H. S. BALDWIN.

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APPLICATION FILED MAY 28, 1907.

916,968.

Patented Apr. 6, 1909.

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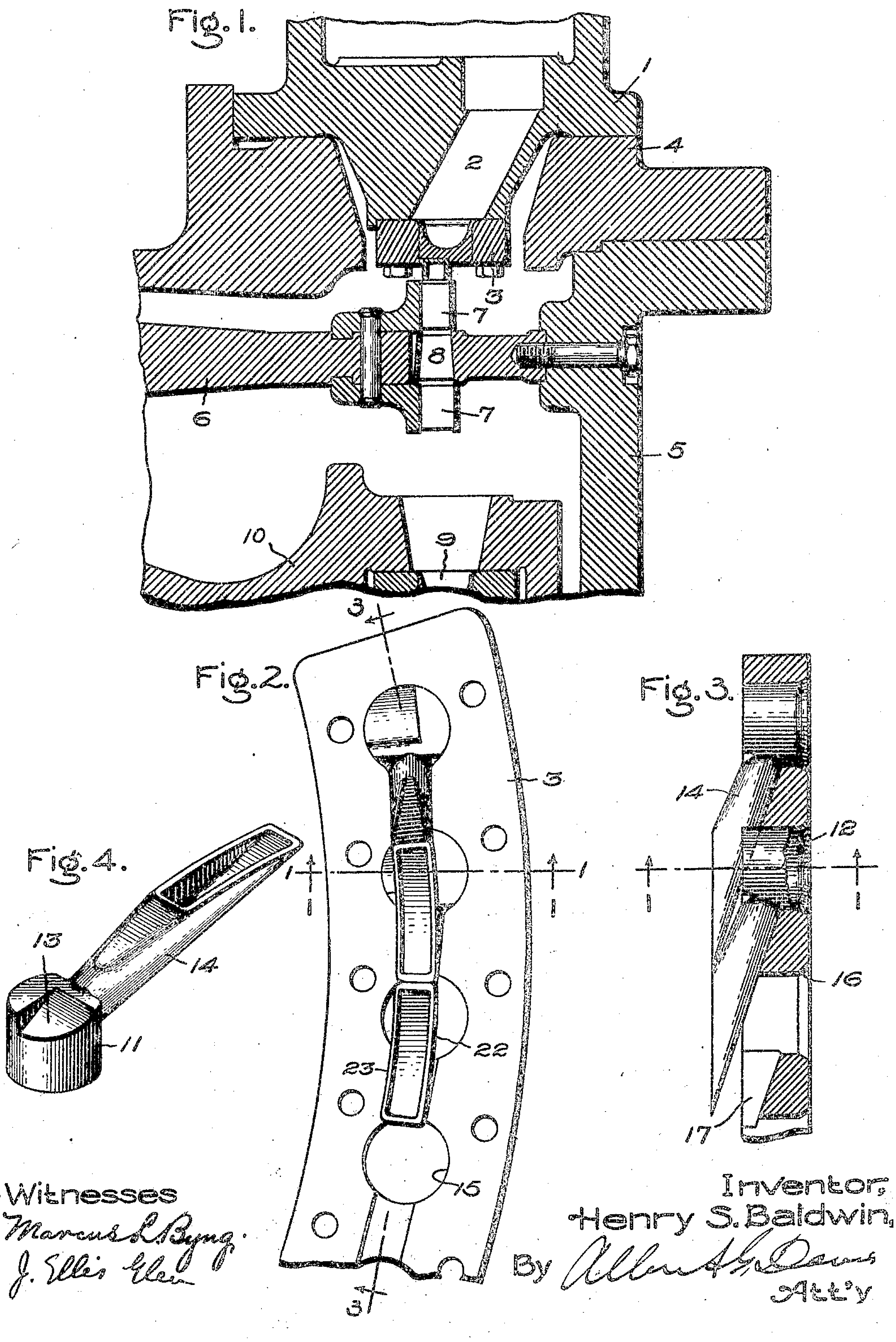

Witnesses

Marcus L. Byng.

J. Ellis Glen

Inventor,

Henry S. Baldwin,

By Albert G. Davis

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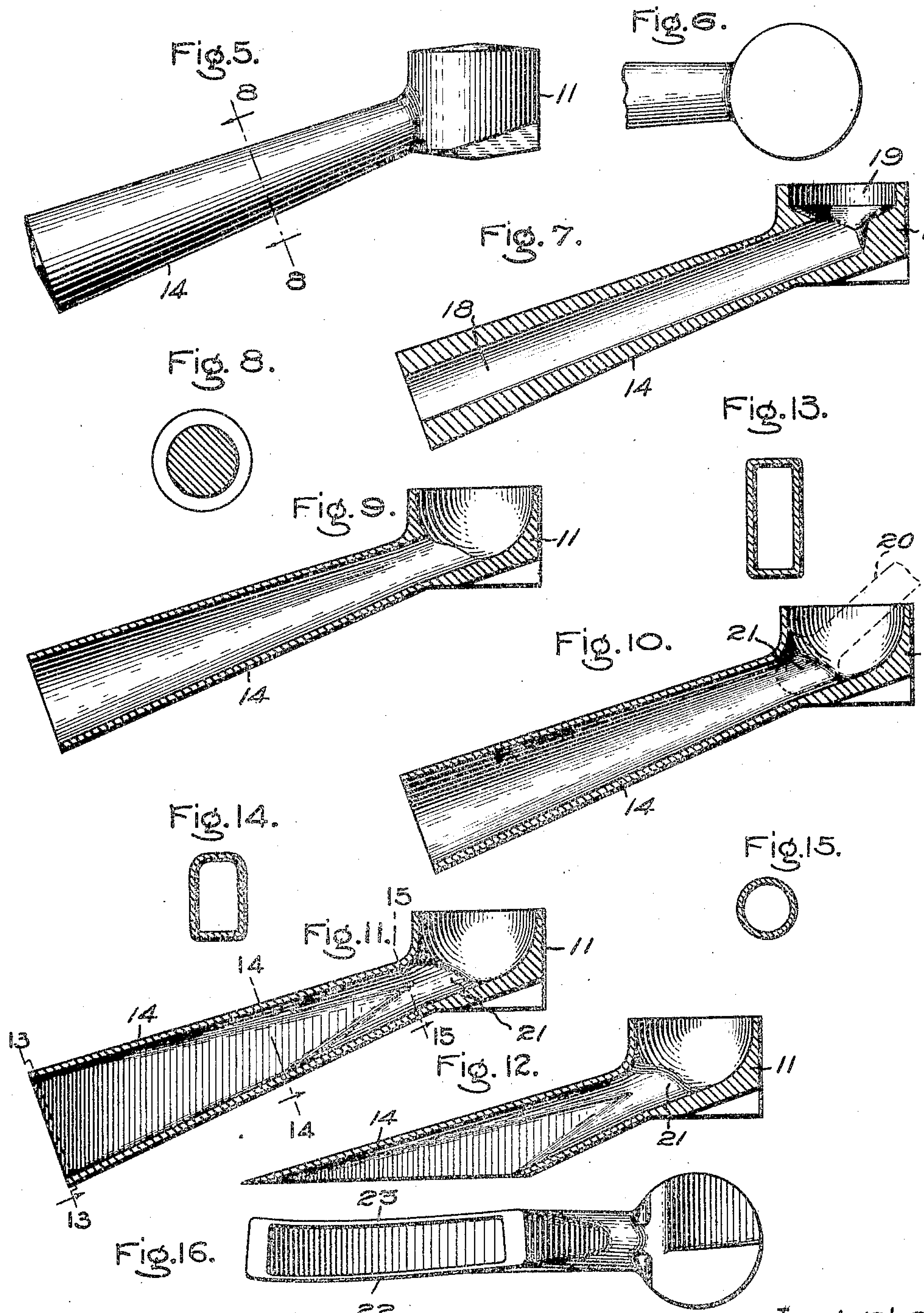

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UNITED STATES PATENT OFFICE.

HENRY S. BALDWIN, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

NOZZLE FOR ELASTIC-FLUID TURBINES.

No. 916,0 Specification of Letters Patent. Patented April 6, 1909.

Application filed May 28, 1907. Serial No. 376,064.

To all whom it may concern:

Be it known that I, HENRY S. BALDWIN, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Nozzles for Elastic-Fluid Turbines, of which the following is a specification.

With turbines as ordinarily constructed the nozzles are the most expensive and difficult parts to make, owing to the exacting requirements. This is due chiefly to the fact that the passages have to be of peculiar shape and no one tool is capable of properly forming them. As a result there is a great deal of hard work necessary and it is exceedingly difficult to form two nozzle passages which are absolutely alike in every particular. This is particularly true where the throat is round or oval in cross-section, and the discharge portion rectangular in cross-section. The difficulty in properly forming passages is further increased in those nozzles where there is a certain expansion or increase in the size of the nozzle passage from the throat to the discharge end.

My invention has for its object to overcome the objections above set forth, and to provide a nozzle and nozzle support of improved construction.

My invention further has for its object to improve the manufacture of these nozzles by a drop forging process.

In the accompanying drawings which illustrate one of the embodiments of my invention, Figure 1 is a partial axial section of a turbine, the section of the nozzle being taken on line 1—1 of Fig. 2; Fig. 2 is a view of the nozzles and the supporting plate viewed from the discharge side; Fig. 3 is a section taken on line 3—3 of Fig. 2; Fig. 4 is a perspective view of a finished nozzle; Fig. 5 is a view in elevation of a drop-forged nozzle blank; Fig. 6 is a partial plan view of the same; Fig. 7 is a longitudinal section of the blank after it has been rough-bored; Fig. 8 is a cross-section of the blank taken on the line 8—8 of Fig. 5; Fig. 9 is a longitudinal view of the blank after it has been reamed; Fig. 10 is a view showing the means for forming the throat of the nozzle; Fig. 11 is a longitudinal section of the nozzle blank after the discharge portion has been shaped in dies; Fig. 12 is a view of the nozzle after the discharge end has been cut off at the proper angle; Fig. 13 is a section taken on line 13—13 of Fig. 11; Fig. 14 is a section taken on line 14—14 of Fig. 11; Fig. 15 is a section taken on line 15—15 of Fig. 11; Fig. 16 is an inverted plan view of the finished nozzle.

Referring to Fig. 1, 1 indicates a steam-chest having a plurality of passages 2 which supply steam or other elastic fluid to the nozzle bowls. The nozzles are supported by a plate 3 which is bolted or otherwise secured to the under side of the valve chest. The chest itself is supported by the head 4, the latter resting upon the wheel casing 5. Mounted within the casing are wheels 6, of which one is shown. On the periphery of the wheel are rows of buckets 7 and between the rows of buckets are intermediates 8. After the steam leaves the first wheel it passes through stage nozzles 9 to the wheel of the second stage, and so on. The stage nozzles are carried by the diaphragm 10, which divides the chamber within the casing into wheel compartments. The nozzles are counterparts in the construction so that a description of one of them will suffice.

Referring to Fig. 4 showing a finished nozzle, 11 indicates the cylindrical portion or head containing the bowl 12, Fig. 3. I have shown this portion as being cylindrical, the main feature being to provide a head the exterior of which will act as a support for the nozzle when it is mounted in the nozzle plate and prevent the same from moving toward or away from the wheel buckets. The cylindrical portion or head is cut away on one side at an incline as shown at 13 in Fig. 4, the object being to permit the separate nozzles to be closely associated as shown in Figs. 2 and 3, so that the steam therefrom will issue as a solid jet or column, and further, that the angle of discharge of every nozzle will be the correct one and the same as that of every other. The shoulder thus formed on the under side of the head is also utilized as a part of the means for holding the adjacent nozzle in place.

Extending from the head is a stem or a discharge portion 14 containing a discharge passage that gradually increases in cross-sectional area from the throat to the point of exit. I have described this nozzle as being of the expanding type, but it is quite evident that it may be of the non-expanding type if it will satisfy the conditions of operation in the turbine. The nozzle plate is provided with as many orifices 15 as there are nozzles. Each of these orifices is of such shape that it will receive the head 11 of the nozzle and form a support therefor throughout its length. The openings are chamfered slightly, as at 16, so that when the metal forming the finished head is expanded, the nozzle will be firmly secured in place. In order to nest the nozzles closely, it is necessary to remove a certain amount of the metal between the openings 15, and in the same circumferential plane as indicated at 17. When the nozzles are in place the discharge portions or stems extend through the slots 17, and the walls of the same engage the sides of the discharge portions and prevent the same from turning in the orifices 15.

Referring to Figs. 5 to 16, the method of forming the nozzles will be described. The blank to form the nozzle is made by the drop-forging process and from some suitable material, such, for example, as steel, nickel-steel, Tobin bronze, or the like. The blanks are drop-forged to exact dimensions and of desired outside shape. By making the blanks in this manner, the nozzles can be cheaply constructed and made to exact dimensions and will also be counterparts. It is also possible to use one die or set of dies for several different kinds of nozzles which differ from each other only in a slight degree. After the blank is completed as shown in Fig. 5, which may be done by one, two or more operations, it is placed in a suitable jig and the stem rough bored at 18 to form the discharge passage and the head at 19 to form the bowl, sufficient metal being left to provide for finishing. The next operation is to ream out the stem or discharge portion by a reamer of such size and construction as will provide the exact cross-section of nozzle area desired at every point. The bowl is then milled out by means of a rose mill. The next step is or may be to mill out the throat between the bowl and the discharge portion, which results in the construction shown in Fig. 10. In this figure 20 represents the mill for cutting away the metal to form the throat 21. If a rectangular delivery section is required in order to lessen the height of the wheel buckets and at the same time cause them to be filled with steam, the outlet end of the nozzle may be pressed cold into the desired shape, as shown in Figs. 11 to 14, the throat section being shown in Fig. 15. In order to accurately form the nozzles at this stage of manufacture, a mandrel or former of suitable shape is provided which is inserted in the discharge portion either at the beginning of the operation or prior to final finishing. The next operation is to place the nozzles in a circular jig in the same relative position which they will occupy when in the turbine and face off the lower end as shown in Fig. 12. In this case the discharge angle is 20°. Instead of milling out the bowl after the reaming operation I may reserve this until after the pressing operation or until after the end has been beveled, as shown in Fig. 12. The advantage in milling the throat after the pressing operation resides in the fact that there is a little more metal left at the throat to resist the strains to which the nozzle is subjected in changing its form from a round to a rectangular section. At the time the nozzle is given the rectangular discharge section, it is also curved as shown in Fig. 16, so that the opposed walls 22 and 23 are concentric with the axis of the turbine. Referring to Fig. 2, the last nozzle in the group, considering the direction of rotation of the wheel, is first mounted in place and the wall of the bowl expanded or staked over the chamfered portion of the nozzle plate, then the second nozzle is mounted in place and so on until they are all in place. The nozzle plate is subsequently bolted to the valve chest or other support.

Nozzles made in accordance with my improved process of manufacture are much superior to those constructed heretofore with which I am familiar. By drop-forging the blanks the metal forming the walls of the nozzle will be homogeneous and therefore free from irregularities in structure which would cause one part to wear more rapidly than another. By reaming the parts as described, each will be exactly to dimensions and practically nothing is left to the skill of the workman. By making the stem and head integral all joints to be acted upon by the motive fluid are obviated. Further, the surface of the parts subjected to the action of the fluid will be hard and smooth, thereby reducing losses to a minimum. The nozzles will be exact counterparts, and such being the case, it is possible to make them in large quantities and apply them to machines as desired. They can also be shipped as supply parts with the certainty that they will fit the machine for which they are intended and also be like those already in use.

The nozzles can be made in a variety of sizes to suit the requirements, and can be used between stages as well as for the purpose of admission. They may be used for axial-flow machines, as shown, or for tangential or radial flow as desired.

By actual comparison I have found that nozzles made in accordance with my invention are much cheaper to manufacture than those heretofore made by the casting and hand processes.

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 support containing a plurality of cylindrical orifices with connecting slots, and drop-forged nozzles carried thereby, the heads of which are cylindrical and make a snug fit with the walls of the orifices and are cut away on the under side, and overlapping stems which pass through the slots in the support and also through the cut-away portions of the heads.

2. A drop-forged nozzle for an elastic-fluid turbine comprising a head which has straight sides for holding the nozzle in its support, is cut away on a bevel on one side of its under side to receive the stem of the adjacent nozzle when mounted in place and is cut away internally to form a bowl, and a stem which is made integral with the head and contains a bore that communicates with the bowl.

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

HENRY S. BALDWIN.

Witnesses:

JOHN A. McMANUS, Jr.,
PHILIP F. HARRINGTON.