

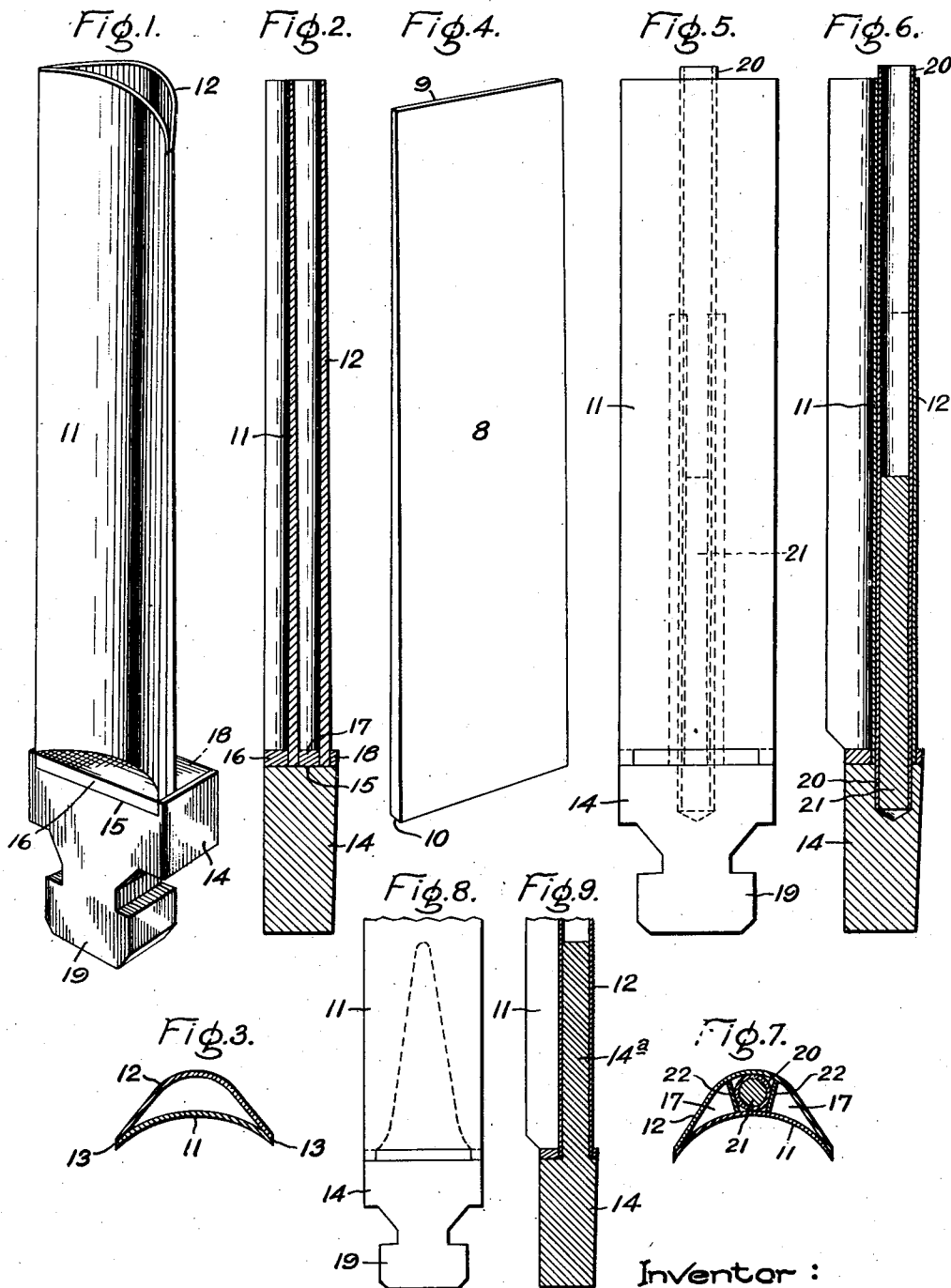
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TURBINE BUCKET

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UNITED STATES PATENT OFFICE.

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TURBINE BUCKET.

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To all whom it may concern:

Be it known that I, CHARLES E. EVELETH, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Turbine Buckets, of which the following is a specification.

In elastic fluid turbines, especially those of large outputs, the buckets in the low pressure stages have to be very long owing to the great volume of steam which has to be handled thereby. It is not uncommon to have buckets which are over two feet long in such stages. These buckets are subjected to very high stresses due to centrifugal force which tend to tear them loose from their fastenings, and also to forces which tend to cause lateral vibrations, and these forces at times are of such a nature and magnitude as to cause serious injury to the buckets or even their complete destruction. The standard practice is to make the buckets solid which means that the body of the rotor has to be very heavy and the shaft therefor of large diameter to support them.

It has been proposed to use hollow buckets for turbines to decrease the weight of the rotating parts but so far as my knowledge goes, they have been structurally too weak to withstand the stresses to which large low pressure buckets are subjected and have never been used for the purpose.

The object of my invention is to improve the construction of hollow buckets for turbines and especially such buckets as are of relatively great length and intended for use in the low pressure stage or stages of turbines of large output.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and the claims appended thereto.

In the accompanying drawing which is illustrative of my invention, Fig. 1 is a perspective view of a long hollow turbine bucket especially intended for low pressure stages; Fig. 2 is a longitudinal section thereof; Fig. 3 is a cross-section; Fig. 4 is a perspective view of a blank; Fig. 5 is a front elevation of a modified form of bucket; Fig. 6 is a longitudinal section of the same; Fig. 7 is a cross-section of said bucket; Fig. 8 is a view in elevation of a

bucket illustrating a further modification, and Fig. 9 is a longitudinal section thereof.

Since it is essential that each bucket be stiff and strong and of minimum weight consistent with the duty to be performed, I make the bucket hollow but instead of making it of uniform mass throughout its length I so construct it that its mass increases from its outer end to its base. In general two such constructions are shown herein. In one case, the bucket is formed of two pieces or members of sheet stock bent to the proper shape in cross-section and each tapering in thickness from the outer end to the base and preferably, but not necessarily this change of thickness or mass takes place uniformly. In the second case the sheet blade stock is of uniform thickness and the necessary increase of mass or cross-section is obtained by adding metal in such a way as to obtain the same or substantially the same effect. This arrangement permits of the use of front and rear walls made of non-corrodible metals, such for example as monel, which are of lower strength than the material such as steel, of which the reinforcing means is made.

Referring first to Fig. 4, this shows a piece of sheet stock 8, such as monel for example, which gradually increases in thickness or mass at a uniform rate from the end 9 to the base 10. It may be formed by suitable rolling or other dies. The piece thus formed is then bent by suitable dies to the shape shown in Fig. 1. The front wall 11 of the bucket which is the working face against which the motive fluid acts, has a somewhat different curvature than the back wall 12 but the general formation is the same. These members are united along the side edges 13, as, for example, by fusing them. This can readily be done by what is briefly termed copper brazing. In performing this operation the front and back walls of the bucket are held by any suitable clamping means in firm contact along their edges, after which they are put into a hydrogen furnace with a certain amount of copper near the joints in a manner now well understood and subjected to fusing temperature. After the body is formed it is united with a base or root 14 by the same method as outlined above. From Figs. 1 and 2 it will be seen that the base has a groove or

recess 15 in the top to receive the inner end of the hollow bucket and also the filling or spacing pieces 16, 17 and 18, the former being in front of the bucket, 17 between the walls of the bucket, and 18 in the rear of the bucket. The filling pieces in the fusing process are firmly fused both to the base and to the bucket walls with the result that the parts are firmly united. It is preferable to fuse all or as many of the parts as possible in one operation but for convenience the various steps have been described as more or less separate operations.

The base 14 has an inverted T-shaped head 19 or other equivalent means for anchoring the same to the rotor. The base will ordinarily be finished to size and the edges of the bucket body sharpened after the fusing operation.

Referring now to Figs. 5 to 7, the front and back walls 11 and 12 of the bucket are made of sheet metal as before but are of uniform thickness and the increase of mass or stock necessary for structural reasons is obtained by the addition of metal. This may be done in a gradual manner from the outer end to the base or by a series of steps, the latter being somewhat simpler as a manufacturing proposition. One means for carrying out this feature of my invention is illustrated. The bucket base 14 is drilled out, and inserted in the hole thus formed is a tube 20 which extends the whole length of the bucket. Its outer end may be employed as a means for securing the bucket cover when such a cover is employed as is usually the case. The wall of the tube may be of uniform section or it may be slightly tapered, increasing in cross-section from the end toward the base. If it is so tapered the front and rear parts of the bucket will of course be slightly inclined to each other so as to make firm engagement. In this construction the intermediate spacer 17 will also be provided with an opening through which the tube extends. As the tube is of a diameter equal to the distance between the front and rear walls of the hollow body it follows that in this construction the spacer will be made in two pieces, each filling the space bounded by the members and the tube. Inside the tube 20 and snugly fitting the same is a rod or plug 21 which also enters the hole in the base. This plug may extend approximately half the length of the bucket body. Located at the sides of the tube 20 and extending radially with respect to the center of the working face or wall 11 of the bucket, are braces 22 which are in firm contact with the front and rear members of the bucket and also with the tube. The braces may be of uniform thickness or they may taper in the manner illustrated in Fig. 4. Where the increase of mass of the bucket is by steps they may, for example, termi-

nate about midway between the upper end of the plug 21 and the tip of the bucket. After the parts are formed and suitably assembled together with the base and space blocks they are fused together by the copper brazing method above described. Due to the brazing operation all of the parts are united into a homogeneous whole with the result that the same effect is obtained as in Figs. 1 to 3, although in a somewhat different manner. It will be evident that this arrangement of the reinforcing means can also be used in those cases where the bucket walls are tapered in thickness as in Figs. 1 to 4.

In Figs. 8 and 9 is illustrated a further modification of the invention in which the reinforcement is obtained by means of a member or extension 14^a formed integral with the base 14 and extending outwardly between the bucket walls for a suitable distance to reinforce them. Owing to the curvature of the bucket walls the front and back surfaces of the member should be similarly curved. This arrangement can also be used with bucket walls which taper from the end to the base or with walls of uniform thickness as will be readily appreciated. From Fig. 9 it will be seen that in the embodiment of the invention illustrated the member 14^a has parallel front and rear faces and widens quite rapidly from the outer end to the base. The length of the reinforcing element or member will be determined of course by the stresses to which the bucket is to be submitted. It is united with the bucket walls by the fusion of metal as previously described, and because its front and back surfaces, which are relatively large, conform in shape to the sheet metal bucket members the latter will be firmly anchored in place.

It will be seen that in each case there is a progressive increase of mass or cross-section of the metal forming the bucket body from the outer end to the base. I have not attempted to show a bucket of full length because if the parts were in proportion some of the details of construction would be so small as to make the drawing difficult to read.

A bucket constructed as above set forth is light and also extremely strong and rigid and hence particularly well adapted for use in the low pressure parts of a turbine where very large volumes of steam have to be handled. On account of the decrease of weight brought about by the use of hollow buckets and to the distribution of the mass as herein described, the wheel body can be lighter and the shaft smaller in diameter. Thus the danger due to vibration at running speeds will be less and the shaft packing leakages reduced.

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 may 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 turbine bucket comprising a base having a surface adapted to receive one end of a hollow body and anchoring means on opposite sides thereof below said surface, a hollow body one end of which is fused to said surface, the mass of said body increasing from its outer end toward the base.

2. A turbine bucket comprising a base having a surface adapted to receive one end of a hollow body and anchoring means on opposite sides thereof below said surface, a pair of thin, curved metal members which are united to each other along their edges and at one end to the base to form a hollow body against which the motive fluid acts, the mass of said body being greatest at the base and decreasing toward the outer end.

3. A turbine bucket comprising a base, a pair of sheet metal members which are united to each other along their edges and also to the base to form a hollow body, the mass of said body increasing from the outer end toward the base, and spacers between the members and also on the outer sides thereof, said spacers being united to the members and also to the base.

4. A turbine bucket comprising a base having a surface adapted to receive one end of a hollow body and anchoring means on opposite sides thereof below said surface, a pair of thin, curved metal members which are united to each other along their edges and at one end to the base to form a hollow body against which the motive fluid acts, the mass of said body being greatest at the base and decreasing toward the outer end, and spacing means for the inner ends of the members which are fused to the members and also to the base.

5. A turbine bucket comprising a base with a pair of thin metal members which are united to each other and to the base by the fusion of metal to form a hollow body against which the motive fluid acts, and means for progressively adding mass to the body from the region near its outer end to the base.

6. A turbine bucket comprising a base, a hollow body portion secured thereto and comprising sheet metal members, and a reinforcing element which is located within the body and extends longitudinally there-

of and is united to both of the members by the fusion of metal, the mass of said element decreasing from the base outwardly.

7. A turbine bucket comprising a base, a hollow body portion therefor, comprising a pair of sheet metal members, and a reinforcing tube which extends longitudinally between the members, and is united to them and also to the base by the fusion of metal.

8. A turbine bucket comprising a base and a hollow body portion made of sheet metal members which are united with the base, and means for progressively adding mass toward the base end of the body which comprise concentric elements located inside of the body which are secured to the base and to the members.

9. A turbine bucket comprising a base and a pair of sheet metal members which form a hollow body and are united with the base, and means located within and extending longitudinally of the body which are secured to the base and to said members, said means being of different lengths so that the mass of the body increases by steps from its outer to its base end.

10. A turbine bucket comprising a base and a pair of sheet metal members which form a hollow body and are united with the base, a tube which is located within and extends longitudinally of the body and is secured to the base and said members, and a rod which is secured within the base end of the tube.

11. A turbine bucket comprising a base and a pair of sheet metal members which form a hollow body and are united with the base, a tube which is located within and extends longitudinally of the body and is secured to the base and said members, and braces which are located within the body, on opposite sides of the tube and extend radially to the working face of the body and are secured to the base and to said members.

12. A turbine bucket comprising a base and a pair of sheet metal members which form a hollow body and are united with the base, means located within and extending longitudinally of the body and which are secured to the base and to said members, said means being of different lengths so that the mass of the body increases by steps from its outer to its base end, and elements which are located within and extend longitudinally of the body and are arranged to increase the mass of the body toward its base end, said members and the parts enclosed thereby being united to each other and to the base by the fusion of metal.

13. A turbine bucket comprising a base, a reinforcing element which extends longitudinally of the bucket, said element in-

creasing in mass from its outer end toward the base, and front and rear walls for the bucket which are secured to the base and also to said element.

- 5 14. A turbine bucket comprising a base, anchoring means formed thereon, a reinforcing element which extends longitudinally of the bucket, said element having curved front and rear walls and increasing

in mass from the outer end toward the 10 base, and front and rear walls for the bucket which are united to said walls, to each other along their edges and to the base by the fusion of metal.

In witness whereof, I have hereunto set 15 my hand this 22nd day of September, 1922.

CHARLES E. EVELETH.