United States Patent

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[54] CENTRIFUGAL BLAST WHEEL

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[52] **U.S. Cl.** **72/53**

[51] **Int. Cl.** **C21d 7/06**

[58] **Field of Search** 72/53; 51/9, 8, 119, 120

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Attorney—David E. Dougherty and Robert E. Walter

[57] **ABSTRACT**

A centrifugal blast wheel for projecting peening balls comprises a runnerhead having a plurality of radial vanes mounted thereon and an impeller mounted in an impeller case in the central area of the runnerhead. Means are provided to prevent the peening balls from being trapped between the impeller blades and the slot in the impeller cage.

15 Claims, 8 Drawing Figures

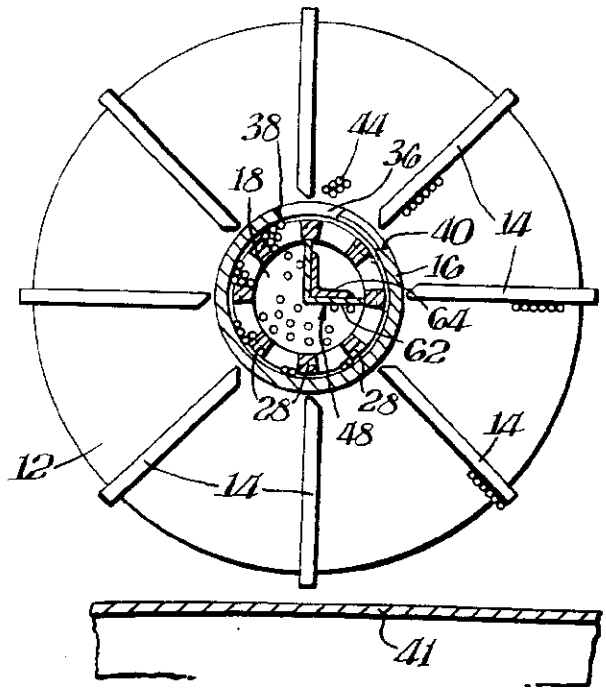


Fig. 1 (Prior Art)

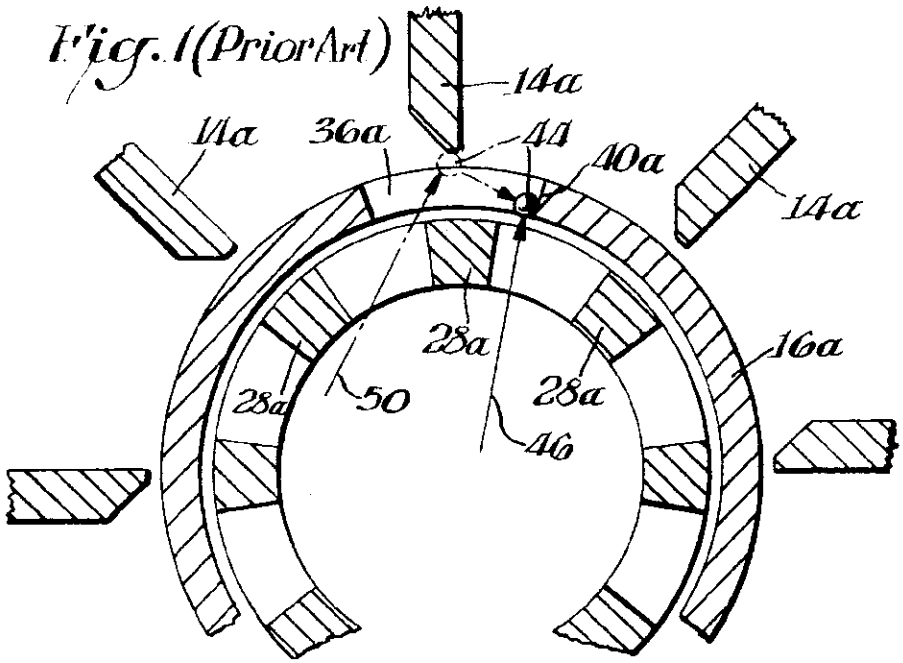


Fig. 8.

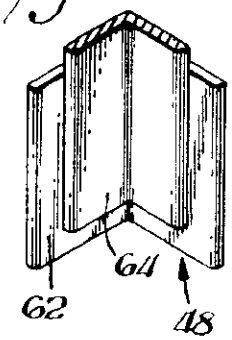


Fig. 4.

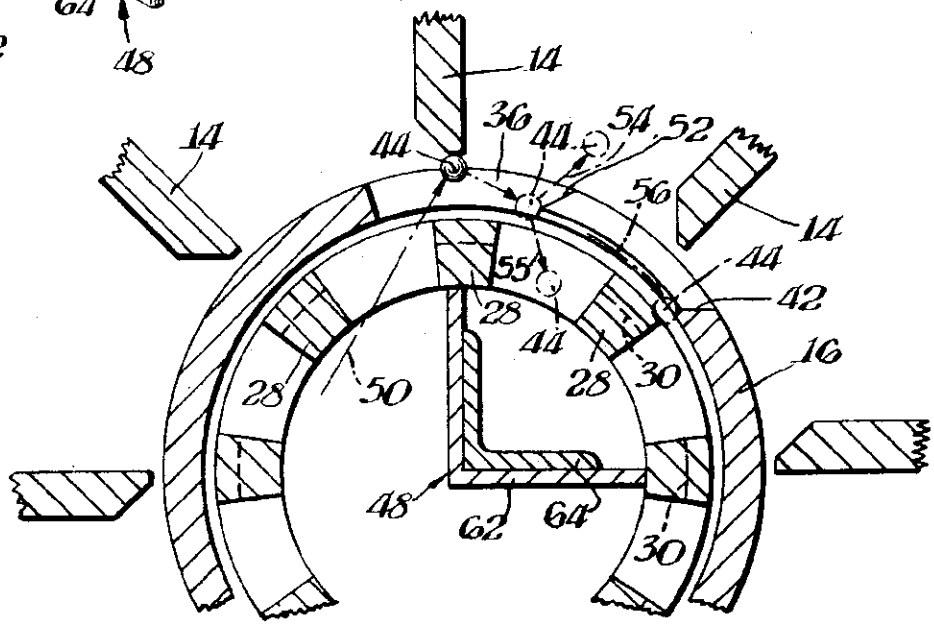


Fig. 2.

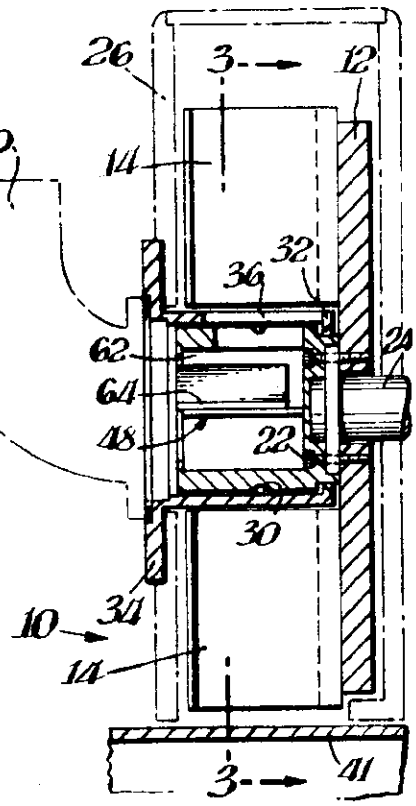


Fig. 3.

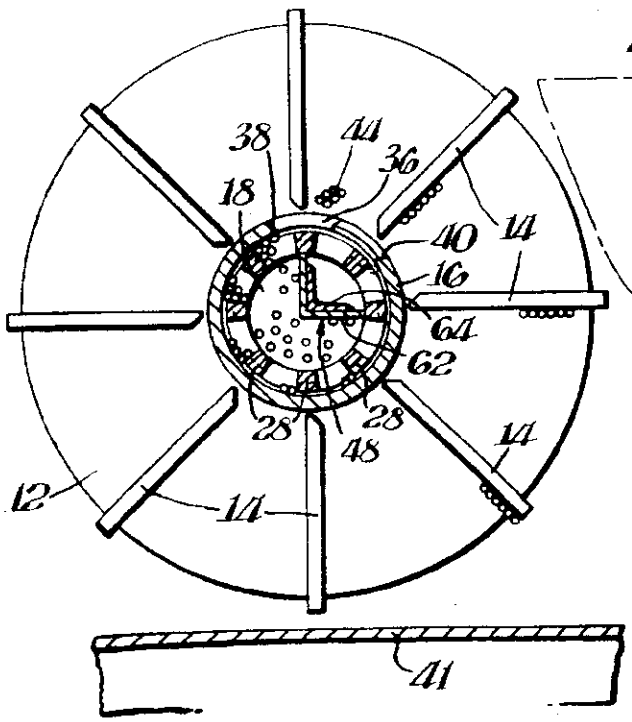


Fig. 4.

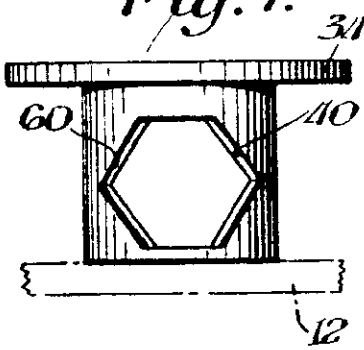


Fig. 5.

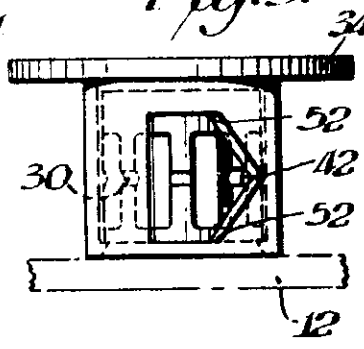
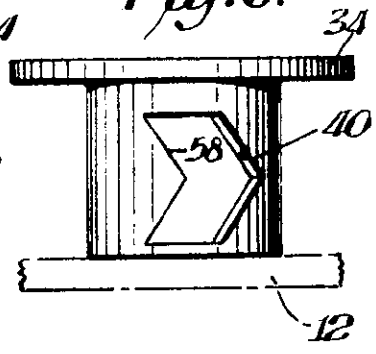


Fig. 6.



CENTRIFUGAL BLAST WHEEL

BACKGROUND OF INVENTION

Peening with shot propelled by centrifugal wheels or compressed air has long been practiced in the art. One use for peening has recently been found wherein compressed air nozzles are used for peen forming. This process is considerably cheaper than stretch die forming or other die forming methods. However, larger jumbo type airplanes require machines that can propel large quantities of shot economically. The use of compressed air for peen forming the skins of such aircrafts is expensive and aerospace firms are finding that the cost of operating compressed air type machines is excessively high.

Because of the above disadvantages with compressed air peening, the possibility of peen forming by centrifugal type blasting now takes on new importance. Experimentation has shown that peen forming can be done with a small diameter shot in centrifugal wheels. However, with thick aluminum skin sections, the small diameter shot velocity must be high in order to obtain the desired form or curve. High velocity, however, produces a rough finish which is unacceptable for skin sections. The finish can be reduced by over peening with a finer shot at a lower velocity. Even here, however, the finish is still not what is desired.

Another approach is to over-blast with large balls (e.g., one-eighth inch diameter or greater) or to do the initial forming with large balls. The larger diameter ball impresses a larger dimple and with 100 percent coverage results in a smoother finish. Propelling large balls with a centrifugal blast wheel, however, presents a serious problem in that in order to render conventional wheels jam-free all clearances must be at least of three ball diameter. If this clearance is not maintained balls may become jammed or wedged between the rotating impeller blades and the trailing edge of the stationary impeller case slot. When, however, the three ball diameter clearance is maintained (for example the clearance between the impeller and its case would be three-fourths inch for one-fourth inch balls) the balls are ejected through the impeller case slot at all times during rotation. This results in an uncontrolled stream of balls being picked up by the vanes which in turn results in an uncontrolled blast pattern. Additionally, for a given flow the impeller and its case must have a large diameter to allow for the three ball clearance between all moving parts through which the abrasive flows.

SUMMARY OF INVENTION

An object of this invention is to provide a centrifugal blast wheel which eliminates the three ball clearance of conventional wheels and maintains a controlled blast pattern.

A further object is to provide such a wheel which is particularly adapted for peen forming aircraft skin sections.

A still further object of this invention is to provide such a blast wheel which prevents the blast particles from being trapped between the impeller blades and the case slot.

A still further object of this invention is to provide novel impeller, case and a baffle structure for use in such a blast wheel.

In accordance with this invention a centrifugal blast wheel includes a runnerhead having a plurality of radially mounted vanes with an impeller disposed inside an impeller case in the central area of the runnerhead. Means are provided in this central area to prevent particles or balls from being trapped between the impeller blades and the slot in such a manner that a small clearance can be utilized rather than the prior art three ball clearance.

A baffle may be provided in the impeller to shield the trailing edge of the impeller slot so that balls are prevented from going directly to trailing edge from within the impeller. Additionally, the trailing edge might be slanted with a point at its rearmost portion (for example being V or arrowhead shaped) whereby any balls ricochetting from a vane heel back to the slot, will ride down the slot to the point. A groove is provided around the impeller blades adjacent the point of the slot so that the ricochetting balls may then fall into the groove rather than cause jamming or being sheared.

THE DRAWINGS

FIG. 1 is a plan view in cross section of a portion of a prior art arrangement;

FIG. 2 is a side view in elevation and partly in section of a blast wheel in accordance with this invention;

FIG. 3 is a cross-sectional view taken through FIG. 1 along the line 3—3;

FIG. 4 is a view similar to FIG. 1, but in accordance with the invention;

FIGS. 5–7 are elevation views of the impeller and impeller case showing different slot formations in accordance with this invention; and

FIG. 8 is perspective view of a baffle in accordance with this invention.

DETAILED DESCRIPTION

FIG. 2 shows a centrifugal blast wheel **10** which includes runnerhead **12** and particle throwing vanes **14** mounted radially thereon. The heels of the vanes **14** are spaced from each other in the central area of the runnerhead. Disposed in this central area is an impeller case **16** in which is mounted impeller **18**. Particles such as peening balls are fed from feed spout **20** into impeller **18**. Impeller **18** is mounted upon runnerhead **12** by any suitable fasteners **22** so that the impeller and vanes rotate along with runnerhead **12** by rotation of shaft **24**. Feed spout **20** and impeller case **16**, however, are stationarily mounted with respect to these rotating parts by being for example secured to wear housing **26**.

Impeller **18** is in the form of a cylindrical body which, as best shown in FIG. 2, is closed at one end for attachment to runnerhead **12** while being open at the other end for receiving the balls from feed spout **20**. The body is of skeletal form with a plurality of equal spaced longitudinal blades **28** (FIG. 3). As described in greater detail hereinafter a groove **30** extends completely across each blade with the grooves being coarcuate so that the resultant effect is to form a completely annular groove about the impeller which is broken only by the spacing between the individual blades.

Impeller case **16** is also a cylindrical body which has an annular lip **32** at one end whereby impeller **16** may fit thereon with sufficient clearance to rotate while the case is stationary. The other end of case **16** is open and terminates in notched flange **34** for receiving feed spout **20**. A slot **36** is formed in case **16** and the cylindrical wall of the case is otherwise imperforate. Slot **36** includes a leading or forward edge **38** and a trailing edge **40**. As later described trailing edge **40** is slanted from upper and lower ends **52** and comes to a central point **42** which is disposed adjacent the grooves **30**. In the preferred embodiment of this invention trailing edge **40** is V or arrowhead shaped with point **42** being the apex thereof.

During operation of blast wheel **10** particles are projected from within impeller **18** through the spaces between blades **28** and out of stationary slot **36**. Groups of the particles are then picked up by rotating vanes **14** and projected against the surface **41** being treated. For example when large balls **44** are used in the blast wheel **10** the balls are projected in a controlled pattern to impart the desired shape in a peen forming operation for an aircraft skin section **41**.

FIG. 1 shows a prior art arrangement similar to FIGS. 2–3 in that it includes vanes **14***a*, impeller case **16***a*, impeller blades **28***a*, and slot **36***a*. The trailing edge **40***a* of slot **36***a*, however, is vertical or straight and not arrowhead shaped as is slot **40** in FIG. 3.

In the close clearance arrangement of FIG. 1 there would be a danger of particles or balls being sheared or trapped between the trailing edge **40***a* of the stationary impeller slot and the rotating impeller blade **28**. The two most common causes of this problem are when a ball **44** travels directly from the interior of the impeller adjacent to the trailing edge **40***a* of

the slot by taking for example the path **46** indicated in FIG. **1**. This danger is prevented, however, in the inventive arrangement of FIG. **4** by the provision of the novel baffle **48** which as later described effectively shields the entire trailing edge **40** so that balls cannot travel directly to the trailing edge.

A second possible danger of ball shearing or wedging occurs when a ball **44** is deflected from heel of a vane and ricochets back toward the trailing edge such as indicated by the path **50**. This danger is obviated in the arrangement of FIG. **4** by the provision of the slanted trailing edge **40** having the blade grooves **30** disposed at its edge apex **42**. With this arrangement a deflected ball **44** may take three paths: (1) path **54** between vanes **14**; (2) path **55** back into the impeller; or (3) path **56** down edge **40**. For example, if a ball contacts end point **52** at the upper end of the trailing edge **40**, it may ride along the tapered trailing edge until it comes to apex **42** where it will then fall into the groove **30** and eventually be ejected.

Although it is possible to practice this invention by using either the baffle or the tapered edge and groove arrangements, the incorporation of both arrangements is highly effective in eliminating the possibility of balls being sheared or wedged between the impeller and slot while still permitting small clearance between the impeller and its case. This concept of small or close clearance results in a given or measured number of balls **44** being carried by each impeller blade **28** which insures that each vane **14** has deposited on it a measured and controlled amount of balls. Each vane moves the same amount at the same instant and in the same form to assure a uniform and constant blast pattern against surface **41**.

Having such a uniform and consistent discharge on the impeller makes it possible to shape the impeller case slot in varied manners to vary the length and shape of the pattern and consistently keep and maintain this pattern. FIG. **6** shows a triangular shape imparted to the lead edge **58** of the impeller slot. In this case leading edge **58** is parallel to trailing edge **40**. Such a triangular shape to the leading edge lengthens the blast pattern since the balls would be deposited upon the vane over a longer period of time.

FIG. **7** shows still another modification of the impeller case slot wherein the lead edge **60** is the mirror image of trailing edge **40**. The embodiment of FIG. **7** is particularly adapted for both clockwise and counter clockwise rotation since either edge **40** or edge **60** would act as the trailing edge in accordance with the direction of rotation.

In order to effectively shield the trailing edge **40** of the impeller case a particularly designed baffle **48** is used. As best shown in FIG. **2–3** and **8** baffle **48** includes an angle shaped frontal member **62** which is at substantially a right angle having its apex at the center of impeller **18**. A backing member **64** of the same general shape is secured to frontal member **62**. The sides of the frontal member are wider than the sides of the backing member and extend to a juxtaposed position with respect to the blades **28**. In this manner the frontal member provides an effective barrier for maintaining the trailing edge **40** completely shielded. The purpose of the backing member is to provide means for maintaining this barrier stationary although it is disposed within the rotating impeller **18**. In this respect the backing member **64** extends above the frontal member **62** and is secured in any suitable manner to a stationary body such as the feed spout **20** or impeller case **16**. A particularly advantageous means of securement is to provide a clamping arrangement with respect to the feed spout **20** and baffle **48** so that the position of the baffle can be accurately adjusted when the feed spout is secured in place. In this manner the baffle **48** can be so positioned as to take into account for example whether the edge **40** or the edge **60** will act as the trailing edge. Baffle **48** is shown to be in a right angle because with the particular arrangement illustrated herein such an angle will dispose the sides of frontal member **62** sufficiently apart to shield completely the trailing edge **40**. If, of course, a different sloped trailing edge is used, the angle of baffle **48** would also be changed to be of greater or lesser angle as required. Since the purpose of backing member **64** is to act as securing means it is not necessary for the sides of the backing member **64** to extend completely to the impeller blades or to the impeller floor as is the case with the frontal member **62**.

With the arrangement described above, it is possible to use large balls for peening without requiring large diameter impellers and impeller cases and to use such balls in a controlled blast pattern for effectively peen forming large objects such as aircraft skin sections.

I claim:

1. A centrifugal blast wheel for projecting peening particles comprising a runnerhead, a plurality of particle throwing vanes radially mounted on said runnerhead, the heels of said vanes being spaced from each other whereby a central area of said runnerhead is free from said vanes, an impeller case mounted adjacent said runnerhead in said central area disposed adjacent said heels of said vanes, a slot in the wall of said case, an impeller in said case, said impeller having peripheral blades closely disposed adjacent to said case, feed means for feeding particles into said case whereby the particles will be discharged between adjacent blades through said slot and against said vanes, and means for preventing particles from being trapped between said impeller blades and said slot of said case, said impeller case having a horizontal axis, said slot having a trailing edge wall which includes an inner edge disposed toward said impeller and an outer edge disposed toward said vanes and each of said inner edge and said outer edge being slanted with respect to the horizontal axis and coming to a point at its rearmost position.

2. A centrifugal blast wheel for projecting peening particles comprising a runnerhead, a plurality of particle throwing vanes radially mounted on said runnerhead, the heels of said vanes being spaced from each other whereby a central area of said runnerhead is free from said vanes, an impeller case mounted adjacent said runnerhead in said central area disposed adjacent said heels of said vanes, a slot in the wall of said case, an impeller in said case, said impeller having peripheral blades closely disposed adjacent to said case, feed means for feeding particles into said case whereby the particles will be discharged between adjacent blades through said slot and against said vanes, and means for preventing particles from being trapped between said impeller blades and said slot of said case, and said means for preventing particles from being trapped including a baffle in said impeller.

3. A centrifugal blast wheel as set forth in claim **2** wherein said slot includes a trailing edge which is slanted and comes to a point at the rearmost portion thereof.

4. A centrifugal blast wheel as set forth in claim **3** wherein each of said blades includes a groove extending completely thereacross in its outer surface, all of the grooves in said blades being coarcuate with the arc disposed at the same distance away from said runnerhead as said point in said slot.

5. A centrifugal blast wheel as set forth in claim **4** wherein said baffle is stationary with respect to said case, said baffle being an angle shaped member having divergent sides which shield said trailing edge of said slot.

6. A centrifugal blast wheel as set forth in claim **5** wherein said trailing edge is arrowhead shaped with its apex being said point, and said point being at approximately the center of said trailing edge.

7. A centrifugal blast wheel as set forth in claim **6** wherein said slot has a forward edge which is parallel to said trailing edge.

8. A centrifugal blast wheel as set forth in claim **6** wherein said slot has a forward edge which is the mirror image of said trailing edge.

9. A centrifugal blast wheel as set forth in claim **6** wherein said baffle is an angle member having an apex and a pair of sides, said apex being at the center of said impeller and said sides extending to said blades, and said blades extending to substantially as high as the height of said slot and whereby said baffle shields said trailing edge of said slot.

10. An impeller case for use in a centrifugal blast wheel comprising a cylindrical body with a horizontal axis for receiving an impeller therein, one end of said body being open for receiving a feed spout, an enlarged axial slot being in the side wall of said body with said side wall being otherwise imperforate, said slot having a trailing edge wall, said trailing edge wall having an inner edge and an outer edge, and each of said inner edge and said outer edge being slanted with respect to the horizontal axis and coming to a point at its rearmost position.

11. An impeller case as set forth in claim 10 wherein said trailing edge is arrowhead shaped with its apex being said point and being at about the center of said edge, and said slot having a forward edge which is substantially parallel to said trailing edge.

12. An impeller case as set forth in claim 10 wherein said trailing edge is arrowhead shaped with its apex being said point and being at about the center of said edge, and said slot having a forward edge which is substantially the mirror image of said trailing edge.

13. An impeller for use in a centrifugal blast wheel comprising a cylindrical body, fastening means at one end for securing said body to a blast wheel runnerhead, the other end of said body being open for receiving blast particles therein, the side of said body being in skeletal form with a plurality of equally spaced longitudinal blades forming said skeletal form, a groove extending completely across the outer surface of each blade, and all of said grooves being coarcuate.

14. A baffle for use in an impeller having a floor in a centrifugal blast wheel comprising an angle shaped frontal member having a pair of sides joined at an apex to define a substantially right angle therebetween, an angle shaped backing member secured to said frontal member and disposed within said right angle formed by said frontal member sides, said backing member being at the same angle as said frontal member whereby said backing member and said frontal member fit snugly against each other, said sides of said frontal member being wider than said sides of said backing member and being of sufficient width whereby said sides are juxtaposed the blades in an impeller when said apex of said frontal member is disposed at the center of the impeller, said sides of said frontal member extending below said sides of said backing member for resting upon the floor of an impeller, and said sides of said backing member extending beyond said sides of said frontal member to present a surface for securement to a stationary body whereby said baffle will remain stationary when the impeller is rotating.

15. In a method for peen forming aircraft skin sections including feeding peening balls into a centrifugal blast wheel having radial vanes and an impeller which is mounted within a slotted case, the diameter of the peening balls being larger than the clearance between the impeller and the impeller case, preventing balls from being trapped between the forward edge of the slot in the impeller case and the blades of the impeller by deflecting some balls off a stationary baffle within the impeller to prevent balls from rebounding from the interior of the impeller directly to the trailing edge of the slot and by forming the trailing edge of the slot with a slanted wall which terminates in a point disposed over an annular groove formed by grooves in the outer surface of the impeller blades with the distance between the impeller case and the base of the groove being large enough to hold a ball so that balls deflected from the heel of a vane to the trailing edge would ride down the slanted trailing edge and fall into the groove.

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