C. P. STEINMETZ.

BUCKET FOR ELASTIC FLUID TURBINES.

APPLICATION FILED NOV. 6, 1907.

924,852.

Patented June 15, 1909.

2 SHEETS—SHEET 1.

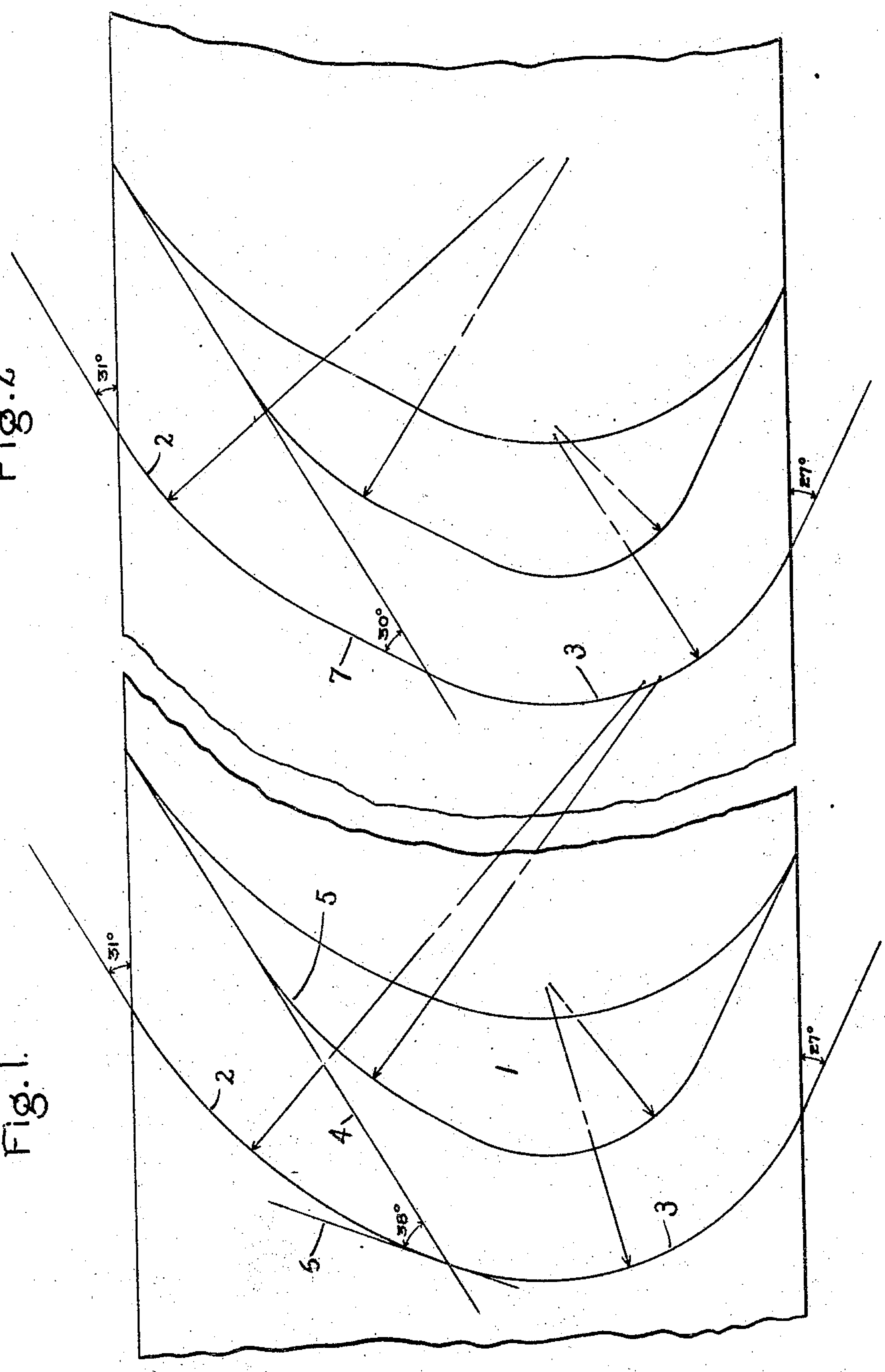

Fig. 2

Fig. 1.

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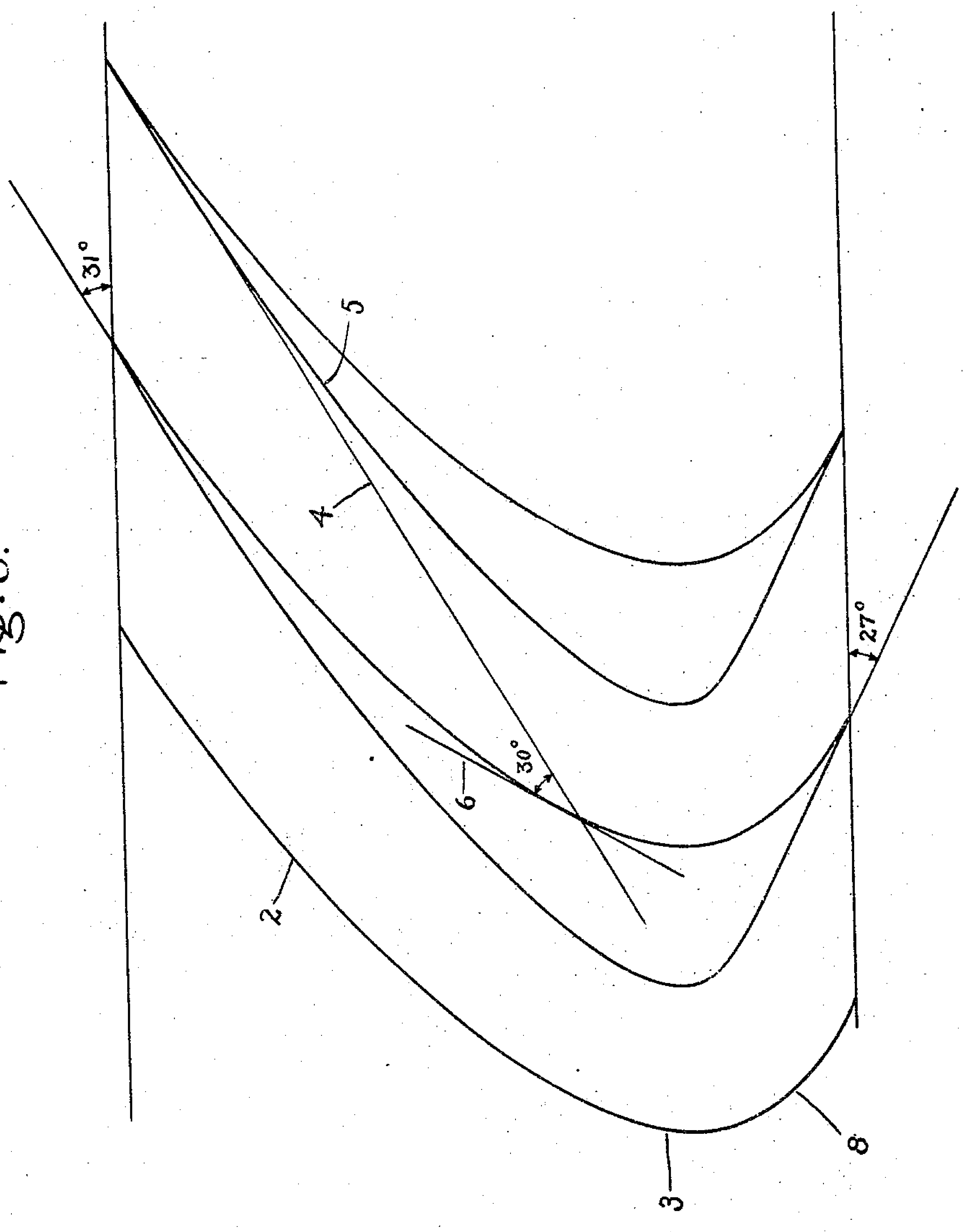
Fig. 3.



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UNITED STATES PATENT OFFICE.

CHARLES P. STEINMETZ, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

BUCKET FOR ELASTIC-FLUID TURBINES.

No. 924,852. Specification of Letters Patent. Patented June 15, 1909.

Application filed November 6, 1907. Serial No. 400,921.

To all whom it may concern:

Be it known that I, CHARLES P. STEINMETZ, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Buckets for Elastic-Fluid Turbines, of which the following is a specification.

Investigations show that in an impact elastic fluid turbine as the fluid flows through the working passages and acts on the bucket faces, a loss occurs which decreases the efficiency of the machine. This loss is due principally to the turning of the fluid stream by the curved face of the bucket, and to the shock due to the impact of the fluid particles on said face.

My invention has for its object to improve the shape of the working face of the buckets and thereby eliminate or largely reduce the loss mentioned above. To reduce this loss to a minimum my improved buckets are provided with an entrance portion that is very much less curved than the exit portion, and the shock or impact angle is made as small as possible consistent with the effective extraction of energy from the motive fluid.

In one of the forms illustrative of the invention the working face of the bucket is composed of circular portions struck from different radii, the said bucket being unsymmetrical and having different entrance and exit angles. In a second form the working face is composed of circular portions joined by a straight portion, the bucket also being unsymmetrical. In these forms the centrifugal force of the fluid stream on the entrance side of the bucket is less than would be the case with a bucket whose face forms a part of a cylinder, the common construction in elastic fluid turbines of the impact type, and is less on the entrance than on the exit side. In both of these forms the shock or impact angle is less than would be the case with circular buckets and the same nozzle angle.

In a third and preferred form of my invention the working face of the bucket is composed of spirally curved portions so that the centrifugal force of the fluid stream is gradually increased from zero or a small finite value to a maximum and decreased again to zero or to a small finite value at the point of discharge. The bucket is also unsymmetrical.

Since the release of the fluid stream or jet from centrifugal acceleration can take place without injurious effects much more rapidly than its application, I so arrange the buckets that the discharge or exit side is shorter than the inlet. In the preferred form of my invention the point of maximum curvature will be fairly near the exit, and the initial part of the centrifugal acceleration will increase at a much slower rate than the centrifugal deceleration. To produce a small impact angle, the entrance portion of each bucket from the entrance to the point of maximum curvature may consist of two spiral parts joining each other and such that the second, or middle portion of the bucket, gives a greater rate of increase of curvature and so of centrifugal acceleration, than the first or entrance portion.

In the accompanying drawing, showing buckets illustrative of my invention, Figure 1 is an end view of a bucket having a small shock of impact angle whose walls are composed of circular portions of different curvature; Fig. 2 is an end view of a similar bucket having curved portions united by straight portions, and Fig. 3 is an end view of my preferred form of bucket composed of spiral parts having different rates of increase of curvature.

Referring to Fig. 1, 1 indicates a compound bucket which may be integral with or separate from its support as desired. When separate, any good mechanical means may be employed to unite the buckets with their support. The working face of each bucket is composed of two circular portions 2 and 3, the radius by which the portion 2 is struck being considerably longer than that employed for portion 3. The rear faces of the buckets are similarly shaped but made with shorter radii. The cross-sectional area of the bucket spaces or working passage should be great enough to carry the motive fluid without choking on the one hand or permitting it to unduly expand on the other. The angle of entrance of the buckets in this particular embodiment is 31° and the angle of discharge 27°. The line 4 is tangential to the rear face 5 of the bucket and indicates the direction of movement of the steam particles in the jet. The line 6 is tangential to the curve of the working face of the bucket at the point of intersection with the line 4 and the angle between these two lines is 38° which is the shock or impact angle. Owing to the peculiar curvature of the bucket face this angle is very much smaller than would be possible for a given nozzle angle and a bucket with a circular face, meaning by "circular face" a bucket whose face forms a part of a true cylinder.

In Fig. 2 is shown another form of compound bucket wherein the curved portions 2 and 3 of the bucket are joined by a straight portion 7, the rear wall of the bucket following the same arrangement. In this case, the angle of impact is 30°, which is less than in the first illustration.

In Fig. 1 as the steam enters the bucket its centrifugal force immediately rises to a moderate value and later rises to a maximum value which is maintained until the steam is discharged.

In Fig. 2 as the steam enters the bucket its centrifugal force immediately rises to a moderate value, then decreases to zero as it reaches the straight portion and finally rises to the maximum which is maintained until the steam is discharged. In both of these cases, however, the centrifugal force of the steam in the inlet portion of the bucket is less than it would be in the case of a circular bucket, and the shock angle is very much smaller. Hence a turbine fitted with either of these two forms has the advantages accruing from moderate initial centrifugal compression of the steam and a small shock angle.

In Fig. 3 is shown the preferred form of my invention wherein the working face of the bucket is composed of three curved portions 2, 3 and 8. In this embodiment the length of the curved or inlet portion 2 greatly exceeds the length of the curved or discharge portion 8. The angle of impact is small, being 30°, so that I gain all of the advantages resulting therefrom. As the steam passes over the portion 2 to the point of impact, the rate of increase of the centrifugal force is small. From this point to that of maximum curvature, the rate of increase of centrifugal force is larger. From the point of maximum curvature to the exit the rate of decrease of centrifugal force is large.

The portions or sections 2 and 3 are made up of two different spiral curves having different rates of increase of curvature. It will be noted that the bucket is unsymmetrical with the inlet portion much longer than the discharge portion. This means that the increase and decrease of the centrifugal force of the steam takes place gradually, but the rate of increase is less than the rate of decrease or release.

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. A bucket for an elastic fluid turbine, having a working face composed of entrance and exit portions of varying curvature, one of said portions being less curved than another to produce a variation in the centrifugal force of the fluid jet as it flows over it.

2. A bucket for an elastic fluid turbine having a working face composed of entrance and exit portions of different and varying curvature, the entrance portion being less curved and the rate of its change of curvature also being less than that of the exit portion, so that the centrifugal force will be less on the entrance than on the exit portion.

3. A bucket for an elastic fluid turbine, having a working face composed of two or more portions of dissimilar and varying curvature to produce a gradual variation in the centrifugal force of the fluid stream as it flows over said face.

4. A bucket for an elastic fluid turbine having a working face which is so shaped that the centrifugal force of the motive fluid is less on the entrance than on the discharge side, said force gradually increasing from zero or a small finite value at the inlet to a maximum value and then gradually decreasing to zero or a small finite value at the outlet.

5. A bucket for an elastic fluid turbine, having a working face one portion of which is shaped to gradually increase the centrifugal force of the jet to the maximum and has an angle of impact which is less than that of a cylindrical surface with the same entrance angle, the discharge portion being shaped to gradually release the jet of its centrifugal force at a greater rate than it was acquired.

6. A bucket for an elastic fluid turbine having a working face comprising inlet and outlet portions, the inlet portion being curved to gradually increase the centrifugal force of the jet and the discharge portion being curved to gradually decrease the centrifugal force of the jet, the said inlet portion being longer than the outlet.

7. A bucket for an elastic fluid turbine having a working face comprising inlet and outlet portions, the inlet portion forming a part of a spiral curve which gradually increases the centrifugal force of the jet, the discharge portion also forming a part of a spiral curve which releases the jet of said force at a greater rate than it was acquired.

8. An unsymmetrical bucket for an elastic fluid turbine having a curved working face, the entrance angle of which is greater than the discharge angle, the said face being composed of two portions forming reversed spiral curves, one of said curves being longer than the other.

9. An unsymmetrical bucket for elastic fluid turbines, having a curved working face whose entrance angle is greater than the discharge angle and is composed of two portions forming reversed spiral curves, the inlet portion being longer than the outlet and shaped to gradually increase the centrifugal force of the fluid jet to the maximum, the outlet portion being shaped to release the jet of its centrifugal force at a greater rate than it was acquired.

10. An unsymmetrical bucket for elastic fluid turbines having a curved working face, the inlet portion of which has a varying curvature which causes the centrifugal force to increase at a given rate for a certain distance along said face and then causes it to increase at a greater rate to a maximum at the beginning of the discharge portion, said discharge portion having a varying curvature which decreases the centrifugal force at a greater rate than it was increased by the inlet portion.

11. An unsymmetrical bucket for elastic fluid turbines having a curved working face, the inlet portion of which is longer than the discharge portion and is formed on spiral curves whose curvature gradually increases at a given rate for a certain distance along said face, and then increases gradually at a greater rate to a maximum at the beginning of the discharge portion, said discharge portion being formed on a spiral curve whose curvature gradually decreases at a greater rate than the curvature of the inlet portion increases.

12. A bucket for an elastic fluid turbine having a working face formed of three portions of different curvature.

13. A bucket for an elastic fluid turbine having a working face formed of three spiral curves having different rates of increase of curvature.

In witness whereof, I have hereunto set my hand this 5th day of November, 1907.

CHARLES P. STEINMETZ.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.