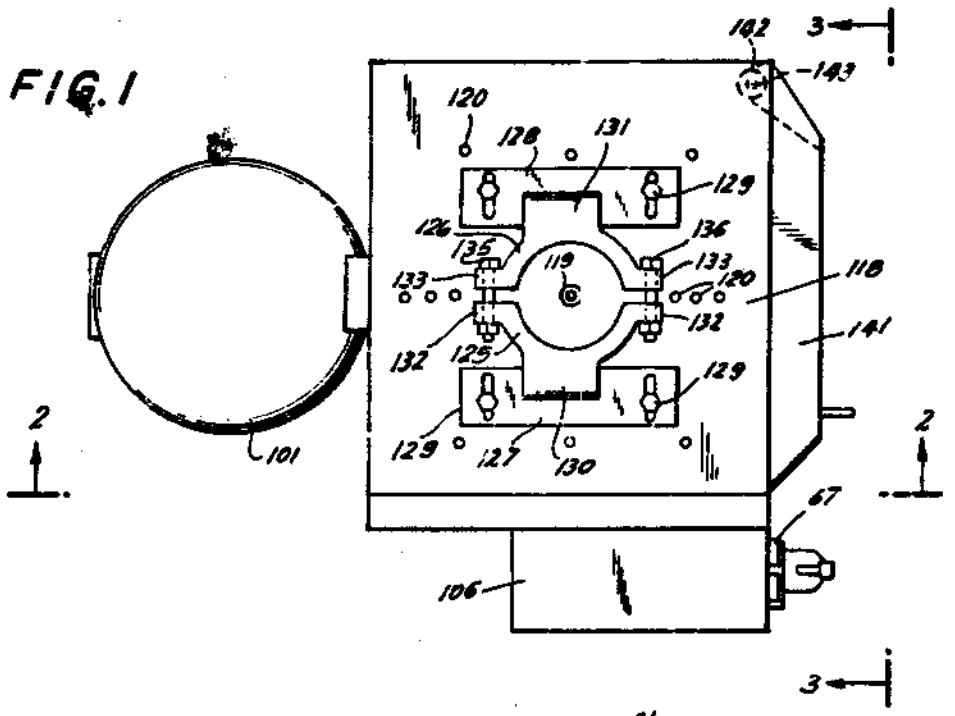
RICHARD J. HERBST, Primary Examiner

Dec. 23, 1969 H. W. BURNEY 3,485,073

INTERNAL PEENING APPARATUS

Filed May 10, 1966 4 Sheets-Sheet 1

FIG. 1



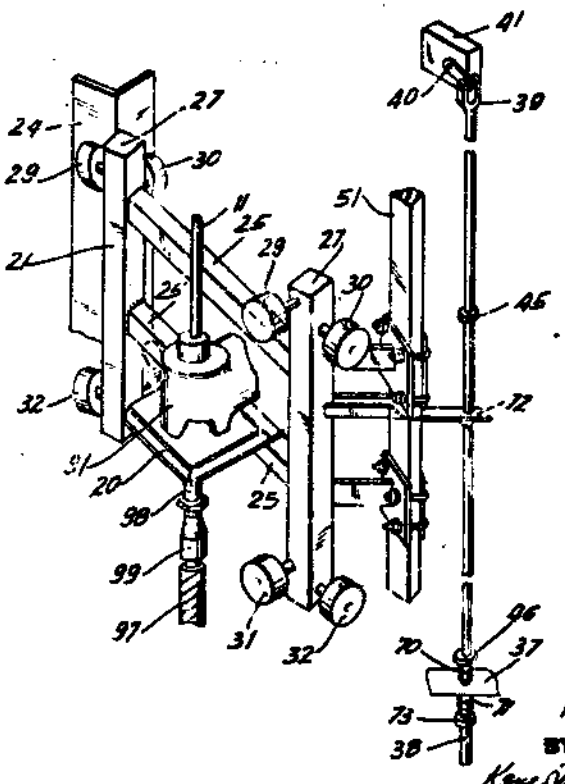


FIG. 4

INVENTOR
HAROLD W. BURNEY

BY
Kane, Dalsimer, Kane & Sullivan

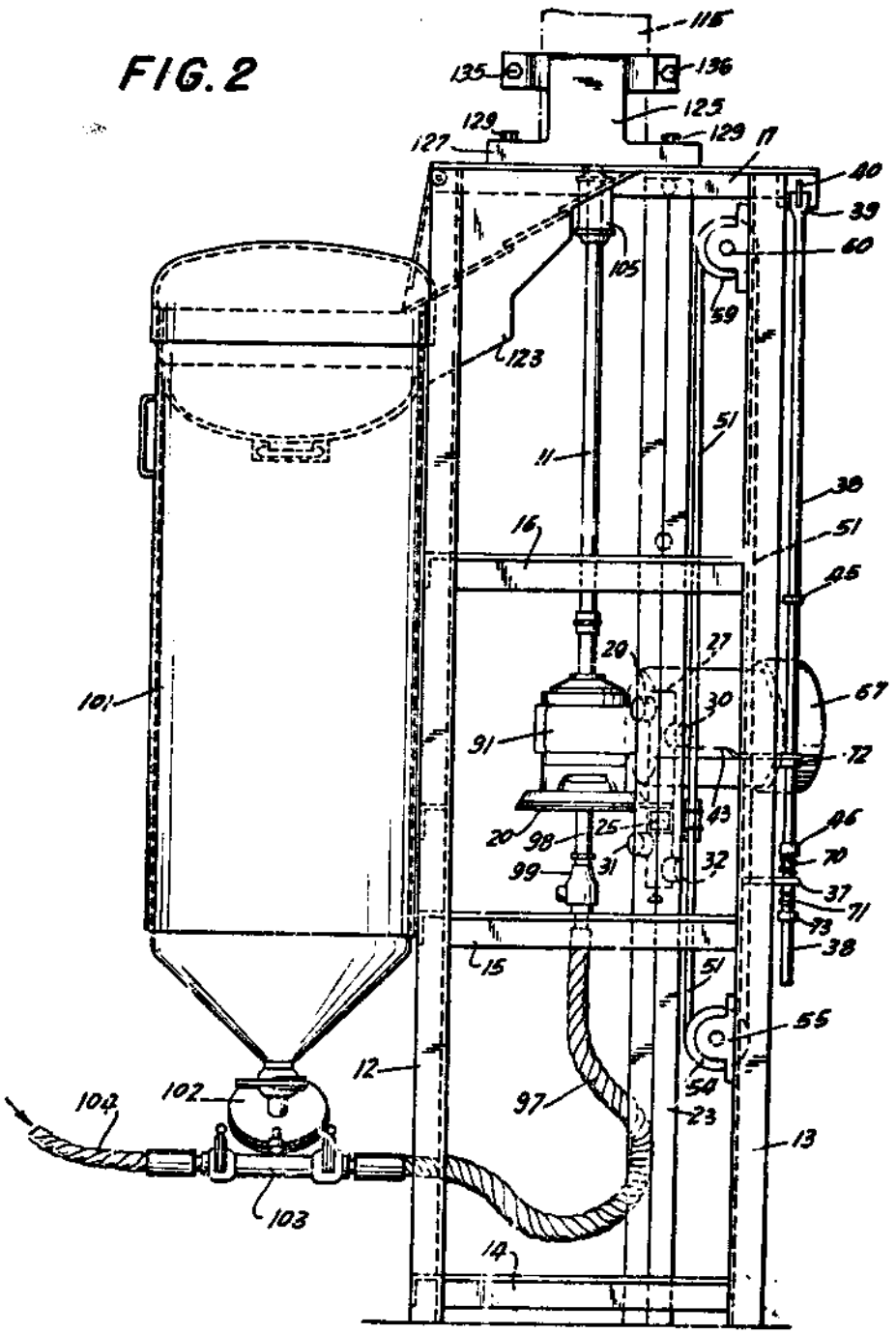
ATTORNEYS

Dec. 23, 1969 H. W. BURNEY 3,485,073

INTERNAL PEENING APPARATUS

Filed May 10, 1966 4 Sheets-Sheet 2

FIG. 2



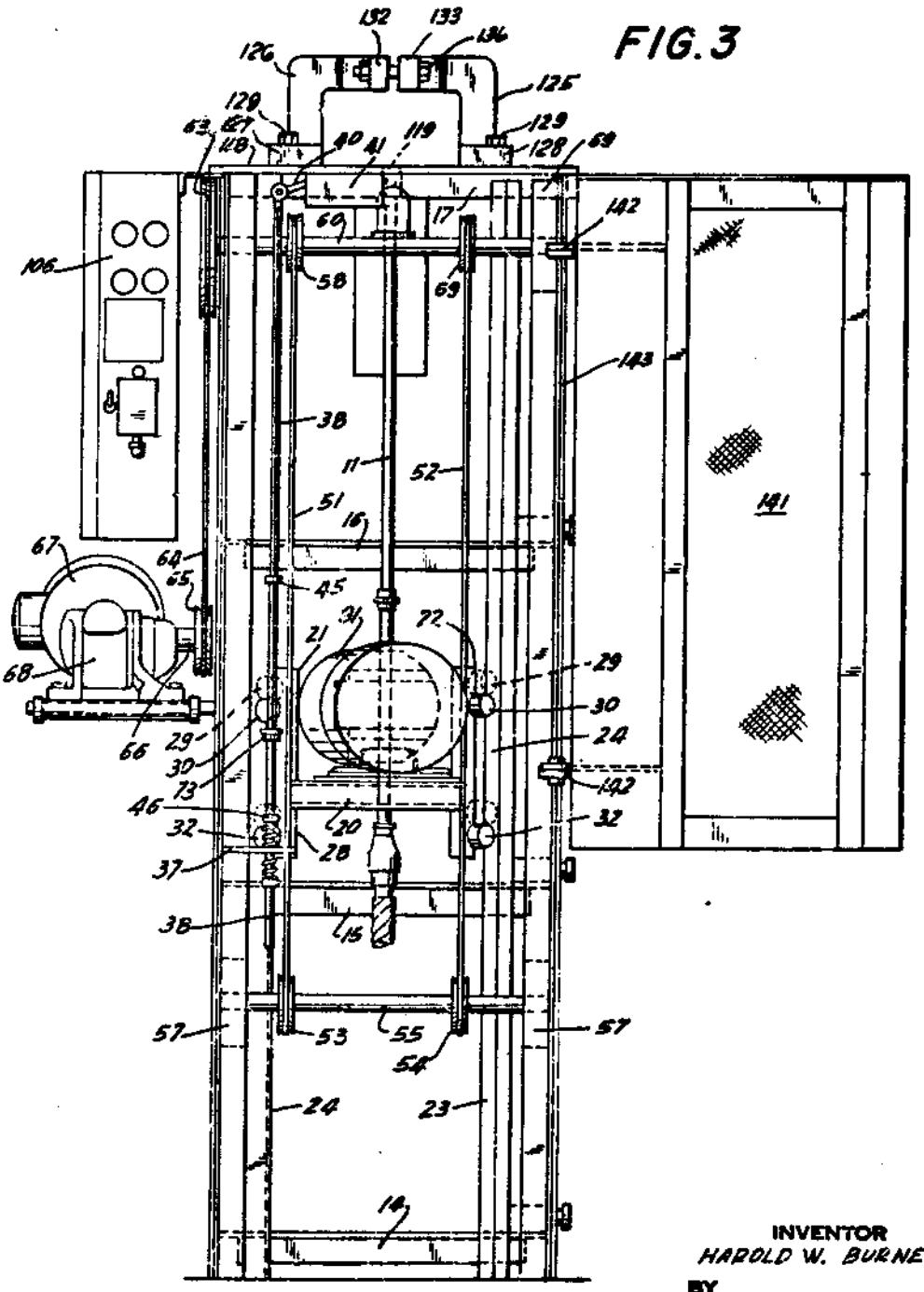
INVENTOR
HAROLD W. BURNEY
BY
Kane Dalsimer, Kane & Daniel
ATTORNEYS

Dec. 23, 1969 H. W. BURNEY 3,485,073

INTERNAL PEENING APPARATUS

Filed May 10, 1966 4 Sheets-Sheet 3

FIG. 3



INVENTOR
HAROLD W. BURNEY

BY
Kane, Dalsimer, Kane & Ward
ATTORNEYS

Dec. 23, 1969 H. W. BURNEY 3,485,073

INTERNAL PEENING APPARATUS

Filed May 10, 1966 4 Sheets-Sheet 4

FIG. 5

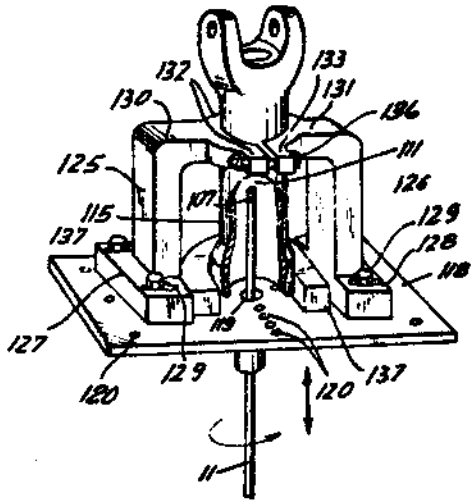
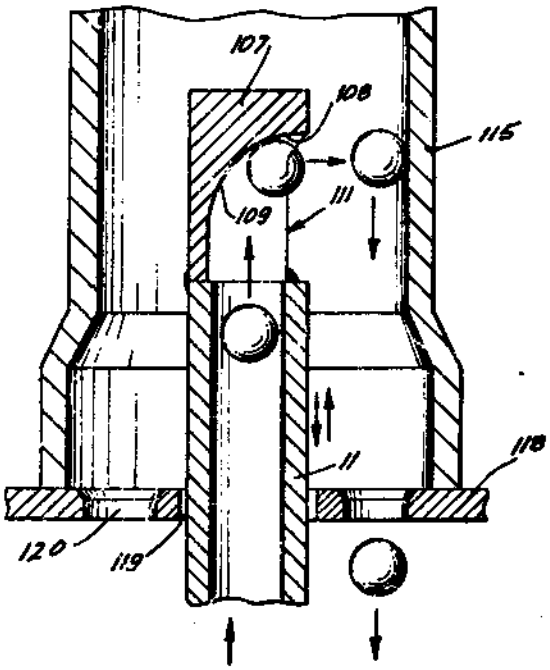


FIG. 6



INVENTOR
HAROLD W. BURNEY

BY
Kane, Dalsimer, Kane & Sullivan
ATTORNEYS