W. F. RICE.

TURBINE BUCKET.

APPLICATION FILED MAY 27, 1907.

905,460. Patented Dec. 1, 1908.

2 SHEETS—SHEET 1.

Fig. 1.

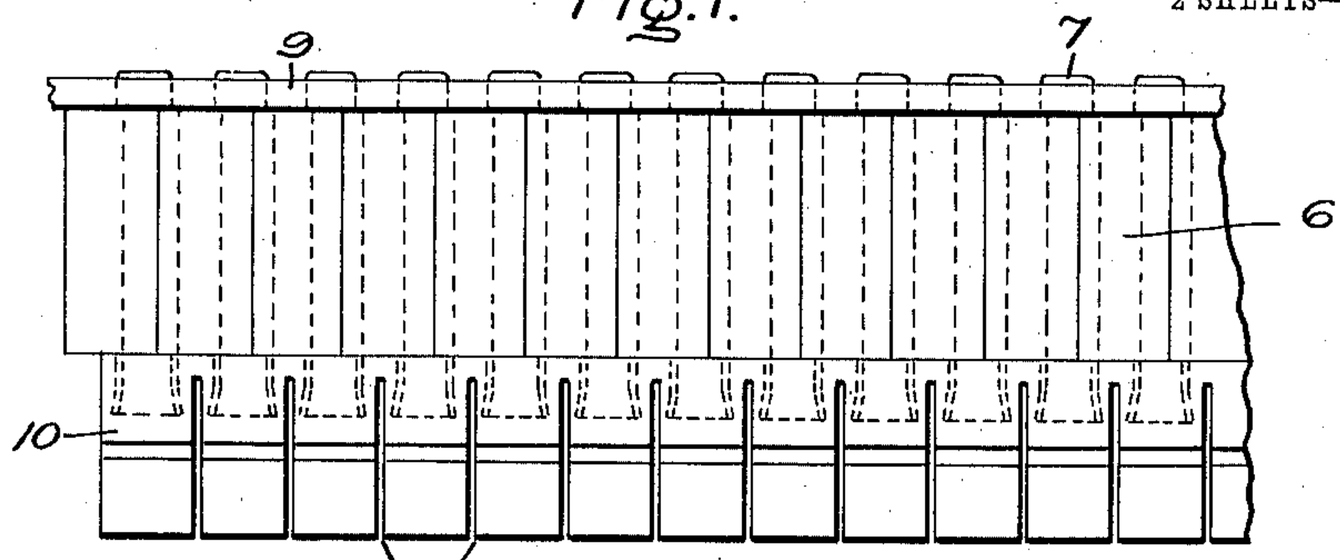


Fig. 2.

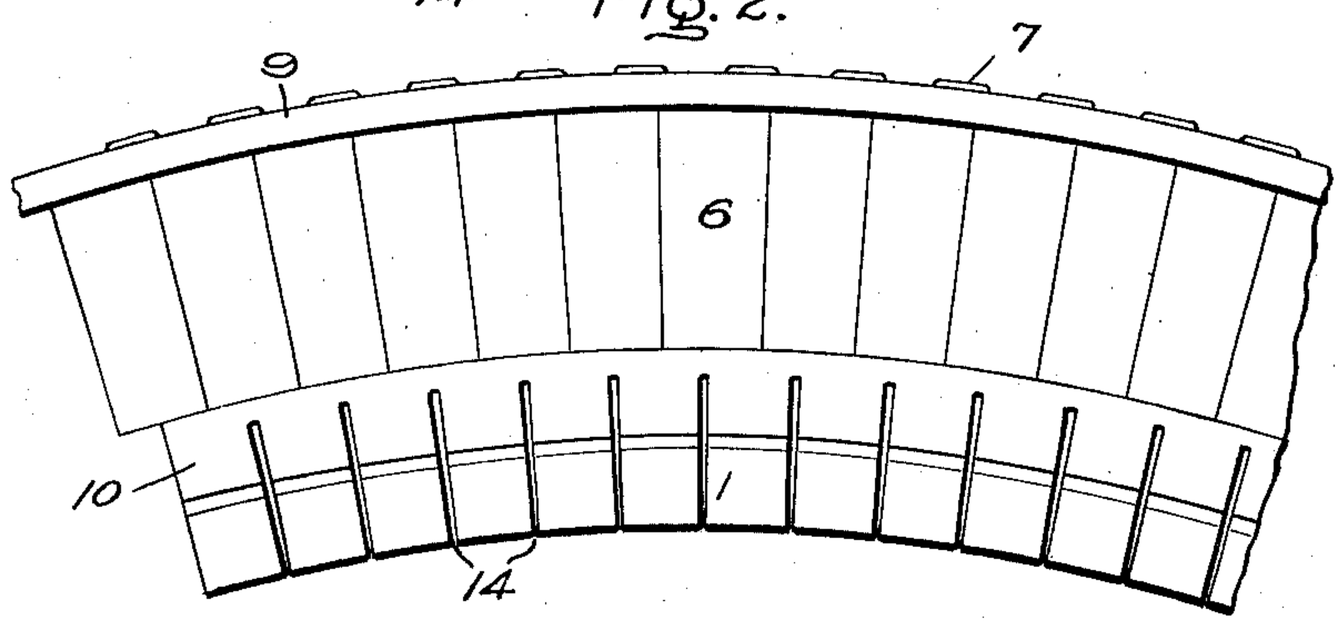


Fig. 3.

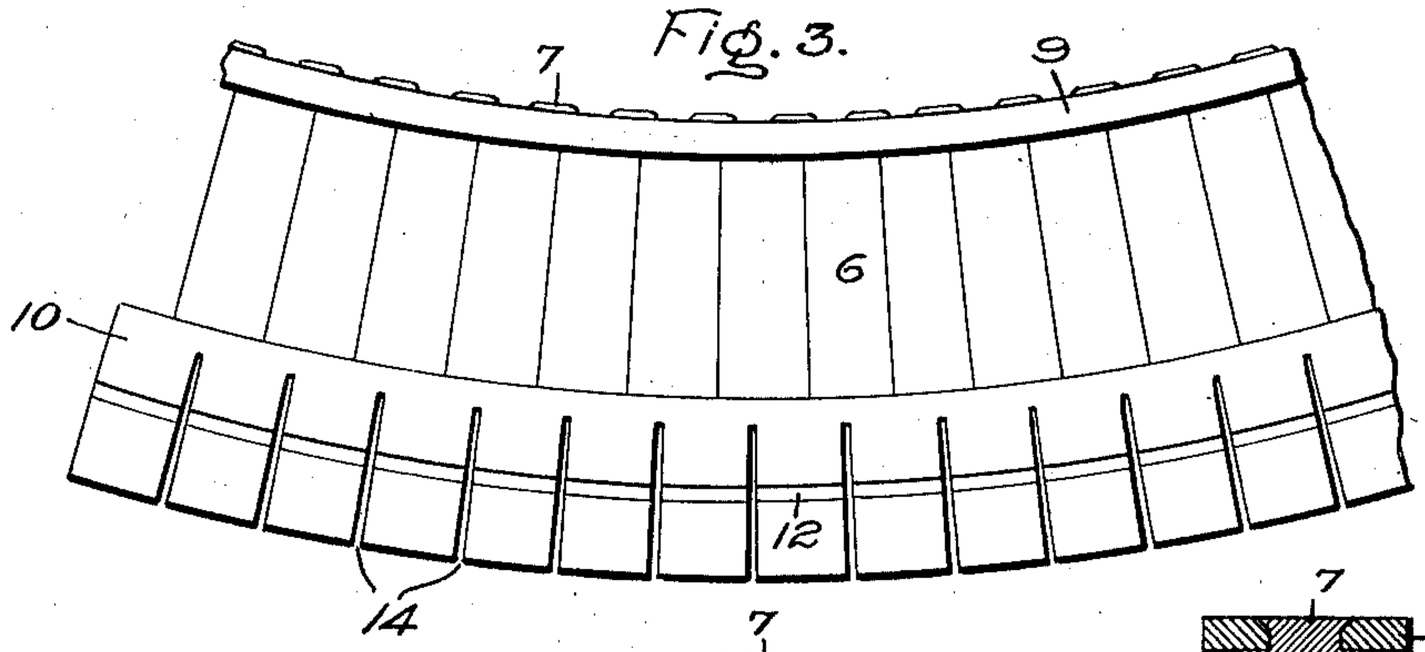


Fig. 4.

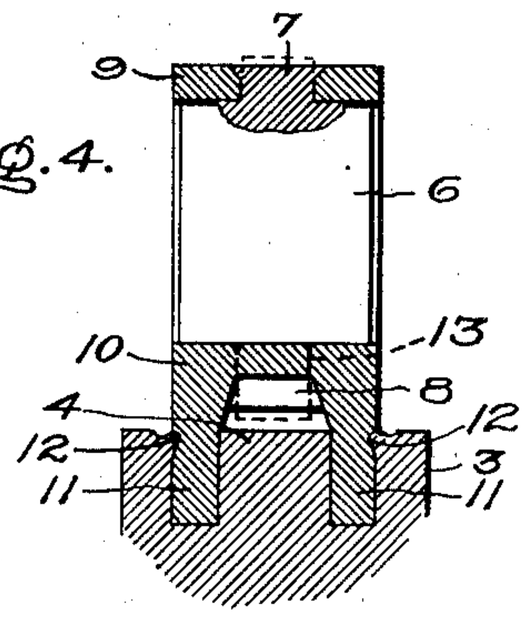
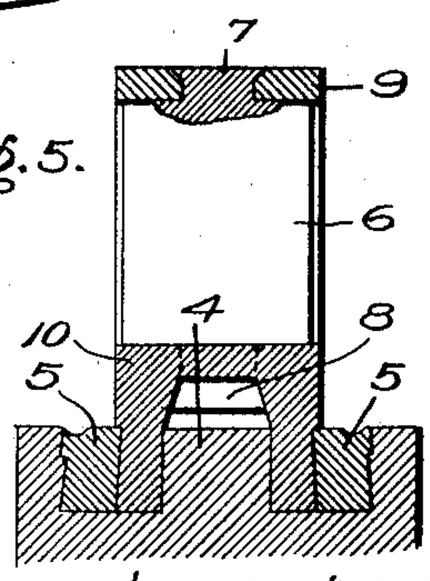


Fig. 5.



Witnesses:
Marcus L. Byng.
J. Ellis Glen

Inventor:
Walter F. Rice,
By Albert G. Davis
Att'y.

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2 SHEETS—SHEET 2.

Fig. 6.

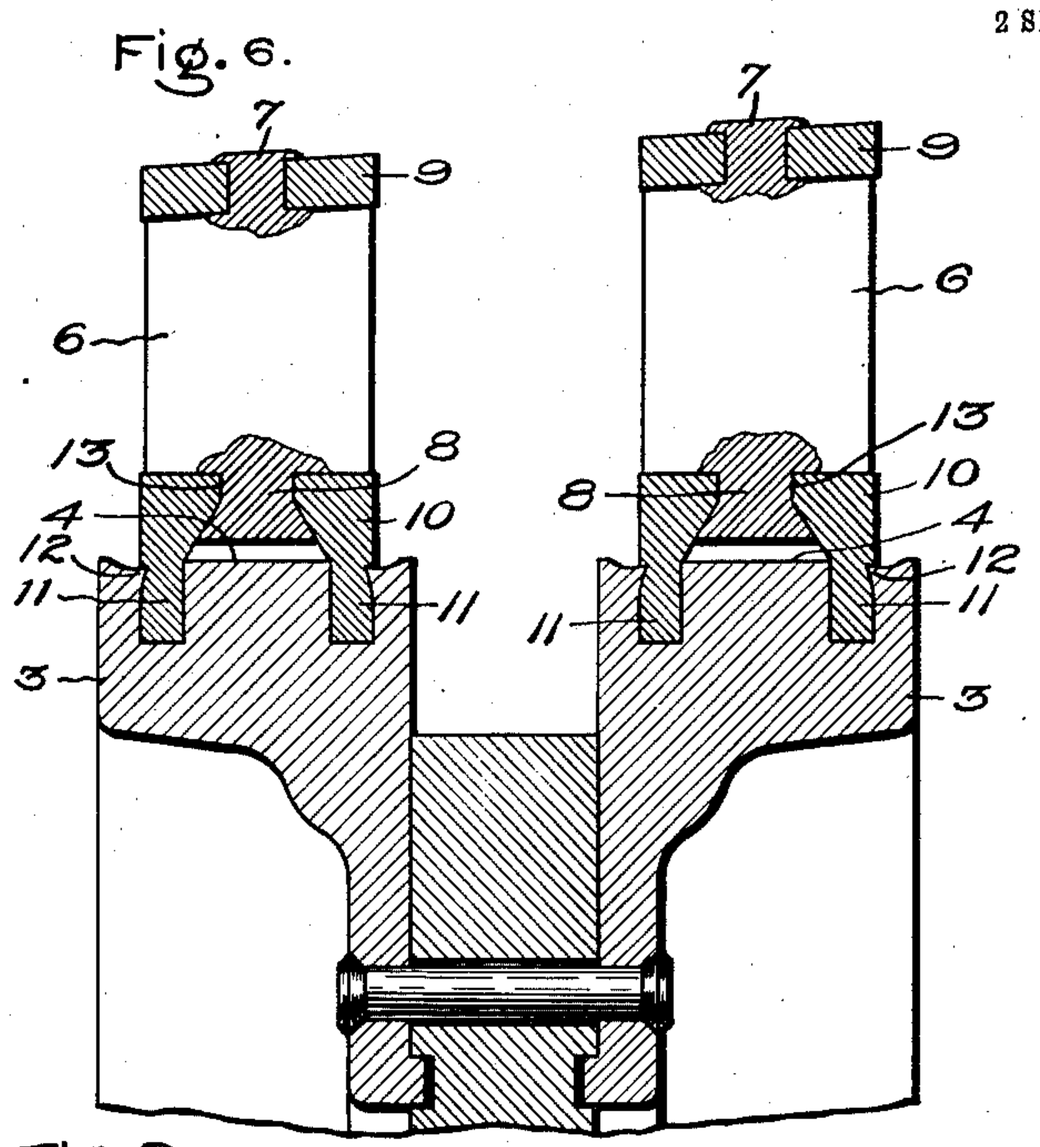


Fig. 8.

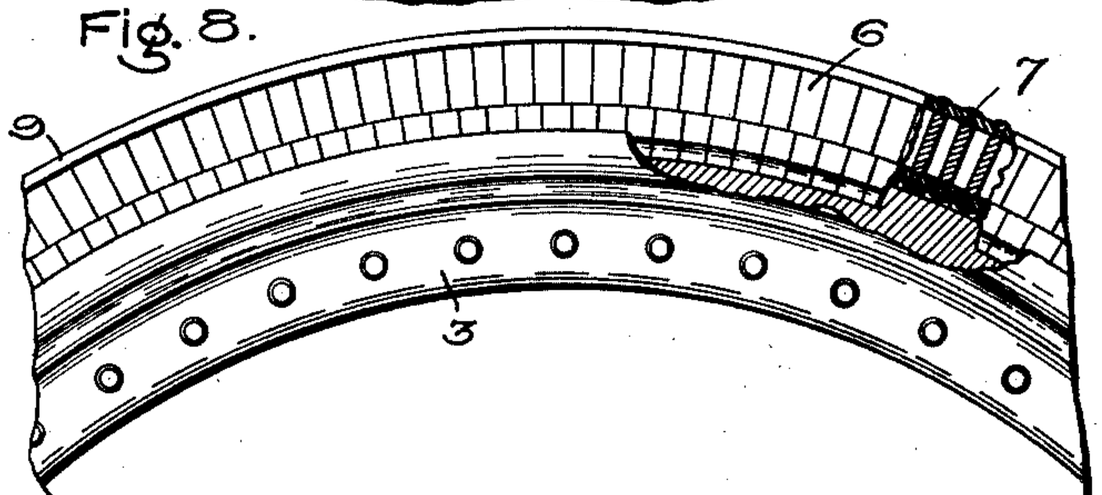
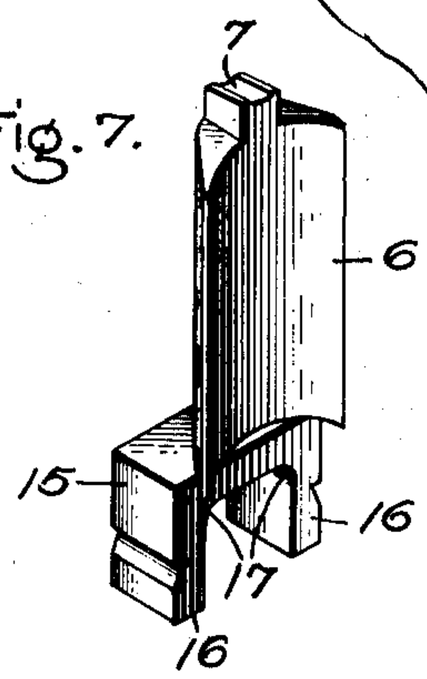


Fig. 7.



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By Albert G. Davis

Att'y.

UNITED STATES PATENT OFFICE.

WALTER F. RICE, OF QUINCY, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

TURBINE-BUCKET.

No. 905,460. Specification of Letters Patent. Patented Dec. 1, 1908.

Application filed May 27, 1907. Serial No. 375,853.

To all whom it may concern:

Be it known that I, WALTER F. RICE, a citizen of the United States, residing at Quincy, county of Norfolk, State of Massachusetts, have invented certain new and useful Improvements in Turbine-Buckets and Means for Attaching Them, of which the following is a specification.

The invention has reference to elastic fluid turbines and relates more particularly to the turbine buckets and the means employed for mounting the buckets upon their supports.

The object of my invention is the provision of an improved construction which attaches the buckets to their supports in a convenient and secure manner, reduces the strain on the rims of the wheels or supports of the movable buckets by reducing the size and weight of the rim, lessens the cost of manufacture and has other advantages all as set forth in the following specification.

In the accompanying drawings illustrating embodiments of my invention, Figure 1 is a side view of a group of buckets showing the bucket base before it is bent to the curvature of its support; Fig. 2 is a side view of the buckets shown in Fig. 1 with the base bent to the curvature of a bucket wheel; Fig. 3 is a side view of a group of buckets with the base bent to the curvature of an intermediate; Fig. 4 is a section through the buckets shown in Figs. 1, 2 and 3; Fig. 5 is a section showing a modification of the means for securing the buckets to the support; Fig. 6 is a section of the rim of a wheel with buckets attached; Fig. 7 is a perspective view of a modification; and Fig. 8 is a side view of a portion of a wheel having buckets of the type shown in Fig. 7.

For convenience, the turbine buckets are shown mounted on the rim of a wheel 1 carried by and rotating with the main turbine shaft 2, but the invention is equally well adapted for use on either stationary or movable intermediates, the buckets projecting radially inward when used for the intermediates (Fig. 3) instead of radially outward as when mounted upon the wheels or rotors (Figs. 2 and 8). The invention, however, is not limited in its use to the mounting of buckets upon the rim or any particular portion of the surface of the wheel or intermediate. It may be employed on the faces as well as upon the rims of the supporting members.

In Figs. 6 and 8, supports 3 are attached to the web of the wheel 1 and the rim thus formed is provided with two rows of buckets. The number of rows may, however, be varied to suit operating conditions. The bases of the buckets have the cross-section of a channel bar, namely, two parallel spaced flanges projecting from a web or central portion connecting them at one end. Ribs 4 are formed upon the faces of the supports 3 by turning parallel grooves therein and the inner surfaces of the flanges of the channel bar section are fitted to the ribs. The grooves between the ribs and the edges of the support may be of substantially the same width as the flanges, Figs. 4 and 6, or of greater width than the flanges, Fig. 5. In Fig. 5 the sides of the grooves adjacent the edge of the rim are undercut. The outer faces of the flanges of the bucket base are also provided with grooves. Suitable staking pieces 5 securely fasten the base and its attached buckets to the rim by engaging the sides of the rim grooves and the outer faces of the flanges and forcing the inner faces into contact with the rib 4. In Figs. 4 and 6, a similar effect is produced by staking over the edge of the rim into the grooves 12 in the flanges.

The buckets 6 may be made from extruded metal bars and provided with a tenon 7 and a shank 8 for uniting them with separate covers 9 and bases 10. The tenons are made straight, as indicated in dotted lines, Fig. 4, and the ends are riveted over in any suitable manner to form the fastening. The hole through the cover may be straight, as in Fig. 6, or its end may be countersunk as in Fig. 4, the angle of the countersink being substantially that of a standard rivet-head. The latter construction tends to draw the cover on more tightly when the projecting end of the bucket tenon is riveted over and for that reason I prefer to use it on large machines.

The bases 10 are made with a suitable channel bar section. The flanges or legs 11 of the channel enter the grooves in the supports 3 and are secured therein by riveting or staking as already described. The staking operation subjects the base to a lateral pressure perpendicular to the general plane of the buckets which force both surfaces of the flanges into gripping or holding engagement with the support. The hole 13 through the base 10 has straight parallel sides. Ad-

jacent the hole the inner faces of the flanges 11 are beveled or inclined toward each other, the angle being substantially that of the standard rivet-head. This angle causes the projection or shank 8 of the bucket when riveted over to draw the bucket and the base tightly together. Beyond the beveled portion the flanges are straight and parallel.

The channel-shaped bases might be cast or rolled to the curvature of the support and suitably finished by machine processes, if necessary, but I find it to be more economical to make the bases from straight channel bars of steel or some other elastic metal or alloy. The bars may be cast or rolled and then planed or milled to the proper size and shape, or they may be rolled to exact form and dimensions, if preferred. Then after punching the holes 13 for the shanks, the buckets are expeditiously riveted to the bars by hand or by a suitable machine. The holes 13 may be punched with their axes at any desired angle to the surface of the bar to set the buckets at a similar angle. It should also be noted that my invention dispenses with the blocks used in many other turbine constructions to space the individual buckets apart, the proper spacing being secured by the location of the holes 13. The omission of these blocks results in a marked saving in the cost of manufacture of all sizes of turbines but particularly so of the smaller machines in which the cost of the spacing blocks often equals or exceeds the cost of the buckets themselves.

Slits or slots 14 are cut in the straight base or bar by a gang of saws or milling cutters. These slits extend to within a short distance of the periphery of the base 10 and are comparatively narrow, but have sufficient width to permit the bar (Fig. 1) to be easily bent to the curvature of its support, whether it be the curvature of a bucket-wheel, as in Fig. 2, or the opposite curvature of an intermediate, Fig. 3. The length of the base may be equal to the circumference of the support or may be divided into segments of shorter length, if preferred. The slotted bars are laid in the grooves and bent by hand, in all but the largest sizes, to the necessary curvature, without deformation while the buckets of the group are kept together in proper alinement by the metal at the bottom of the slits. After placing the bars in the grooves, they are staked in as already described. It will not be necessary to stake them in along the entire circumference, but it can be done, if desired. The fastening will be sufficiently secure if they are staked at suitable intervals, while the removal and replacing of the buckets is facilitated by such a construction. Some of the metal is forced into the slits and acts as a key to hold the bases against longitudinal movement. When the staking is completed, the covers 9 are placed on the tenons 7 and secured to the buckets by riveting over the ends of the tenons by hand or machine.

In Figs. 7 and 8, I show a modification in which each bucket 6 is provided with an individual base 15 of channel-shaped cross-section. These bases are assembled in the grooves in the circumference of the support and are secured by staking or riveting as before. The inner faces of the flanges 16 may be beveled as in Figs. 4, 5 and 6, or they may be provided with rounded corners 17, as in Fig. 7. In the latter form the end of the shank 8 is riveted over to make a rounded head similar to that formed on the tenon 7 in Fig. 6.

In addition to the convenience and reduced cost of the structure described, I am able to use the same channel section for the wheels and intermediates in all the stages of different turbines varying several hundred horse-power in their capacity. Thus a few different sized sections will be sufficient for all sizes of machines. Adequate strength is obtained and the rim made smaller and lighter than in other forms of bucket fastenings with which I am familiar. This reduction of weight at the rim lessens the centrifugal strain on the rapidly rotating wheels in a very advantageous manner. The gripping or holding surface of the base is also double that of the buckets having a solid base of substantially rectangular cross-section. Buckets of the latter form have but the two outer faces of the base in engagement with the support, while my improved base has in addition the inner faces of its flanges in holding contact with the support. Hence the structure is doubly safe guarded against rupture by both reducing the centrifugal strains and increasing the resistance to such strains.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new, and desire to secure by Letters Patent of the United States, is,—

1. In an elastic fluid turbine, the combination of a grooved support, a bucket, a base mechanically attached to the bucket and provided with parallel flanges or legs which enter the grooves, and means for securing the base to the support.

2. In an elastic fluid turbine, the combination of a support having longitudinal grooves, a bucket, a base riveted to the bucket and provided with parallel flanges or legs which enter the grooves, and means for securing the flanges in the grooves.

3. In an elastic fluid turbine, the combination of a support having a plurality of parallel grooves, a bucket base provided with a plurality of flanges each of which enters one of the grooves, and means for securing the base to the support which subjects the flanges to lateral pressure in a direction perpendicular to the plane of the buckets.

4. In an elastic fluid turbine, the combination of a support having grooves concentric with the axis of the turbine, a bucket, a base having a channel-bar cross-section, means for attaching the bucket to the base, and means for securing the flanges or legs of the channel in the grooves by staking or riveting.

5. In an elastic fluid turbine, the combination of a support having a rib, a bucket base having two parallel flanges or legs engaging the rib and provided with grooves in the flanges, and means engaging the grooves for securing the base to the support.

6. In an elastic fluid turbine, the combination of a support, a rib on the support having parallel sides, a bucket, a base riveted to the bucket and provided with a flange or leg at each side of the rib, and means for securing the flanges to the support which engage the outer faces of the flanges and force the inner faces into engagement with the rib.

7. In an elastic fluid turbine, the combination of a support having a series of ribs on its surface, and a bucket base having a flange at each side, one of the ribs engaging the inner faces of the flanges and the adjacent ribs on either side being staked over to secure the flanges to the support.

8. In an elastic fluid turbine, the combination of a grooved support, and a bucket base having a grooved flange at each side which enters a groove in the support, one edge of the support groove being staked over into engagement with the groove in the flange to secure the base to the support.

9. In an elastic fluid turbine, the combination of a curved support, a bucket base of channel-shaped cross-section carrying a group of buckets which project outwardly from the portion of the channel joining its legs or flanges, said base being provided with slits to permit it to be made straight and subsequently bent to the curvature of the support, and means for securing the base to the support.

10. In an elastic fluid turbine, the combination of a curved support, a bucket base having flanges or legs and provided with slits to permit it to be bent to the curvature of the support, and means for securing the flanges to the support.

11. In an elastic fluid turbine, the combination of a curved support having grooves in its surface, a bucket base provided with flanges which enter the grooves and a series of slits to permit the base to be made straight and subsequently bent to the curvature of the support, and means for securing the flanges in the grooves.

12. In an elastic fluid turbine, the combination of a support having grooves concentric with the axis of the turbine, a channel bar forming a bucket base and provided with a series of slits to permit the bar to be made straight and subsequently bent to the curvature of the grooves, and means for securing the flanges of the bar in the grooves.

13. In an elastic fluid turbine, the combination of a support having parallel grooves concentric with the axis of the turbine, a plurality of buckets, a channel-bar attached to the buckets to form a base therefor and provided with a plurality of slits extending from the edge of the bar toward the buckets to permit it to be made straight and bent to the curvature of the grooves after the buckets have been attached to it, and means for securing the flanges of the bar in the grooves.

14. In an elastic fluid turbine, the combination of a support having grooves concentric with the axis of the turbine, a plurality of buckets having shanks, a bar of channel cross-section to which the shanks are riveted, and means for securing the flanges of the bar in the grooves.

15. In an elastic fluid turbine, the combination of a support having grooves in its surface concentric with the axis of the turbine, a plurality of buckets having shanks, a channel bar to which the shanks are riveted, the flanges of the bar entering the grooves but projecting beyond the surface of the support and having their inner surfaces beyond the support inclined toward each other to receive the upset portion of the shank, and means for securing the flanges in the grooves.

16. In an elastic fluid turbine, the combination of a support, a plurality of buckets, a cover attached to one end of the buckets, a channel-bar riveted to the other end of the buckets, and means for securing the flanges of the bar to the support.

17. In an elastic fluid turbine, the combination of a curved support having grooves, a plurality of buckets, a channel-bar attached to one end of the buckets, flanges forming part of the bar and entering grooves in the support, grooves in the outer faces of the flanges into which the edges of the grooves in the support are staked over to secure the bar to the support, and transverse slits in the bar which permit it to be made straight and bent to the curvature of the support before securing it therein.

18. In an elastic fluid turbine, the combination of a support having parallel grooves concentric with the axis of the turbine, a bucket base having a channel-bar cross-section and carrying a group of buckets which

project outwardly from the portion of the channel joining its flanges or legs, and means securing the flanges in said grooves.

19. In an elastic fluid turbine, the combination of a support provided with parallel faces or surfaces, a bucket base having a channel-shaped cross-section, the flanges or legs of the channel engaging said parallel faces, a bucket projecting outwardly from the portion of the channel joining its flanges or legs, and means for securing the flanges to the support.

20. In an elastic fluid turbine, the combination of a curved support, and a channel-shaped bucket base having a group of buckets projecting outwardly from the portion of the channel joining the two flanges thereof, grooves in the outer face of the flanges, and transverse slits in said flanges to permit the base to be made straight and subsequently bent to the curvature of the support, the metal of the support being forced into said grooves and slits to hold the base against radial movement and also to prevent longitudinal creeping.

21. In an elastic fluid turbine, the combination of a support, a bucket base of channel-shaped cross section having a hole through the portion of the channel joining the flanges thereof, the inner surface of the channel adjacent the edge of the hole being inclined outwardly, a bucket having a shank which is inserted in and projects through the hole, the end of the shank being riveted over into engagement with the inclined inner surface of the channel to attach the bucket to the base, and means for securing the base to the support.

22. In an elastic fluid turbine, the combination of a curved support having grooves formed therein, a plurality of buckets, a base mechanically attached to said buckets and provided with flanges which enter said grooves, and means for securing the flanges to the support.

23. In an elastic fluid turbine, the combination of a plurality of buckets having shanks and shoulders adjacent the shanks, a channel-bar forming a base for the buckets and provided with holes in the web portion of the bar joining the flanges thereof to receive the shanks, said shoulders engaging the web portion, a support, and means for securing the bar to the support.

In witness whereof, I have hereunto set my hand this 18 day of May, 1907.

WALTER F. RICE.

Witnesses:

SAMUEL T. MACQUAIM,

LUCY C. HOLLIS.