United States Patent [19]
Ramaswamy
[11] 3,872,624
[45] Mar. 25, 1975

[54] CURVED VANE FOR THROWING WHEELS

[75] Inventor: Kannusami S. Ramaswamy, Knoxville, Tenn.
[73] Assignee: The Carborundum Company, Niagara Falls, N.Y.

[22] Filed: Oct. 29, 1973
[21] Appl. No.: 410,925

[52] U.S. Cl. 51/9
[51] Int. Cl. B24c 5/06
[58] Field of Search 51/9; 241/275

[56] References Cited
UNITED STATES PATENTS

1,108,542	8/1914	Anderson	241/275
2,205,414	6/1940	Keefer	51/9
3,090,166	5/1963	Straub	51/9

Primary Examiner—Donald G. Kelly
Assistant Examiner—Margaret M. Joyce
Attorney, Agent, or Firm—David E. Dougherty; William H. Holt

[57] ABSTRACT

An abrasive particle throwing wheel having throwing vanes extending perpendicular to one face of the wheel and generally radially of the wheel with a forward curve, i.e., in the direction of rotation of the wheel, the curve being shaped so that an angle between a radius through the tip of the vane and a tangent through the vane surface at the tip is, preferably, from about 25° to about 35°, the optimum angle being 31° and 40 minutes. The forwardly curved vane provides abrasive particles with increased velocity or permits slower than conventional wheel rotation without a corresponding decrease in particle velocity. Reduction of wheel speed results in reduction of noise frequency and level, a reduction in turbulence, and also permits a reduction in the number of throwing vanes which further reduces the noise frequency.

2 Claims, 4 Drawing Figures

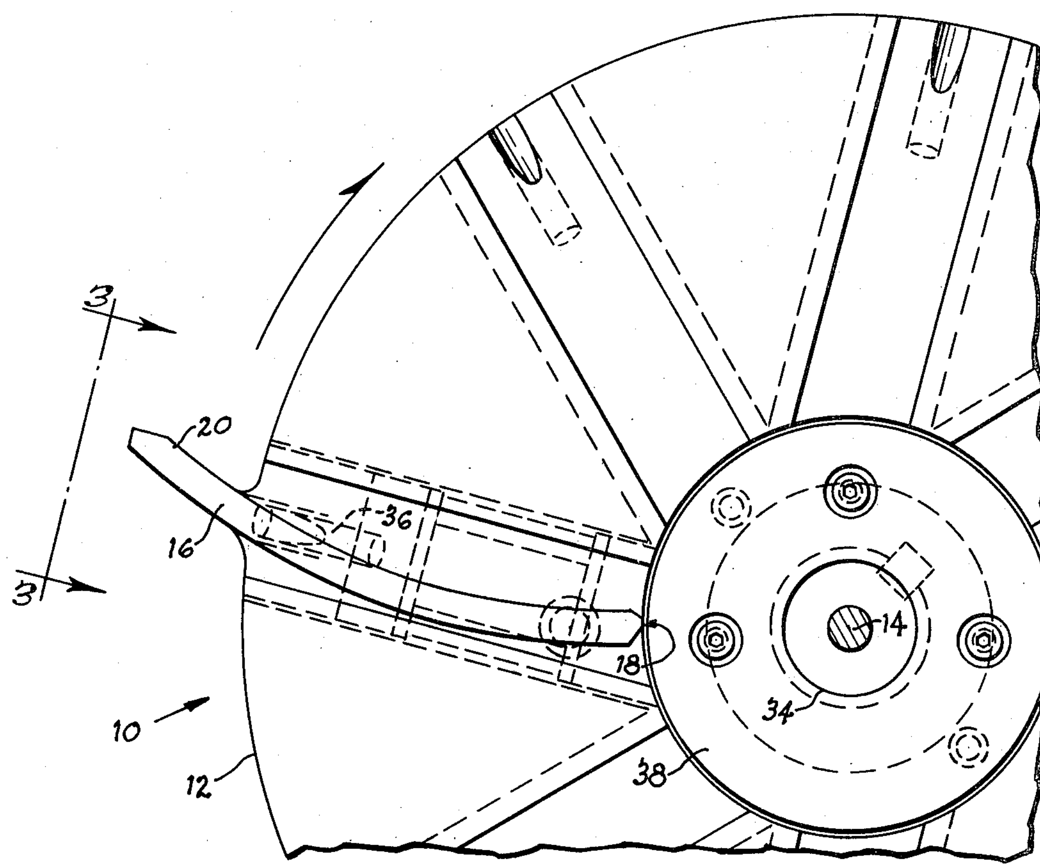
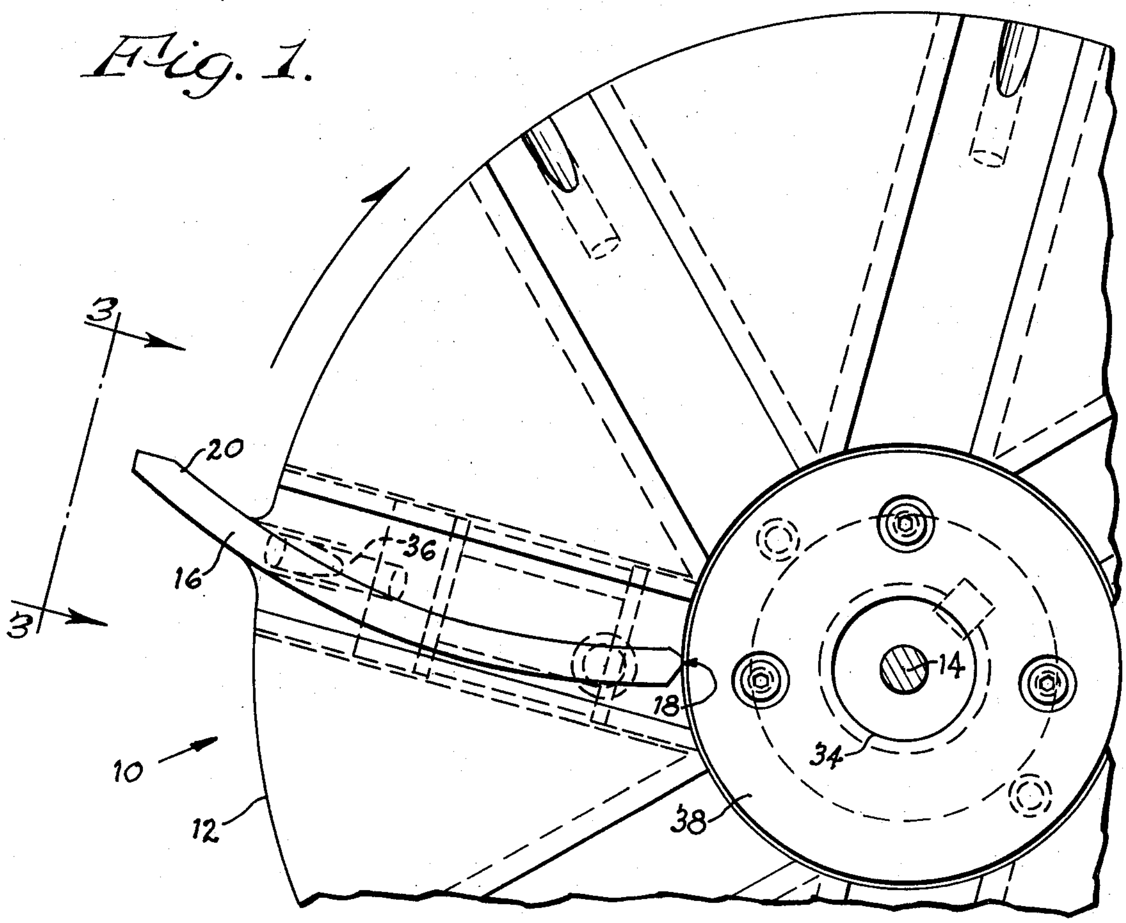


Fig. 1.



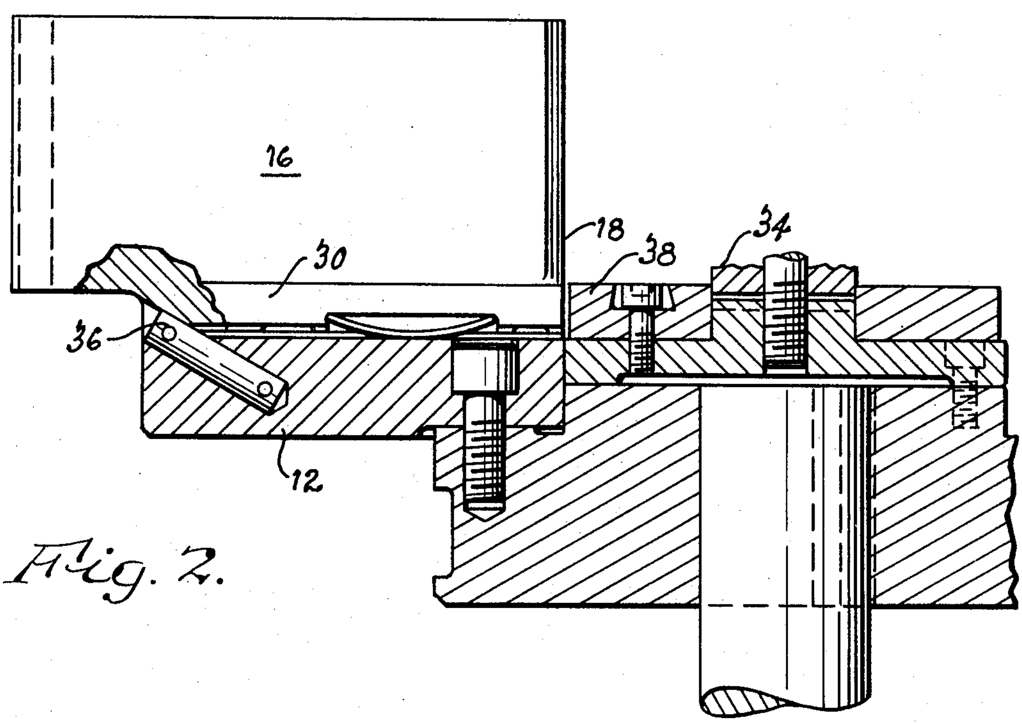


Fig. 2.

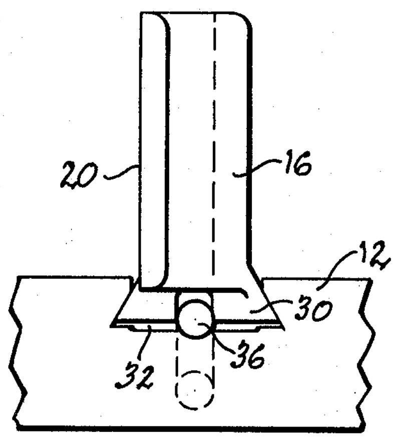
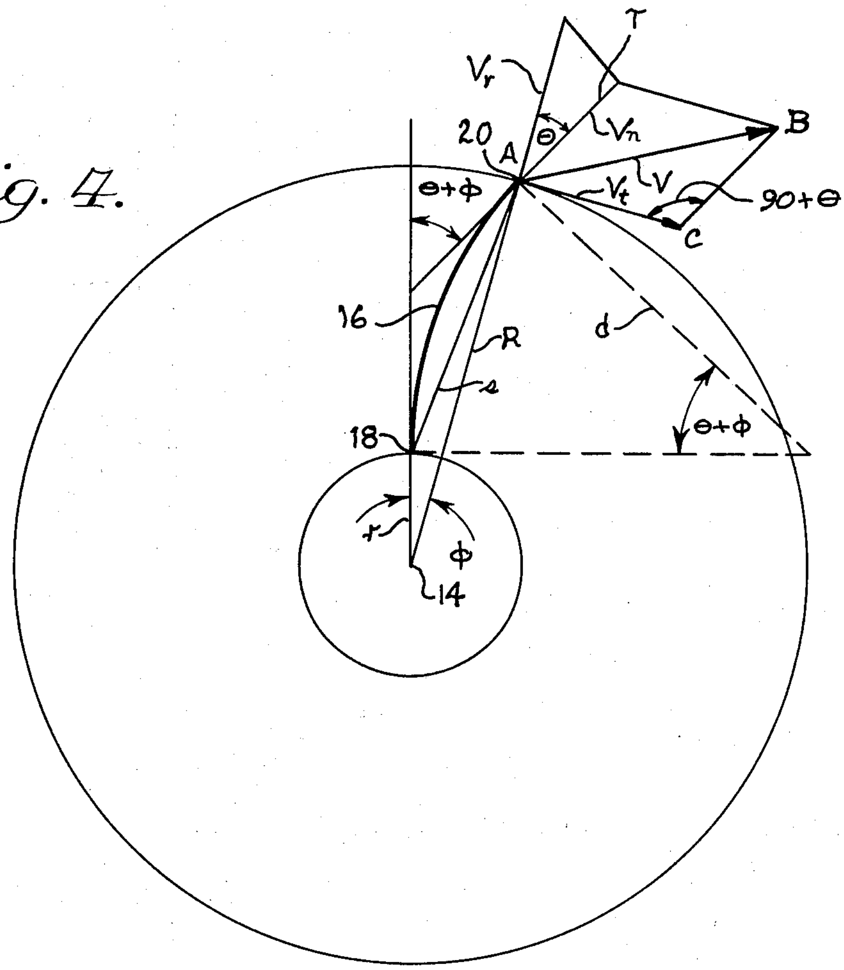


Fig. 3.

Fig. 4.



CURVED VANE FOR THROWING WHEELS

BACKGROUND OF THE INVENTION

Present methods of blast cleaning utilize a centrifugal throwing wheel for projecting abrasive particles. The wheel assembly is comprised of a runnerhead with blades or vanes attached, and an impeller case for feeding abrasive particles to the heel of the vane which propels and discharges the particles centrifugally in any desired direction. Even though the conventional wheel with radial or straight blades or vanes satisfies the needs commercially in blast cleaning, the excessive wear and noise of these wheels warrant a new profile of the vanes to give minimum wear and minimum noise while keeping the final abrasive velocity the same as with straight radial vanes.

U.S. Pat. No. 2,205,414 to Keefer discloses a throwing wheel having vanes with a curved surface which results in the elimination of an impeller and impeller cage for feeding abrasive particles to the vanes. The vanes described in this patent have the innermost extremity curved sharply back with respect to the direction of rotation and merging with a curved gathering surface or pocket which in turn merges with a substantially straight abrasive particle propelling surface.

Heretofore, centrifugal throwing wheels in general use have not utilized a curved vane to significantly reduce the wear and the noise level of conventional throwing wheels.

SUMMARY OF THE INVENTION

According to the present invention, an abrasive particle throwing wheel of the type having an axis of rotation includes a plurality of vanes extending generally perpendicular to one face of the wheel with their innermost ends spaced from the axis of rotation, an impeller cage on said wheel disposed between the innermost ends of said vanes, the improvement comprising curved vanes wherein the curve of each vane is such that the angle between a radius through the outermost edge and a tangent is from about 25° to about 35°, the optimum angle being 31° and 40 minutes.

Tests indicate that a conventional centrifugal wheel having radially extending vanes of 19½ inches diameter, and running at 2,250 rpm has a noise level of 91 decibels in A scale, measured at 3 feet from the wheel. It has been discovered that the substitution of curved vanes on a centrifugal wheel having a diameter of 22 inches but running at a reduced speed of 1,750 rpm results in a noise reduction of 6 decibels while the velocity and the amount of abrasive particles projected per period of time remains the same.

Furthermore, because of the uniquely curved vanes of the present invention, it has been found that the life of the blades are increased. Abrasive wear of the type encountered in a blast cleaning wheel occurs because of sliding or rolling contact of abrasive particles as well as impact of loose particles being batted by the vanes or blades. Tests for abrasive wear indicate that the kinetic energy related to the impact is the prime factor for this phenomena. The tangential velocity with which the vane hits or bats the abrasive particles is the major factor for wear evaluation. This has been proved by testing three different configurations of vanes that have the same abrasive flow and final abrasive velocity but have different tangential velocities. A backward curved

vane having a tangential velocity of 1.29 times the velocity of a radial bladed wheel wore an average of 1.69 times faster than a radial bladed wheel whereas the forward curve blade having a tangential velocity of 0.877 times that of the radial vane wore only an average of 0.73 times that of the radial vane. Since the impact energy imparted is ½ MV_t^2 where V_t is the tangential velocity of any wheel and keeping the final velocity of the particle the same and hence the flow constant in all three cases the following conclusions are drawn:

If V_{tr} is the tangential velocity of the tip of a radial vane, V_{tb} is the tangential velocity of the tip of a backward curved vane and V_{tf} is the tangential velocity of the tip of a forward curved vane, all producing the same final abrasive velocity, the impact on the backward curve blade is $(1.29)^2$ or 1.66 of a radial vane whereas the impact on the forward curve vane is $(0.877)^2$ or 0.77 of a radial vane wheel. These values are at the tip of the vane; however, the wear relationship would be the same at any radial point along the face of the vane. The above theoretical values of 1.66 and 0.77 closely compare with experimental values of 1.69 and 0.73 regarding wear.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmentary view of the face of a throwing wheel and shows one throwing vane which is forwardly curved in accordance with the present invention.

FIG. **2** is a fragmentary sectional view of the throwing wheel shown in FIG. **1.**

FIG. **3** is an end view of a curved vane as mounted on a throwing wheel taken on line **3—3** of FIG. **1.**

FIG. **4** is a pictorial analysis of the velocity vectors and physical characteristics of the curved vane.

DETAILED DESCRIPTION OF THE INVENTION

As illustrated in the drawings, a throwing wheel assembly, generally indicated by the numeral **10,** includes a throwing wheel **12** mounted for rotation about an axis **14** and having a plurality of curved vanes **16** extending generally perpendicular to one face of the wheel. The vanes **16** extend generally radially from the axis of rotation **14** and have an innermost end **18** spaced a given distance r (FIG. **4**) from the axis of rotation **14** and an outermost end **20** spaced a given distance R (FIG. **4**) from the axis of rotation **14.** A conventional impeller cage (not shown) is disposed on the wheel **12** between the innermost ends of the vanes for feeding abrasive particles to the vanes through at least one feed slot in the cage. As illustrated in FIG. **4,** a tangent T through the vane surface at the outermost tip defines an angle θ about 25° to about 35° with respect to a radius R extending from the axis of rotation **14** through the outermost tip **20.** Assuming that an abrasive particle starts from the center of rotation, the values for a radial velocity V_r and a tangential velocity V_t are found from the equations:

$V_t = V_r = 2\pi RN/60$

$V_n = V_r \cos\theta = V_t \cos\theta$

with

V_t = tangential velocity

V_r = radial velocity

V_n = a component of $V_r = V_r \cos\theta$

V = absolute velocity of a thrown particle

Solving the triangle ABC in FIG. **4** by the law of cosines:

$V^2 = V_t^2 + V_n^2 - 2\, V_t V_n \cos(90+\theta)$

$V^2 = V_t^2 + V_t^2 \cos^2\theta + 2\ V_tV_t \cos\theta \sin\theta$

$V^2 = V_t^2\ (1 + \cos^2\theta + \sin 2\theta)$

Let $K = (1 + \cos^2\theta + \sin 2\theta)$

$V^2 = K\ V_t^2$ or $V = (K)^{1/2}\ V_t$

For any given speed N:

$V_t = 2\pi\text{RN}/60$

or

$V = (K)^{1/2}\ 2\pi\text{RN}/60$

For V to be maximum at any given speed, $(K)^{1/2}$ or K should be maximum. Using calculus: for maximum conditions

$d/d\theta\ (K\ (\theta)) = 0$

$d/d\theta\ (1 + \cos^2\theta + \sin 2\theta) = 0$

Since $\cos^2\theta = 1 + \cos 2\theta/2$:

$d/d\theta\ (1 + 1/2 + \cos 2\theta/2 + \sin 2\theta) = 0$

$-1/2\ (2) \sin 2\theta + 2 \cos 2\theta = 0$

$\tan 2\theta = 2$

$2\theta = 63$ degrees 20 minutes

$\theta = 31$ degrees 40 minutes

For all practical purposes, the variation of $(K)^{1/2}$ is found to be small between 25° to 35°.

For a conventional wheel, the radius r is generally less than 1/2 R and, preferably, r is less than about 1/3 R. As indicated in FIG. **4,** the curve of the vane **16** substantially describes an arc of a circle which passes through the innermost end **18** and outermost end **20** of the vane **16.**

The radius through the innermost end **18** and the radius through the outermost end **20** of the vane **16** form an angle phi (ϕ) with respect to the axis of rotation **14** of the wheel **10.** The arc of the vane is described by a radius having an included angle theta (θ) plus phi (ϕ) degrees.

Assuming the values of θ, r and R are known for a particular size of wheel which produces a required velocity of abrasive particles and using the following relations:

$s = R - r$ (approximately)

$s/2 = (d) \sin (\theta + \phi/2)$

$(r + s) \sin \phi = d\ [1 - \cos (\theta + \phi)]$

Values of d and ϕ can be found with trial and error.

For example, for one conventional size wheel having $r = 3\ 1/16$ inches, $R = 11$ inches and desiring $\theta = 30°$, a preferred vane **16** will have $d = 10.47$ inches and $\phi = 15.88°$.

As shown in FIGS. **1–3,** the blades or vanes **16** are equally spaced around the wheel **12** and locked in place by providing an enlarged dove-tailed edge on a base member **30** on one side of the vane **16** snugly engaged within a corresponding dove-tailed slot **32** in the wheel **12.**

To mount the vanes, the vane **16** is introduced at the

wheel periphery into the slot **32** and moved therealong until the innermost end **18** of the vane approaches a center stud **34.** At this point, a wedge type locking pin **36** is inserted into a bored hole in the wheel **12** after which the vane **16** is moved outwardly toward the wheel periphery so that the outer end of the bottom of the vane **16** rides over the pin **36.** A locking ring **38** is then installed in place and forces the vane **16** against the locking pin **36** to form a tight fit.

A similar type of vane locking means is more particularly disclosed in FIGS. 23–30 of U.S. Pat. No. 3,241,266 granted to Joseph E. Bowling, Jr., on Mar. 22, 1966.

While the invention has been described herewith with reference to a preferred embodiment, it is to be understood that various changes and modifications may be made by those skilled in the art without departing from the spirit and scope of the invention as defined in the following claimed subject matter.

I claim:

1. In a centrifugal throwing wheel of the type including a rotatable runnerhead having a plurality of vanes mounted thereon for throwing particles therefrom; the improvement comprising a throwing vane being curved continuously forwardly in the direction of rotation, the curve of said vane defining an arc of a circle extending substantially from an innermost tip to an outermost tip of said vane; the curve of said vane being further defined by an angle formed between a radius extending from the center of rotation through the outermost tip of said vane and a line tangential to said curve at the outermost tip, said angle being substantially 31° and 40 minutes.

2. A particle throwing vane for a centrifugal wheel of the type including a rotatable runnerhead which is rotatable in a direction of intended rotation about a fixed center of rotation and wherein said throwing vane includes a base member for mounting said vane on said runner head in outwardly spaced relation from said center of rotation, the improvement comprising: said vane being curved continuously forwardly in the direction of intended rotation, the curve of said vane defining an arc of a circle extending substantially from an innermost tip to an outermost tip of said vane; said vane and base member being constructed and arranged for being mounted on said runner head such that a radius extending from said center of rotation through the outermost tip of said vane and a line tangential to said curve at the outermost tip define an angle of substantially 31° and 41 minutes.

* * * * *