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UNIVERSALLY ADJUSTABLE PEENING STRUCTURE

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This invention relates to peening apparatus. It is particularly directed to apparatus with which the peening nozzle and jet may be moved readily to one or another of almost an infinite number of positions while still maintaining substantially uniform shot ejection. The invention also encompasses and is directed to a form of peening jet nozzle particularly adapted for structures having different peening requirements at different structural areas.

In one form of the invention, peening shot are supplied from a hopper or bin into which a generally circular outlet is provided in one region. The outlet is covered normally by substantially a ball type structure fitted therein and held closely thereto by any appropriate form of hanging arrangement. The ball member is generally hollow. It preferably has a substantially square entrance port leading into the hollow section. By appropriately securing the ball member within the circular opening, the ball member may be rotated relative to the opening center or it may be tilted to varying degrees in any of its possible positions. By having the ball-shaped member extend within the circular outlet of the supply bin or hopper, it is possible to turn the ball member so that the square opening extends in selected different directions without opening the outlet to any loss of shot.

Normally, the ball-shaped member is appropriately secured to a tubular feed section which may or may not be telescoped. The tubular member leads into a mixing chamber from which the shot are ejected toward the work by way of a suitable nozzle. The mixing chamber is normally a partially cylindrical element having an entrance port along one side wall for the in-falling shot.

The substantially cylindrical mixing chamber is preferably held to one end of the tubular section by a yoke generally appropriately welded to the tubular element and held to the top and bottom sections of the mixing chamber by any desired form of mounting structure. The end of the tubular section generally terminates in a form of an arcuate shoe which overlaps and conforms in shape to a cylindrical side wall of the mixing chamber over a selected angle of any desired arc, such as, for example, about 60°. The arcuately shaped shoe conforming to the curvature of the side wall of the cylindrical mixing chamber permits a limited rotation of the mixing chamber relative to the tubular element while still permitting shot falling through the tubular section to enter into the mixing chamber. It also precludes loss of shot in any relative angular shift in position between the two elements.

The substantially cylindrical mixing chamber element has two additional ports arranged substantially diametrically opposite each other and extending through the cylindrical walls each centered at approximately a 90° angle with respect to the axis of the opening into which the tubular member leads. The two oppositely arranged openings provide, on the one hand, for the introduction of air or other fluid under pressure into the mixing chamber into which shot from the hopper has been passed through the tubular member and, on the other hand, the opposite opening serves to provide a passageway leading to a nozzle structure through which the shot are directed to the work.

The nozzle structure particularly adapted for use with the invention under consideration is preferably of a unique

type with the nozzle proper having its shape changed from the generally circular shape of the opening leading into the mixing chamber to one which is flattened to practically an elongated rectangular shape at the outlet. The nozzle formation is such that fluid and shot under pressure are ejected in greater volume at substantially the center of the rectangular area than at its edges. This, for instance, permits one section of a contacted object to be peened to a greater extent than another section.

Illustratively, a nozzle jet of substantially rectangular form may be directed adjacent to a turbine or compressor blade. Normall, the thin outer edges of the blade do not require as much peening as do the central sections. Consequently, by directing the nozzle transversely of the blade, a single application of peening shot ejected from such a nozzle may serve adequately as the peening instrumentality for thoroughly treating such blades.

Various modifications, of course, may be made in the described structure but, generally speaking, the invention provides a universally adjustable tubular element to deliver shot from a hopper or supply bin to a mixing chamber. The tubular element is adapted to provide both the shot supply path and the support structure for the peening nozzle. It is capable of being rotated completely with respect to the supply bin and tilted with resect to its axis at any desired angle throughout a complete 360°. The length of the supporting tubular member may be appropriately shifted through a telescopic action and the delivered shot from the chamber may then be ejected along a path either downwardly from the mixing chamber or upwardly therefrom in accordance with the nozzle positioning and the applied pressure of the fluid inlet.

With the foregoing in mind, the invention has as one of its main objectives that of providing a shot supply system for peening apparatus which is substantially universally adjustable, as well as being capable of turning in any desired and useful angle. Another object of the invention is that of providing peening nozzle apparatus having ejection characteristics adapting it uniquely to certain selected forms of operation, although within the concept of the invention the form of ejection nozzle may be widely varied in shape. Other objects of the invention are those of providing a structure having wider utility and greater efficiency of operation and one which is usable in connection with more types of peening requirements than nozzle structures heretofore commonly in use.

Other objects and advantages will suggest themselves at once to those skilled in the art to which the invention is directed following a reading of the following description and the appended claims in connection with the accompanying drawings in which:

FIG. 1 is an elevational view partly in section showing a preferred form of the apparatus;

FIG. 2 is a top sectional view taken along the line 2—2 of FIG. 1 looking in the direction of the arrows to indicate the relative positioning and relationship of the supply hopper to the outlet or feeding tubular element;

FIG. 3 is also a sectional view taken on the line 3—3 of FIG. 1 looking in the direction of the arrows to show particularly the adjustability of the ball-shaped inlet to the tubular feed element for supplying shot from the hopper or supply bin to the mixing chamber and outlet nozzle;

FIG. 4 is a side view of a portion of FIG. 1 looking in the direction of the arrows for the section 4—4 to show particularly the telescoping arrangement of the tubular feed member for supplying shot from the hopper or supply bin to the mixing chamber;

FIG. 5 is a sectional view taken along the line 5—5 of FIG. 4 looking in the direction of the arrows to show the general relationship between the mixing chamber with its shot inlet connection to the tubular feed member and fluid supply connection adapted to force shot from the mixing chamber out through an outlet nozzle structure;

FIG. 6 is also a sectional view taken on the line 6—6 of FIG. 5 to show particularly a preferred nozzle structure for feeding out shot from the mixing chamber to the articles to be peened; and

FIG. 7 comprises curves representing the compression of an impacted surface to be peened by shot from a substantially rectangularly shaped nozzle at different pressures but at an assumed fixed distance, with the compression indicated at both an axial and an off-axis location.

If now reference is made to the drawings, for a further understanding of the invention, the peening shot supply source is a hopper or supply bin 11 (only a small end section being shown). The supply bin or hopper 11 has a circular opening 12 into which a ball-shaped element 13 is adapted to be inserted. Where a plurality of outlets are to be supplied each is similar and only one will here be discussed. The ball-shaped element 13, as can be seen particularly from FIG. 1, has a maximum outside diameter just slightly greater than the diameter of the opening 12. The ball-shaped element is fitted into the opening 12 from the lower side to penetrate into the opening to a slight extent but by reason of its larger size it forms a tight fit with the opening when drawn there against by the pressure exerted from the lower side by a tightening plate 14 having a central opening 15 into which the ball-shaped member is inserted. The central opening 15 is usually of a diameter slightly less than that of the opening 12, although it could be of the same diameter.

The plate 14 is usually substantially triangular in shape, as can be seen from the drawing. It is secured to the hopper member by a plurality of bolts 16, each preferably having its headed portion within the hopper and the threaded end extending below the plate at each vertex so that by tightening the indicated fastening nuts the ball-shaped member may be forced upwardly tightly against the outer edge of the circular opening 12 and the triangular shaped tightening plate also forced tightly against the outer periphery of the ball-shaped element below its center. The triangular plate provides with the fastening nuts a convenient means to fasten the element to the hopper in any desired position. The ball-shaped element is formed with a hollow interior, schematically designated at 17. The upper section that is adapted to fit within the hopper or supply bin 12 is slightly flattened, as indicated at 18. It provides a generally square-shaped opening 19 leading directly into the hopper. With the loosening of any of the bolts 16 the plate 14 is loosened so that the relative position of the generally square-shaped opening 19 may be changed with respect to the opening 12, as indicated by the phantom positioning shown by the dot-dash lines 20. The square opening permits the limited amount of rotation of the ball-shaped element 13 relative to the hopper opening while still precluding overflow from the supply. The adjustment of the fastening bolts 16 and the fact that the ball-shaped element 13 is of substantially a spherical outer periphery permits the element to be rotated to any desired position at each loosening of the bolts and secured in any selected position with each tightening of the bolts, the reason for which will be apparent by what is to follow.

The hollow ball-shaped element 13 terminates at its lower portion in a neck section 28 which leads into and is welded to one end of a tubular member 29. The tubular member provides a feed path for the shot from the hopper or supply bin 11 to the working nozzle. In some instances, it is desirable to have a great deal of freedom in adjustment of the length of the tubular member as well as to have the freedom of adjustment of its angular positioning or angular turning. The control of length is provided by having a lower tubular section 30 telescoped over the lower end of the tubular member 29 with the lower tubular section then terminating in the mixing chamber 31, as will later be described. The lower tubular section 30 preferably has its outer end section 32 slotted on one or two opposite sides, as shown at 33, in order that the tubular member 29 may easily fit therein. A pair of lugs or ears 34, 35 is welded on the ends of the slotted section and suitable fastening bolts 36 extend through the lugs and are tightened by means of the fastening nuts 37 to bring about a tight and locking fit.

The entire assembly is then hung from the supply bin or hopper and the shot are fed through the square-shaped opening 19 into the hollow interior 17 of the ball-shaped element 13 and thence, through the upper tubular member 29 and the telescoping lower tubular section 30 to be directed to the mixing chamber 31.

Yoke members 46 and 47 are suitably welded to the lower end of the lower tubular section 30 and terminate in a position beyond the end thereof suitable for positioning adjacent to the mixing chamber 31. A fluid intake section 48 also leads into the mixing chamber and shot are directed outwardly therefrom through the nozzle 49. As is more particularly evident by the cross-sectional showings of FIGS. 5 and 6, the mixing chamber 31 is formed as a generally cylindrical element which is adapted to fit within the forked ends formed by the yoke sections 46 and 47 and fastened therein by suitable fastening bolts 50 and 51 which are threaded into the end sections of the cylindrical mixing chamber. The cylindrical mixing chamber has a height which approximately corresponds to the spread of the yoke elements 46 and 47 where they overlap it.

One cylindrical wall section of the mixing chamber is provided with an opening 51 of a shape and diameter approximating that of the inside diameter of the lower tubular section 30. The mounting of the cylindrical mixing chamber 31 relative to the end of the tubular member 30 by the fastening of the yokes 46 and 47 is normally so arranged that with the fluid intake member and the nozzle member 49 positioned substantially horizontally (see particularly FIGS. 1 and 5) the inside diameters will be substantially alike. In this way, peening shot, schematically indicated at 53, fall through the tubular member 30 and into the interior 54 of the mixing chamber 31. The entrance port 52 is then adjacent to the end of the tubular element and, in addition, the end of the tubular element has a curved section 55 of a height (see FIG. 4) substantially like that of the height of the cylindrical member forming the mixing chamber 31. The curved section 55 has an inner radius of curvature which substantially corresponds to that of the outer periphery of the mixing chamber 31. The two elements are positioned adjacent to each other and arranged to fit reasonably tightly to each other. The curved section 55, as is indicated, is welded or otherwise fastened to the lower end of the lower tubular section 30 and wraps about an arc of the cylindrical mixing chamber section which represents slightly in excess of the total maximum angle which it is desired to tilt the nozzle 49 relative to the tubular section 30. Accordingly, with the elements arranged, as shown by dot-dashed lines by FIG. 1, for instance, each of the fluid intake elements 48 and the nozzle 49 enter into the interior of the mixing chamber 31 by way of openings 60 for the fluid intake and 61 for the connected nozzle 49. The openings 60 and 61 as above stated, are aligned. The common axis is approximately 90° (in the position of FIGS. 1 and 5) to the axis of the lower tubular element 30 and the inlet opening 52.

By appropriately loosening the fastening bolts 50 and 51, the cylindrical elements providing the mixing chamber 31, may be rotated (looking at FIG. 1) in a clockwise fashion to position A or in a counterclockwise fashion to a position B, depending upon whether or not it is desired to eject the shot from the nozzle above or below the point at which it enters the mixing chamber. For conditions where the mixing chamber 31 is rotated relative to the axis of the lower tubular element 30, the opening 52 is turned relative to the interior opening in the lower tubular member. Turning tends to reduce the effective size of the opening into the mixing chamber from the tubular section although, even with turning, an adequate amount of shot can be permitted to enter to accomplish the desired peening operation. However, because turning of the opening, absent a curved section such as that shown at 55, would provide direct access from the exterior into the internal mixing chamber, such a condition would be intolerable because pressure within the mixing chamber would be lost to the exterior and because, if an opening were provided from the mixing chamber to the exterior in such random form, the inlet fluid jet entering at the inlet 48 might be strong enough to eject shot from an undesired area. The result is that the curved section 55 serves to cover the opening 52 for all angular positions of its movement.

At times, it is desirable to adjust the region whereat the falling shot from the hopper or supply bin enter the mixing chamber 31 with respect to the entering fluid. The fluid enters normally through a jet end 62. This jet is normally placed just slightly ahead of the region where the majority of the shot from the tubular element 30 is permitted to enter. However, to move the jet further inwardly and closer to the opening 61 or outwardly and further from the opening, an adjustment is provided by the set screw 68 which permits the adjustment in any desired fashion. Similarly, the nozzle 49 is fitted at its inner end within the opening 61 and held there by the set screw 69.

The nozzle 49 may assume various shapes. Frequently, peening nozzles are formed with a circular outer opening through which the shot are finally ejected to impact the work being operated upon. In this particular invention, the entire assembly is made universally adjustable with the ball connection to the hopper permitting complete 360° rotation of the tubular member about its axis with the support being provided by the ball-shaped member secured to the hopper or supply bin. Likewise, the angular adjustment about an axis normal to the axis of the tubular member is provided in an indefinite number of positions as schematically illustrated in one form in FIG. 1. Further adjustment of the nozzle to an upward or a downward tilt position is provided by the movement about the cylinder axis 70 to reach either of positions A or B, or any position between them.

It was above mentioned that for some uses, it is desirable to provide an output of peening shot where the pressure at which the shot is ejected may be greatest along the axis of the nozzle 49 and the intake fluid tube 48 regardless of the angle of rotation of the nozzle relative to the axis of the cylindrical mixing chamber. Further, along the axial position, the quantity of shot ejected may be greater. By reshaping the nozzle at its exit to provide an outlet 71 of flattened elliptical or generally rectangular shaping, the fluid pressure and shot quantity at the outer edges 72, 73 of the rectangular opening will be less than in the center. As is shown particularly by FIG. 5, such construction offers particular advantage when the nozzle is used with certain curved work pieces. Illustratively, in the case of turbine or compressor blades, it is possible to peen the blade in such a way that the peening action along a path axial with respect to the inlet fluid passage 48 and the nozzle supply opening will be substantially greater than at the edge. Further, in some instances, the rectangular opening may be shifted laterally so that one or the other of edges 70 or 71 may be substantially aligned with the nozzle axis leaving the other edge off center, as it were, which may be done for other types of work. Still further, in some instances, it may be desirable to reshape the nozzle exit port to a form approaching triangular configuration thereby to control the effectiveness of the shot as it impacts the work.

Turbine or compressor blades are subjected to substantial pressures in operation. To increase the fatigue strength of these blades requires peening with extreme care and yet, peening of the outer edges should be less than at the center. The reshaping of the nozzle automatically provides a control of the quantity and impact pressure of the ejected shot. It makes unnecessary a rigorous control of a variable time duration of shot impact at many different areas. The reshaping of the nozzle permits a computation of the impact time for that section of the nozzle wherefrom the greatest density of shot is ejected and the ejected pressure is likewise greatest. The smaller nozzle sections may then be formed by calculating the required extent of peening needed to achieve the desired end result. The shaping of the nozzle end thus becomes effectively a computation, the achievement of which removes human error which otherwise might be present and by a control of the impact period of the ejected shot at one portion of the work, it then becomes possible to provide a rigorous control of the peening action at areas requiring less shot impact.

The effect of the nozzle shaping, as shown for instance at 71 in FIG. 4, is represented by the curves of FIG. 7. These curves assume a nozzle opening approximately corresponding to the form of FIG. 4. The shot leaving the center of the nozzle strike hardest along the nozzle center line as the shot reach the work to be impacted. On the nozzle center line, indicated by the dot-dash line, with the nozzle spaced at about two-and-one-half inches from the impacted surface, at 80 p.s.i.g. the shot impacts the surface to provide a reading of about 0.0103 on the Almen scale (not shown). With the nozzle shape as indicated, at distances approximately three-quarters of an inch at either side of the center line, the reading on the Almen scale for the same impact pressure at the jet is reduced to a value of approximately 0.0076 on the same scale.

As another example of the effect of the shot from the nozzle impacting the surface of the work at which it is aimed, this operation, as is well known, being for the purpose of increasing the fatigue strength of the impacted piece, the Almen scale reading with the shot ejected at about 30 p.s.i.g. is approximately 0.0055 along the center line of the nozzle. At a level of displacement at illustratively three-quarters of an inch at either side of the center line of the nozzle the Almen scale reading drops to about 0.0036. Here it will be observed that the change is such that there is reduction from the impact pressure along the center line to about 75% of the value somewhat laterally removed. This contrasts generally with the circular nozzles where the impact pressure remains relatively constant in line with the nozzle aperture and laterally therefrom the pressure drops off very markedly. The advantage of the nozzle form particularly depicted by FIG. 4 as already mentioned is that of being able to peen elements where the same degree of peening is not required at all impact areas. This is particularly true for instance in the case of turbine blades where the outer edges of the blades do not require peening to the same extent as does the central area.

It may be noted also from the two curves shown by FIG. 7 that there is a general family relationship between the curves for the 80 pound pressure and the 30 pound pressure. The same general conditions hold true for pressure within the range between 80 pounds and 30 pounds and slightly below. Illustratively, for a pressure of about 55 pounds, the Almen scale reading subsantially at the center line of the jet can be assumed to be approximately 0.0079, and the readings laterally spaced from the center line by about the same distance as about the 80 pound and 30 pound curves will be approximately 0.0059. Other values can be expected to be generally proportional.

Various changes and modifications, of course, may be made without departing from the spirit and scope of what is here disclosed and, therefore, the claims are to be interpreted broadly in the light of what is here set forth.

Having now described the invention what is claimed is:

1. A substantially universally adjustable peening apparatus for projecting shot withdrawn from a supply hopper having a substantially circular outlet port comprising
 a hollow ball-element adapted to be supported adjacent to the outlet port to receive shot from the hopper,
 means for adjusting and clamping the ball-element in substantially universal selectable positions relative to the hopper outlet port,
 a shot-mixing chamber having a shot-inlet port and a fluid-inlet port and a fluid and shot outlet port substantially opposite the fluid inlet port,
 tubular means connecting the shot-inlet port and the hollow ball-element to supply shot therethrough from the hopper to the mixing chamber,
 a jet projection nozzle having a feed channel leading to the mixing chamber and substantially aligned with the fluid-inlet port for ejecting shot from the mixing chamber and the nozzle, and
 means for supporting the mixing chamber for rotation about an axis normal to the axis of the tubular means through a selected angular range whereby shot directed into the mixing chamber through the tubular means may be ejected from the nozzle at a selected level above or below the entrance port into the mixing chamber under the pressure of the fluid directed into the chamber.

2. The apparatus claimed in claim 1 comprising, in addition,
 an inlet means to supply shot to the interior of the hollow ball element, said means having a substantially square opening.

3. The universally adjustable peening apparatus as claimed in claim 2 comprising, in addition,
 a substantially triangular plate for holding the ball element adjacent to the hopper, and
 means at each triangle vertex for securing the substantially triangular plate to the feed hopper, and
 means whereby the loosening of a single fastening element only provides freedom of adjustment of the hollow ball element.

4. The universally adjustable peening apparatus claimed in claim 3 comprising, in addition,
 a second tubular feed element telescoped relative to the first tubular feed element for providing a controllable length feed path, and
 means to secure the two telescoped members to each other.

5. The peening apparatus claimed in claim 4 wherein the mixing chamber is provided as the interior of a hollow cylinder.

6. The substantially universally adjustable peening apparatus claimed in claim 5 comprising, in addition,
 yoke means for securing the substantially cylindrical mixing chamber to the end of the tubular element, and

 means for permitting angular adjustment of the tubular mixing chamber element about an axis turned approximately 90° relative to the axis of the tubular element to which it is attached.

7. A nozzle for a peening structure comprising
 an entrance port of substantially circular cross-section,
 means for securing the nozzle to a mixing chamber having an exit port of cross-section corresponding to that of the mixing section entrance port, said nozzle structure having an interior cross-sectional contour through which shot and fluid are passed which changes progressively from substantially circular to substantially flattened elliptical.

8. The peening nozzle claimed in claim 7 comprising, in addition,
 means for controllably determining each of the shot quantity and volume directed from each area of the nozzle element secured to the mixing chamber.

9. A substantially universally adjustable peening apparatus comprising
 a tublular element,
 a substantially ball-shaped member having an internal central opening terminating at one end in the tubular element with the internal opening substantially aligned with the axis of the tubular element,
 means for supporting the ball-shaped member and the tubular element relative to a shot supply source for angular movement about an axis normal to the tubular axis to a plurality of selected angular positions and for rotary movement about the tubular axis,
 a mixing chamber secured to the opposite end of the tubular element and in communication therewith to receive shot therethrough,
 said mixing chamber having an entrance port into which the tubular element connects and also having fluid entrance and exit ports angularly displaced therefrom, the said last-named ports being substantially axially aligned,
 means to introduce fluid under pressure into the chamber through the fluid entrance port, and
 nozzle means aligned with the exit port so that shot directed into the mixing chamber may be ejected therefrom through the exit port and nozzle under applied fluid pressure at the fluid entrance.

References Cited

UNITED STATES PATENTS

2,489,877	11/1949	Fowler	72—53
3,257,759	6/1966	Millhiser	51—319

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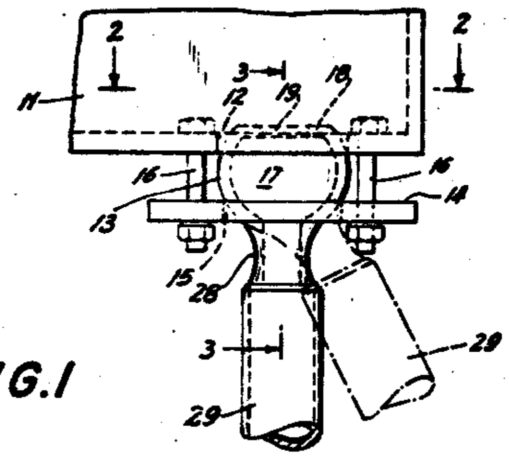


FIG. 1

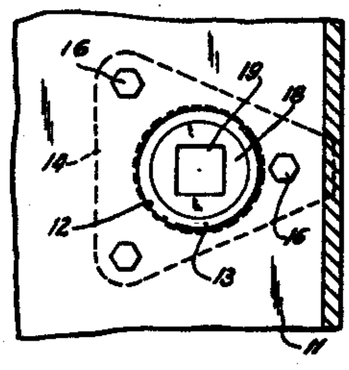
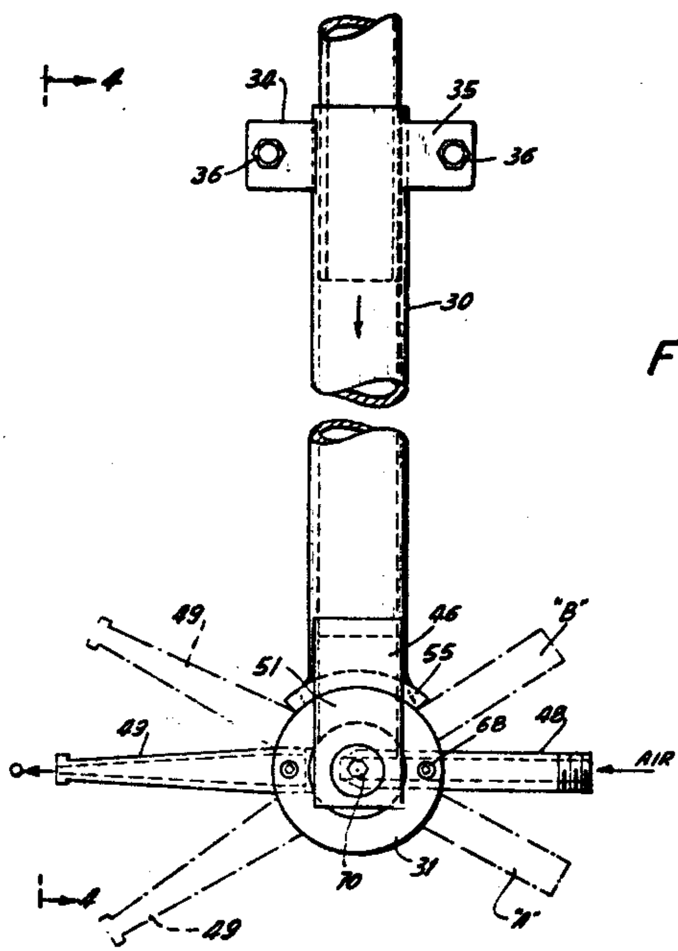


FIG. 2



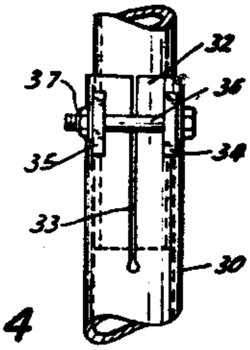


FIG. 4

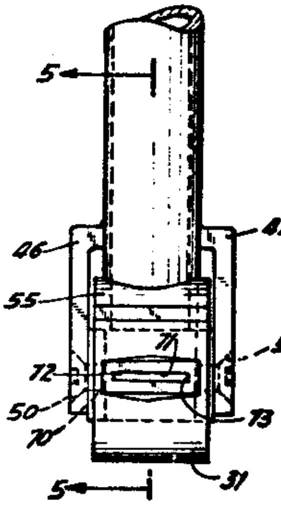


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FIG. 5

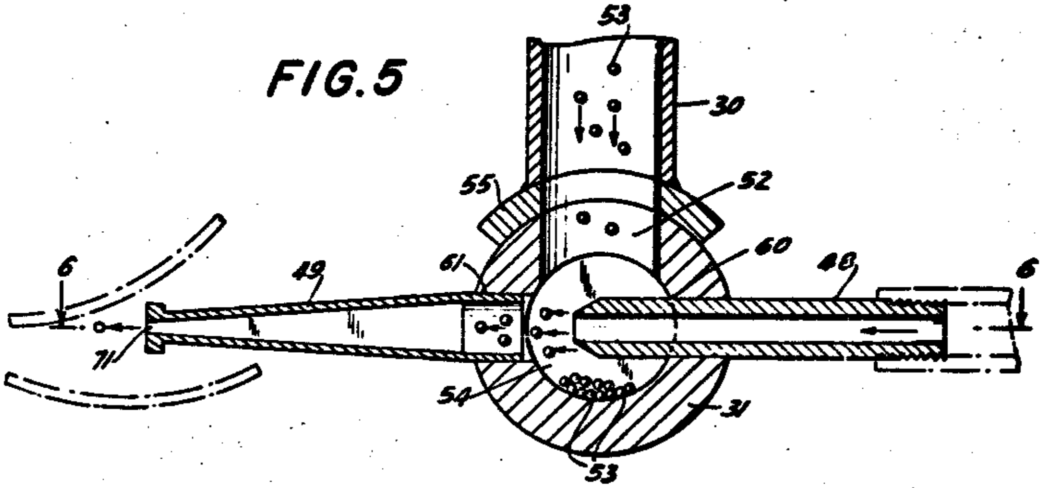
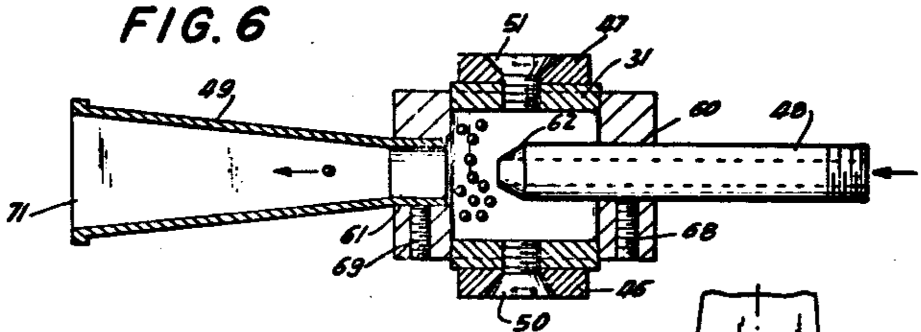


FIG. 6



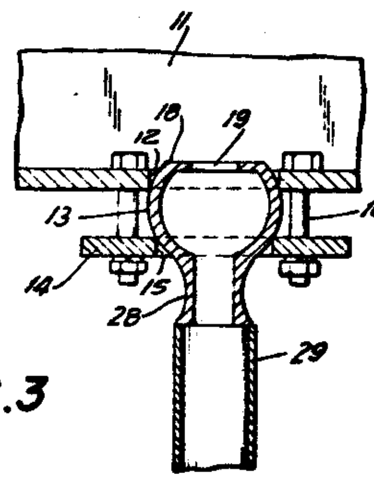


FIG. 3

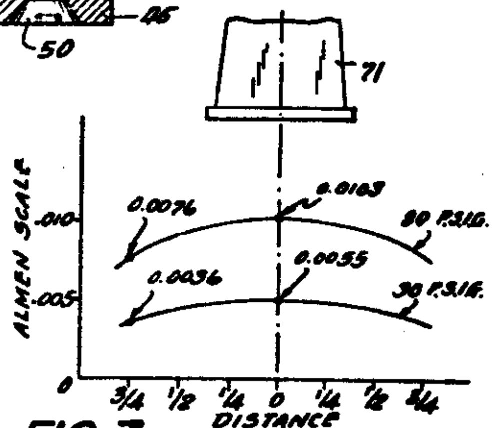


FIG. 7

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