July 1, 1952 D. P. EASTMAN ET AL 2,601,969

TURBINE WHEEL

Filed Jan. 25, 1946 3 Sheets-Sheet 1

Fig. 1

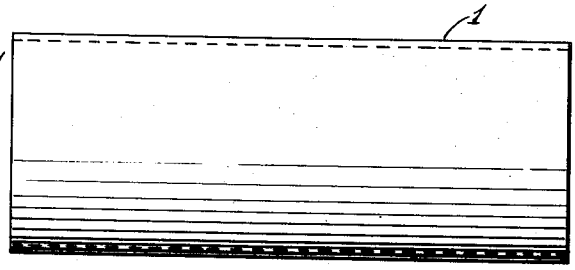


Fig. 2

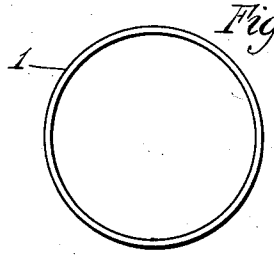


Fig. 4

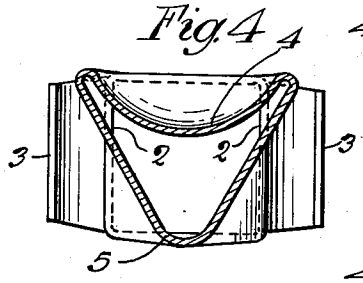


Fig. 3

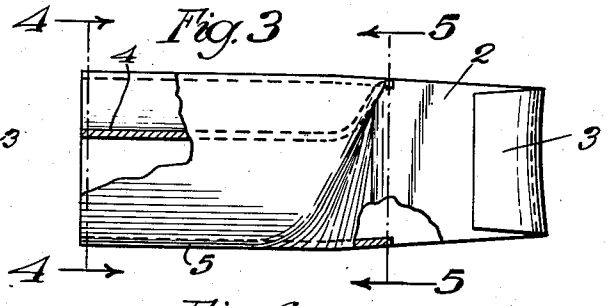


Fig. 5

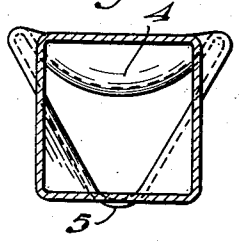


Fig. 6

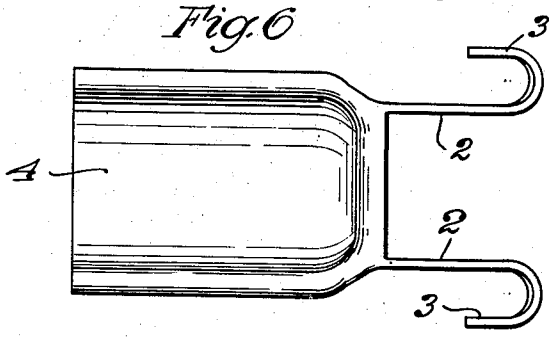


Fig. 7

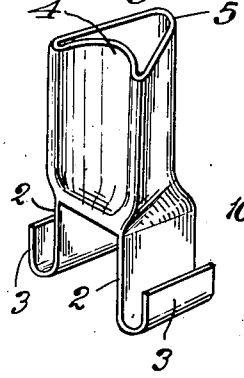


Fig. 9

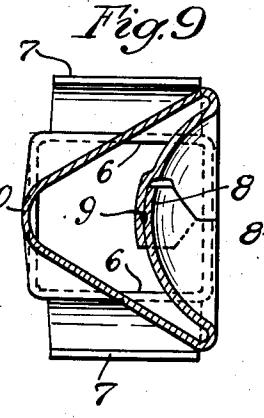
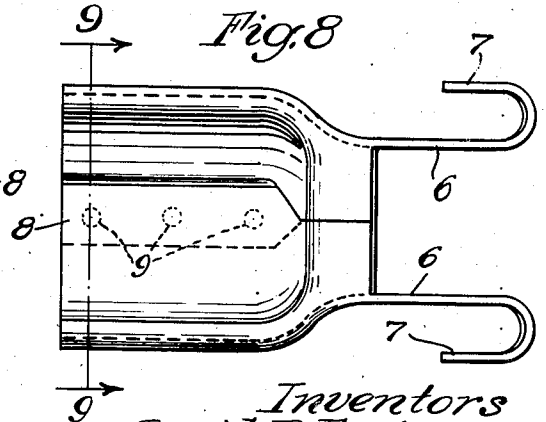


Fig. 8



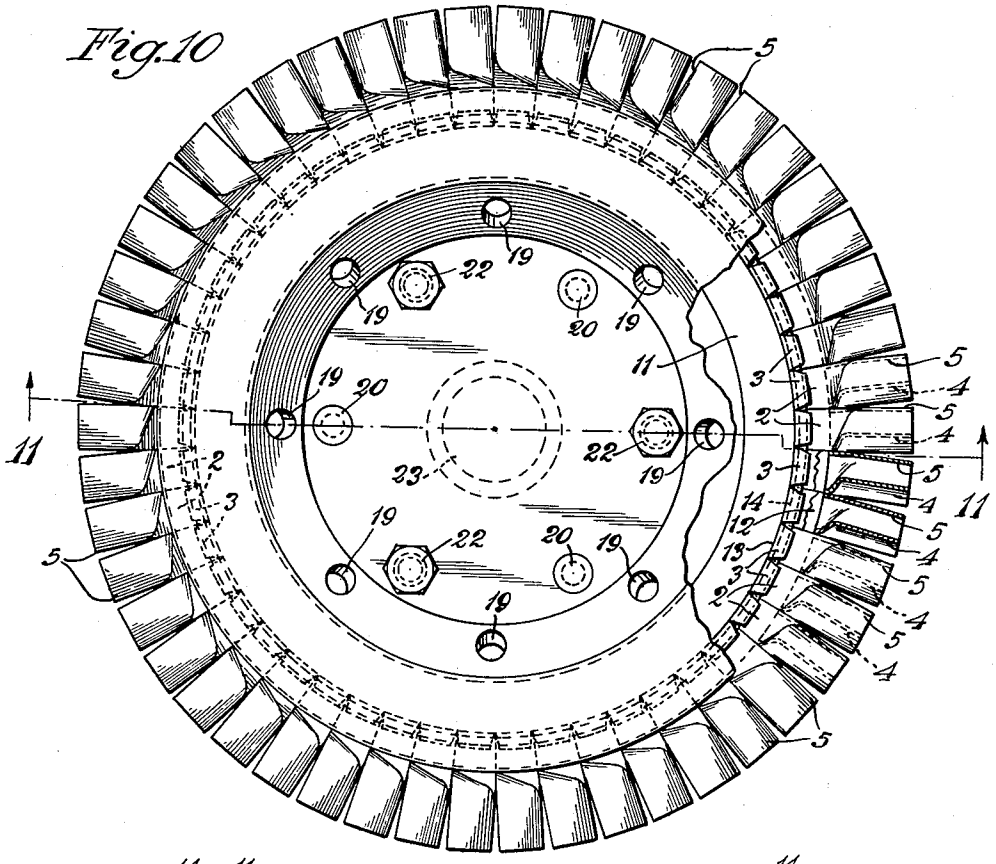
Inventors
David P. Eastman
Theodore L. Swansen
by Parker & Carter
Attorneys.

July 1, 1952 D. P. EASTMAN ET AL 2,601,969

TURBINE WHEEL

Filed Jan. 25, 1946 3 Sheets-Sheet 2

Fig. 10



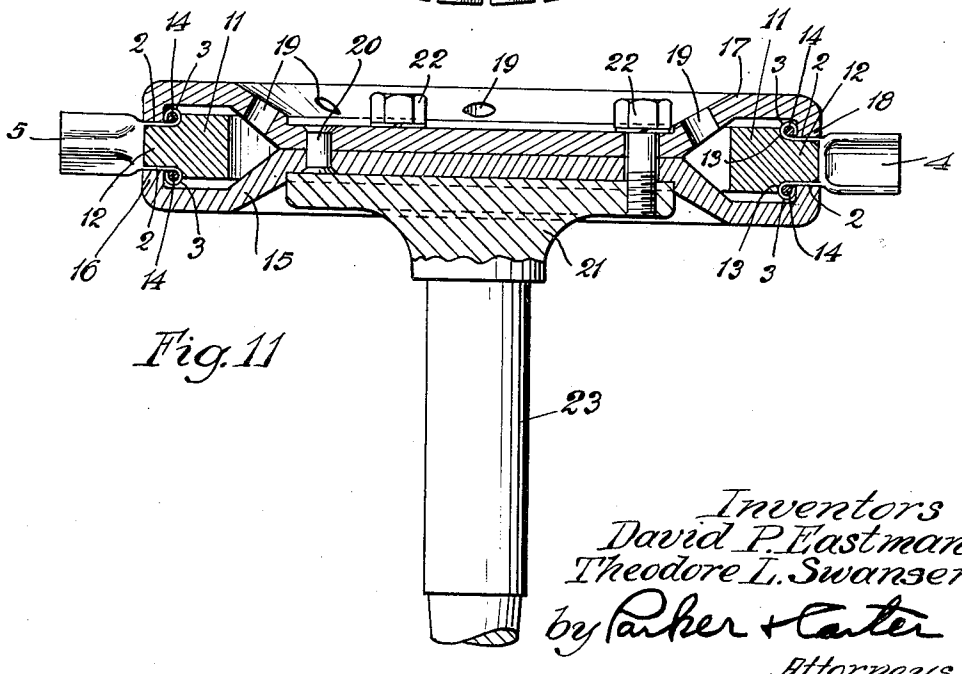


Fig. 11

Inventors
David P. Eastman
Theodore L. Swansen
by Parker & Carter
Attorneys

July 1, 1952 D. P. EASTMAN ET AL 2,601,969

TURBINE WHEEL

Filed Jan. 25, 1946 3 Sheets-Sheet 3

Fig. 12

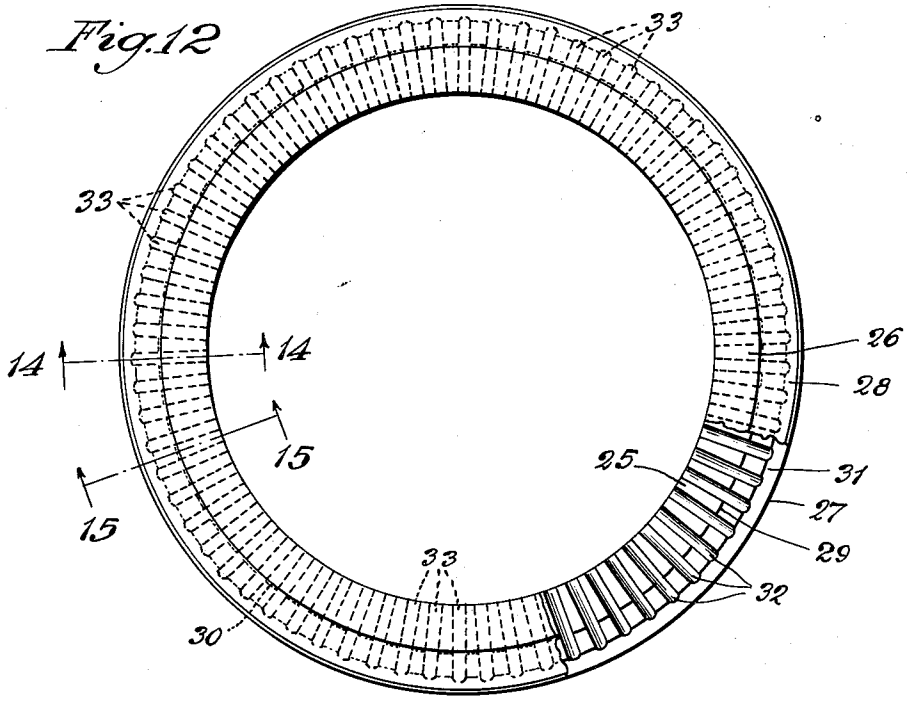


Fig. 13

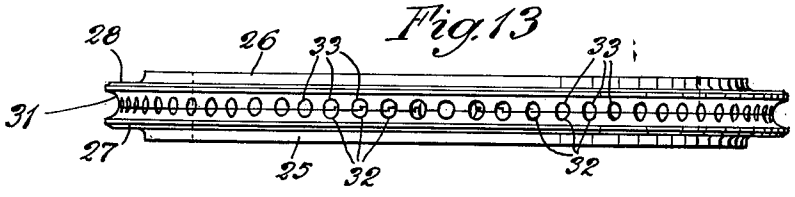


Fig. 14

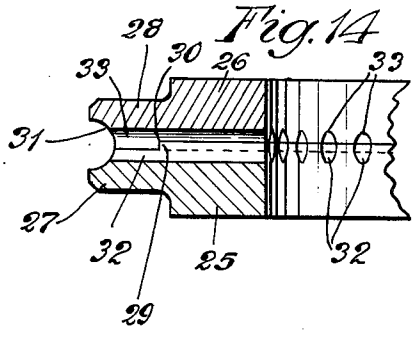
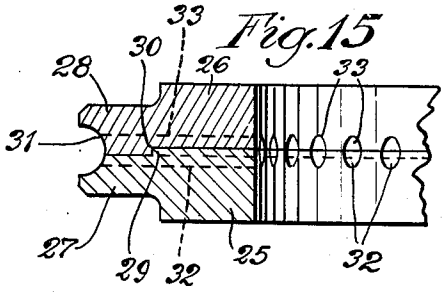


Fig. 15



Inventors
David P. Eastman
Theodore L. Swanzen
by Parker & Carter.
Attorneys.

Patented July 1, 1952

2,601,969

UNITED STATES PATENT OFFICE

2,601,969

TURBINE WHEEL

David P. Eastman, Chicago, Ill., and Theodore L. Swansen, Milwaukee, Wis., assignors to United Specialties Company, Chicago, Ill., a corporation of Delaware

Application January 25, 1946, Serial No. 643,242

13 Claims. (Cl. 253—39.15)

1

This invention relates to a turbine wheel and to a turbine bucket and has for one object to provide a turbine bucket.

Another object is to provide a turbine wheel so arranged that the velocity of the wheel itself tends to hold the buckets in place as centrifugal force increases.

Other objects will appear from time to time in the course of the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawings wherein:

Figure 1 is an elevation of a blank for one form of bucket;

Figure 2 is an end view of the blank of Figure 1;

Figure 3 is a side elevation with parts broken away and parts in section illustrating the bucket after formation;

Figure 4 is a section taken at line 4—4 of Figure 3;

Figure 5 is a section taken at line 5—5 of Figure 3;

Figure 6 is a top plan view of the bucket of Figures 3, 4 and 5;

Figure 7 is a perspecive view of a completed bucket;

Figure 8 is an elevation similar to Figure 6 showing a modified form of bucket;

Figure 9 is a section taken at line 9—9 of Figure 8;

Figure 10 is a side view with parts broken away and parts in section illustrating a turbine wheel to which have been applied the buckets of either of the previous forms;

Figure 11 is a section on the line 11—11 of Figure 10;

Figure 12 is a plan view with parts broken away illustrating one form of bucket retaining ring;

Figure 13 is a side elevation of the ring of Figure 12;

Figure 14 is a section on an enlarged scale taken at line 14—14 of Figure 12; and

Figure 15 is a section taken on an enlarged scale at line 15—15 of Figure 12.

Like parts are indicated by like symbols throughout the specification and drawings.

In the particular form here shown the buckets are illustrated as being formed in two manners. As illustrated in the first seven figures the bucket is formed of tubing. As illustrated in Figures 8 and 9 it is formed of sheet material. The form of the first seven figures will first be described.

A piece of seamless tubing 1 of suitable length forms the blank for a bucket. Portions are cut away to provide tongs 2 and the tongs are curled or bent toward the body of the remaining portion of the tube to form the ears 3. That portion of the tube which is to form the bucket proper is given the contour illustrated in Figures 4 and 5 in section and as shown the tubular member has been shaped to provide a trough-like depression 4 and the enlargement or bulge 5.

2

The invention is not limited to the particular contour or shape of bucket shown and a bucket might be made in many different forms without departing from the spirit of the invention. The bucket is hollow from end to end although this is not essential. Where ventilation or cooling of the bucket is provided it is advantageous to have the bucket hollow.

In the modified form of Figures 8 and 9 the bucket has substantially the same contour and shape as that shown in the earlier figures but instead of being formed of the tube it is formed of a sheet of material. As formed there are extensions 6 from the main body of the bucket and the extensions are shaped or bent to provide ears 7. A depression or trough-like portion 8 is formed in the bucket and along this portion the two edges of the material meet and may be welded as at 9 or otherwise secured together. A bulge or enlargement 10 is formed of the material.

In the formation of a turbine wheel a plurality of buckets made according to either of the forms illustrated in the first nine figures is arranged about the periphery of the wheel. The buckets are first arranged about a ring 11 which has a reduced portion 12. The portion 12 is so shaped that the buckets fit snugly over it with their bottom portions against the periphery of the reduced portion 12 and their respective ears against the shoulder 13 formed between the portion 12 and the ring 11. Ring like members 14 which may be of any desired form or shape are positioned about the ring 11 and the ears 3 or 7 are bent over them into the form shown in Figure 11. The ring like members 14 may preferably be wires or rods which have been given circular shape and they may be endless if desired, or they need not be. When the buckets are positioned upon the ring 11 the ring itself is positioned between two wheel members. These in the particular form shown constitute a member 15 having an inwardly directed flange 16 and a member 17 having a corresponding inwardly directed flange 18. The member 17 may be perforated as at 19 for cooling or ventilation if desired. The two wheel members 15 and 17 are preferably secured

together in any desired manner. As shown, they are held together by rivets 20. A wheel may be secured to a hub 21 by screws 22, or otherwise. A shaft 23 is secured to the hub 21 in any desired manner.

In the assembly the parts are so proportioned that the flanges 16 and 18 fit closely against the ears 3 and also fit closely against the portions 2 or 6 of the buckets so as to press them against the reduced portion 12 of the ring 11. The ring 11 is itself not positively secured to any part of the wheel and is confined solely by the bucket anchors 2, 3 or 6, 7, which in turn are confined by flanges 16 and 18 and wheel members 15 and 17. When the wheel is in use and rotating at high velocity, the ring 11, 12 has a tendency to expand under the influence of centrifugal force. The flanges 16 and 18 also tend to expand under the influence of centrifugal force. However, unlike the ring 11, 12 these flanges are restrained by the solid disc members 15 and 17. The flanges thus expand less than the ring 11, 12 and support a large percentage of the centrifugal load imposed upon the wheel through the buckets 2 and 3 or 6 and 7 and the ring members 14.

This tendency results in an increased compression on the ears 3 or 7 and upon the retaining wire members 14. Thus as rotation increases and centrifugal force which would normally tend to throw the bucket out of the wheel is increased, the ring expands sufficiently to increase the compression on the ears 3 or 7 of the buckets and thus additionally to hold them in place. Means are thus provided for gripping the buckets more tightly in the wheel at the exact time when the tendency to throw them from the wheel is increased.

For some purposes it is desirable to provide means for ventilating or cooling the turbine wheel and it is for this purpose that the holes or perforations 19 are formed in the wheel member 17. To provide a path for cooling material to reach the buckets themselves the ring construction is modified from that shown in Figures 10 and 11. This modified construction appears in Figures 12 to 15, inclusive. As there shown, the ring comprises two annular members 25 and 26 having respectively reduced portions 27 and 28. The portion 25 is provided with a shoulder 29 and the portion 26 is provided with a depression 30 into which the shoulder fits. The members 25 and 26 when assembled together, as shown generally in Figures 12 and 13 and in detail in Figures 14 and 15, are then assembled between the plate 15 and 17 in the manner in which the ring 11 is shown in Figure 11. The portions 3 of the buckets are engaged about the wires 14 in the manner as shown in Figure 11, and the assembly in a finished wheel is the same as that shown in Figure 11. The passages formed by the grooves 32 and 33 are tubular, as shown in Figures 13, 14 and 15, particularly, and communicate with the peripheral groove 31 to provide for ventilation.

A peripheral groove 31 may be formed in the two ring portions 25 and 26. This groove is aligned with the bottom of the buckets and in communication with the hollow interior of each bucket. Each of the ring portions 25 and 26 is provided with grooves. The grooves in the portion 25 are numbered 32 and those in the portion 26 are numbered 33. Together they provide radial or outwardly extending perforations or passages.

By means of the ring construction of Figures 12 to 15, inclusive, cooling fluid which reaches the wheel portion 17 passes through the perforations or openings 19 to the space defined between the wheel members 15 and 17. Thence it moves outwardly through the perforations formed by the grooves 32 and 33 and reaches the annular groove 31 and so is discharged to and passes through the buckets. In most situations in which a turbine wheel such as that shown is to be mounted or used, one side of the wheel is positioned so that a cooling fluid may be discharged against it and this fluid, when the ring construction of Figures 12 to 15 is present, passes to and into the wheel and outwardly through the peripheral buckets. Centrifugal force is effective to move the fluid and other forces such as suction present about the wheel may also assist in this movement. The invention is, of course, not limited to the presence of means for cooling or ventilating the bucket.

Although we have shown an operative form of our invention, it will be recognized that many changes in the form, shape and arrangement of parts can be made without departing from the spirit of the invention, and our showing is therefore to be taken as, in a sense, diagrammatic.

The use and operation of the invention are as follows:

The buckets of either of the forms shown are preferably made of metal although they might be made of other materials. The choice of material will depend largely upon the use to which the wheel is to be put, the speed at which it is to operate and the propelling fluid with which it is to be used. However, as the buckets are made they are provided with the extensions 2 or 6 and with the ears 3 or 7. A suitable number of buckets is then positioned upon a ring either as shown upon the ring 11 or upon the ring shown in the latter figures. The buckets fit snugly about the reduced portions of the ring and are held in place by the members 14 about which the ears 3 or 7 are bent. The ring with the ears upon it is then assembled between two wheel members and proportions of the parts are such that the ears are gripped tightly between the shoulders formed at the reduced portion 11 and the inwardly bent flanges 18 and 16 of the wheel members. When the wheel members are then fastened together the buckets are additionally held in place.

The ring construction of Figures 12 to 15 lends itself equally well to the method of assembly and securing just described. The buckets are positioned over the reduced portion formed by the members 27 and 28.

When the bucket and wheel construction illustrated is embodied in a turbine, propelling fluid is discharged against the buckets and the wheel is revolved. As the wheel revolves rapidly, centrifugal force is developed with increasing speed of rotation and a tendency to throw the buckets outwardly develops. Before this tendency develops to dangerous proportions, the same centrifugal force is effective upon the ring 11 and tends to stretch or spread it sufficiently to cause it to yield outwardly slightly and to exert an added compression upon the ears 3 or 7 of the buckets. This forces these parts with increasing pressure against the more highly restrained flanges 16 and 18, and therefore the centrifugal force which in one sense tends to throw the buckets away from the wheel, in another sense sets up a condition which additionally and in-

creasingly tends to hold the buckets tighter and tighter as the speed of rotation increases.

The structure of this invention comprises not merely a useful bucket and wheel construction but provides a bucket and wheel construction which in itself is so to speak self-tightening under conditions of use.

We claim:

1. In combination in a turbine wheel, a shouldered ring, a plurality of buckets provided with portions adapted to fit over said ring and against said shoulder, and a plurality of members extending around said ring and engaging said buckets, and a pair of members positioned to embrace said ring to hold said buckets thereon, said ring being free in said embracing members.

2. In combination in a turbine wheel, a main wheel body shaped to provide a cavity adjacent its periphery, and to provide a continuous peripheral opening therefrom, the width of said opening being less than the major width of said cavity, and a bucket-retaining ring positioned for movement within said cavity, the maximum thickness of said ring being greater than the width of said opening, and a plurality of buckets positioned on said ring, each bucket being provided with members extending inside of said cavity, and retainers within said cavity, said bucket members being engaged about them.

3. In combination in a turbine wheel, a main wheel body shaped to provide a cavity adjacent its periphery, and to provide a continuous peripheral opening therefrom, the width of said opening being less than the major width of said cavity, and a bucket-retaining ring positioned freely partly in said cavity and partly in said opening, the maximum width of said ring being greater than the width of said opening, and a plurality of buckets positioned on said ring, each bucket being provided with members extending inside of said cavity, and retainers within said cavity, said bucket members being engaged about them.

4. In combination in a turbine wheel, a main wheel body shaped to provide a cavity adjacent its periphery, and to provide a continuous peripheral opening therefrom, the width of said opening being less than the major width of said cavity, and a bucket-retaining ring positioned within said cavity, the maximum width of said ring being greater than the width of said opening, and a plurality of buckets positioned on said ring, each bucket being provided with members extending inside of said cavity, and retainers within said cavity, said bucket members being engaged about them, said ring being free to move outwardly with respect to said wheel, and thereby to hold the buckets against the retainers.

5. In combination in a turbine wheel, a main wheel body shaped to provide a cavity adjacent its periphery, and to provide a continuous peripheral opening therefrom, the width of said opening being less than the major width of said cavity, and a bucket-retaining ring positioned partly in said cavity and partly in said opening, the maximum width of said ring being greater than the width of said opening, and a plurality of buckets positioned on said ring, each bucket being provided with members extending inside of said cavity, and retainers within said cavity, said bucket members being engaged about them, said ring being free to move outwardly with respect to said wheel, and thereby to hold the buckets against the retainers.

6. In combination in a turbine wheel, a main wheel body shaped to provide a cavity adjacent its periphery, and to provide a continuous peripheral opening therefrom, the width of said opening being less than the major width of said cavity, and a bucket-retaining ring positioned within said cavity, the maximum width of said ring being greater than the width of said opening, and a plurality of buckets positioned on said ring, each bucket being provided with members extending inside of said cavity, and retainers within said cavity, said bucket members being engaged about them and extending away from said peripheral opening.

7. In combination in a turbine wheel, a main wheel body shaped to provide a cavity adjacent its periphery, and to provide a continuous peripheral opening therefrom, the width of said opening being less than the major width of said cavity, and a bucket-retaining ring positioned partly in said cavity and partly in said opening, the maximum width of said ring being greater than the width of said opening, said ring being provided with shoulders, and a plurality of buckets positioned on said ring, each bucket being provided with members extending inside of said cavity, and retainers within said cavity, said bucket members being engaged about them and being seated in said shoulders, said ring being free to move outwardly with respect to said wheel, and thereby to hold the buckets against the retainers.

8. In combination in a turbine wheel, two main wheel members having inwardly directed flanges spaced from each other, a bucket-retaining ring positioned in part between said members and projecting through the space between said flanges, a portion of said ring being of greater thickness than the space between said flanges, and a plurality of buckets positioned on said ring, said buckets provided with members embracing the periphery of said ring and extending into the space between said wheel parts, said ring being free for movement with respect to said wheel members.

9. In a turbine wheel, a bucket clamping couple including a pair of clamping members including axially overlapping portions defining clamping surfaces opposed radially with respect to the wheel axis, bucket members, each including an anchoring portion disposed between the clamping surfaces of said clamping members, and means for holding said clamping members in clamping engagement with said anchoring portion of said buckets, one of said clamping members including a portion which is movable toward the other clamping member under the action of centrifugal force, thereby to increase the gripping force on said anchoring portion of the bucket members when the wheel is rotated.

10. In a turbine wheel, a bucket clamping couple including a pair of clamping members including axially overlapping portions defining clamping surfaces opposed radially with respect to the wheel axis, bucket members, each including flexible anchor portions disposed between the clamping surfaces of said clamping members, and means for holding said clamping members in clamping engagement with said anchor portions of said buckets, one of said clamping members including a portion which is movable toward the other clamping member under the action of centrifugal force, thereby to increase the

gripping force on said anchor portion of the bucket members when the wheel is rotated.

11. In a turbine wheel, a plurality of buckets and means defining a main wheel body, said buckets being positioned upon said body, means in said main wheel body defining a pair of oppositely placed continuous annular shoulders, parts of said wheel being positioned adjacent each of said annular shoulders in axially overlapping relation thereto and defining therewith clamping surfaces opposed radially with respect to the wheel axis, said buckets having pairs of oppositely placed anchoring members, said anchoring members being disposed between said clamping surfaces, the means defining said annular shoulders being free to move outwardly under the action of centrifugal force to increase pressure on said anchoring members to hold them against said shoulders, said anchoring members being shaped to have an abrupt change of direction within the wheel structure and within the space bounded by said shoulders.

12. In combination in a turbine wheel, a plurality of buckets and means for securing them together, said means comprising a ring-like shouldered member having continuous concentric annular surfaces, and means embracing said shouldered member and including portions axially overlapping said annular surfaces and defining therewith clamping surfaces opposed radially with respect to the wheel axis, said buckets being provided with anchoring portions shaped to fit over the periphery of said shouldered member and between said clamping surfaces, said shouldered member being free to move outwardly under the influence of centrifugal force.

13. The apparatus described in claim 12 wherein air passages are provided through said embracing means and through said shouldered member through which air is free to pass to said buckets.

DAVID P. EASTMAN.
THEODORE L. SWANSEN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
849,992	Frikart et al.	Apr. 9, 1907
886,515	Jude	May 5, 1908
900,739	Jude et al.	Oct. 13, 1908
1,035,543	Dake	Aug. 13, 1912
1,178,452	London	Apr. 4, 1916
1,345,678	Kasley	July 6, 1920
1,366,119	Darling	Jan. 18, 1921
1,516,607	Johanson	Nov. 25, 1924
1,801,427	Holzwarth	Apr. 21, 1931
1,947,347	Lorenzen	Feb. 13, 1934
2,240,742	Allen	May 6, 1941
2,354,304	Celio	July 25, 1944
2,421,855	Soderderg	June 10, 1947
2,484,274	Eastman	Oct. 11, 1949

FOREIGN PATENTS

Number	Country	Date
14,964	Great Britain	July 14, 1908
64,805	Sweden	Jan. 14, 1922
369,996	Germany	Feb. 26, 1923
383,506	Germany	Oct. 13, 1923