No. 829,831. PATENTED AUG. 28, 1906.

H. S. BALDWIN.

NOZZLE FOR ELASTIC FLUID TURBINES.

APPLICATION FILED MAR. 3, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

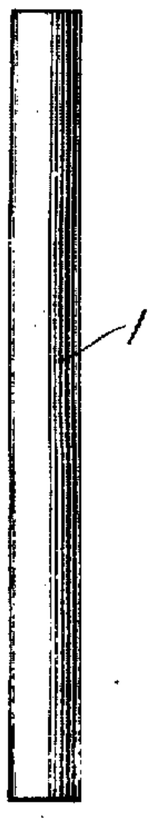


Fig. 2.

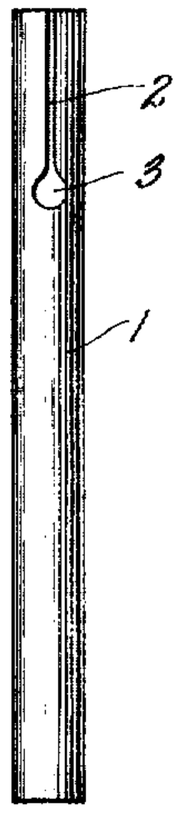


Fig. 3.

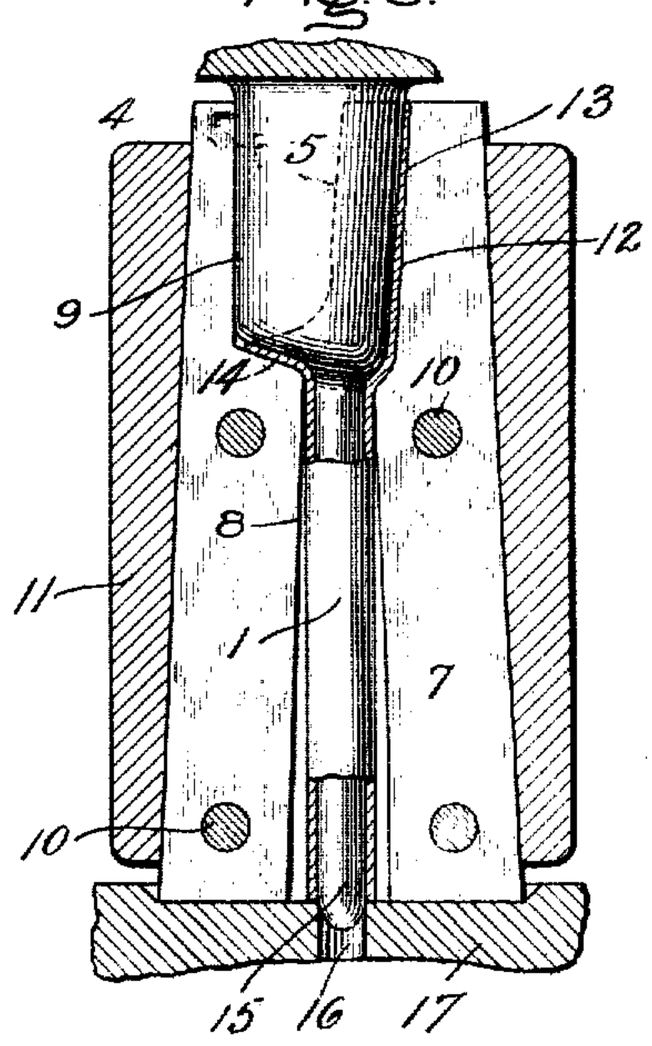


Fig. 4.

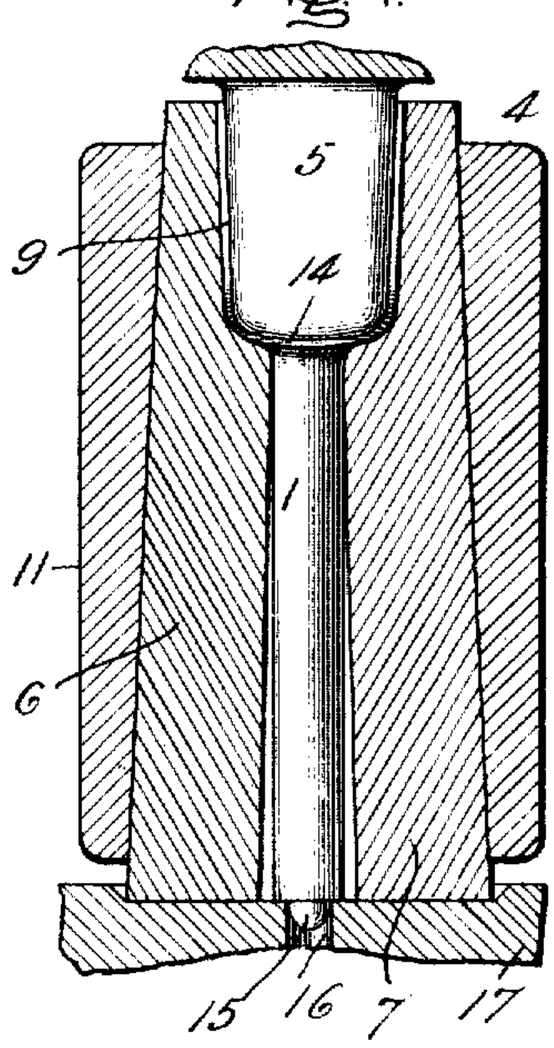


Fig. 5.

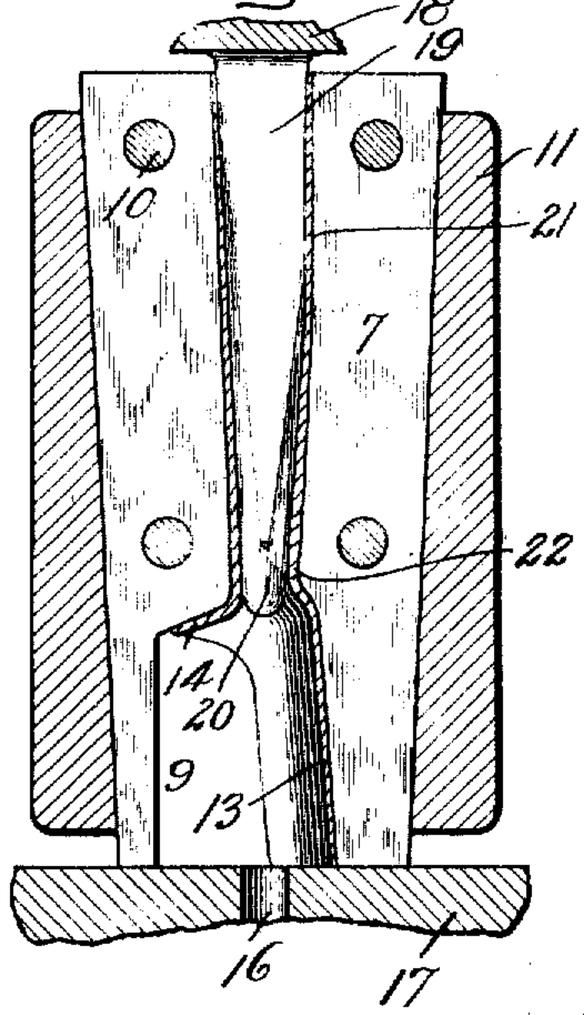


Fig. 6.

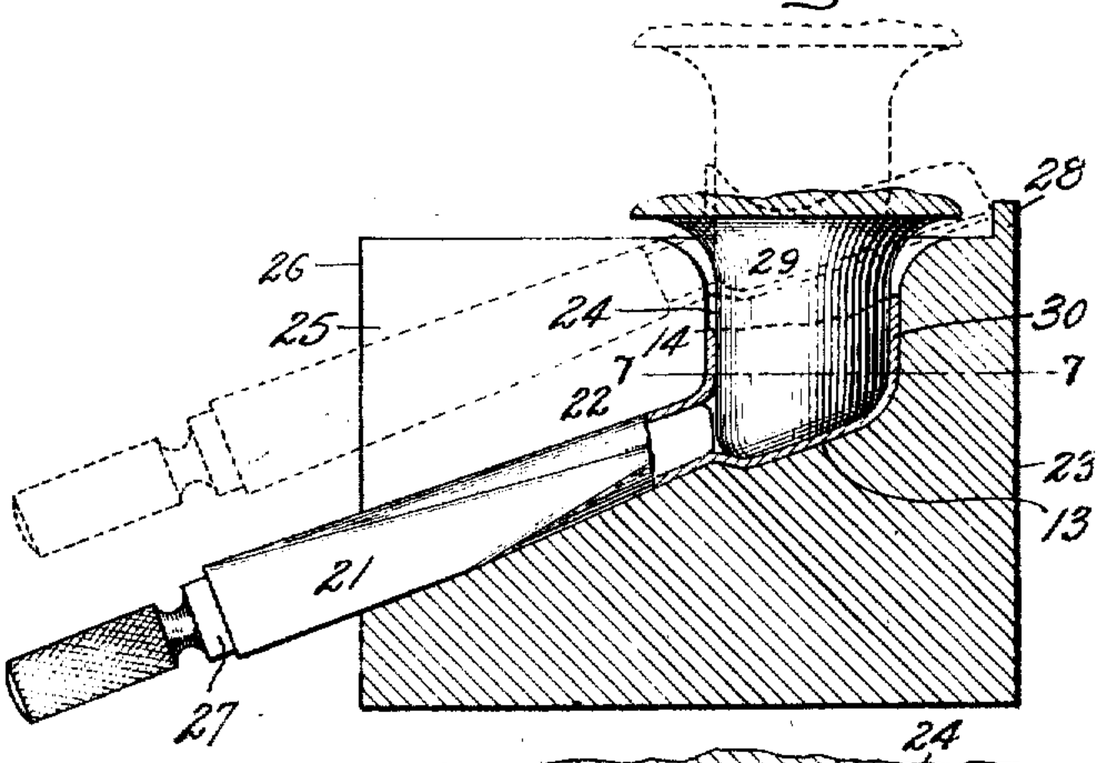


Fig. 7.

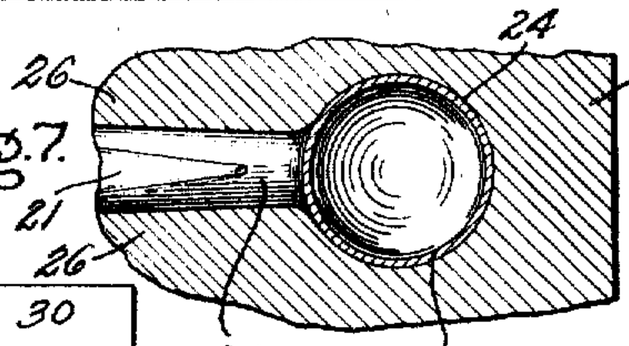
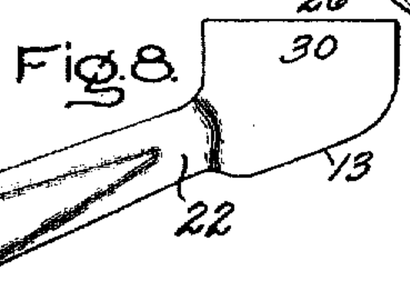


Fig. 8.



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2 SHEETS—SHEET 2.

Fig. 12.

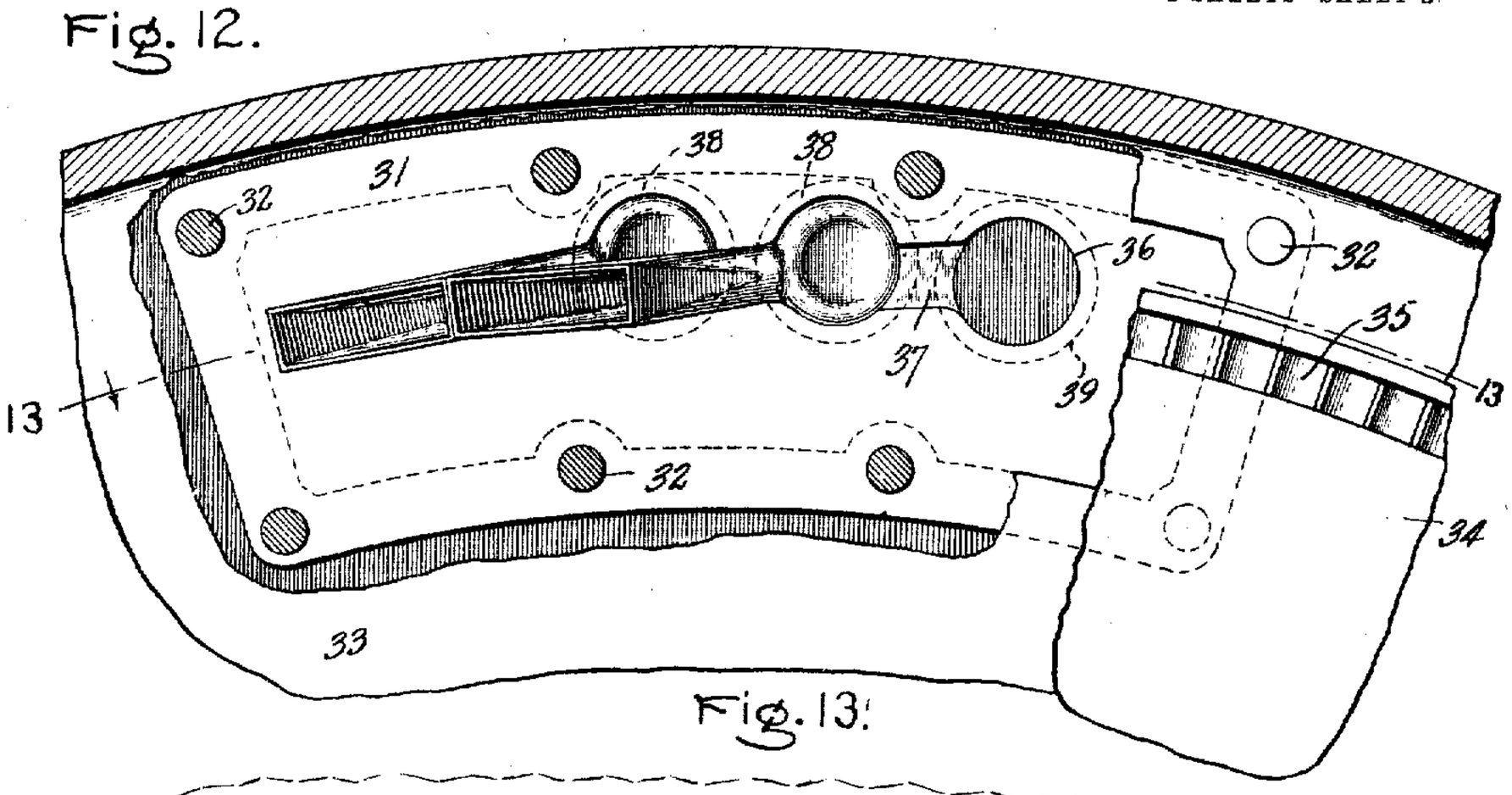


Fig. 13.

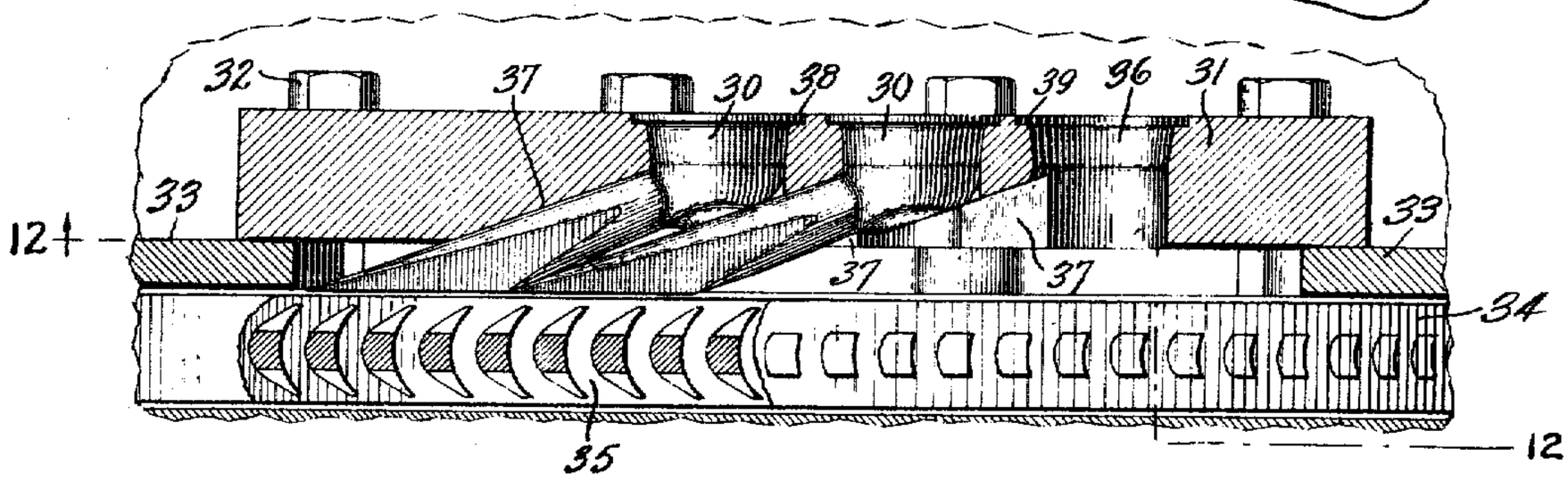


Fig. 10

Fig. 9.

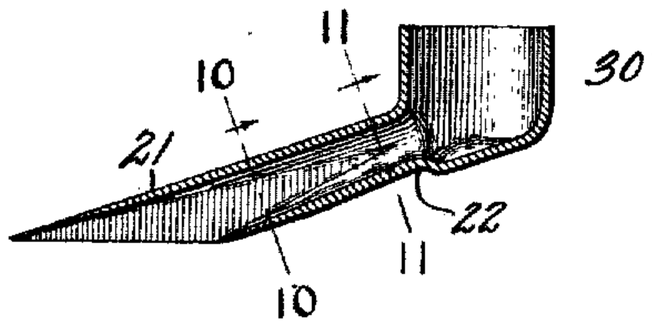
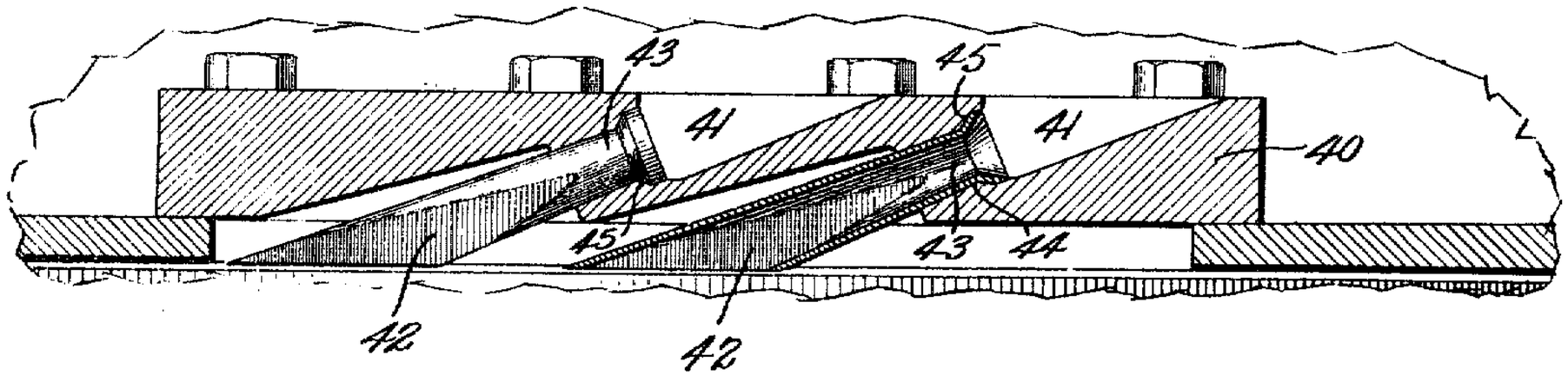


Fig. 11.

Fig. 14.



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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. 829,831. Specification of Letters Patent. Patented Aug. 28, 1906.

Application filed March 3, 1905. Serial No. 248,206.

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.

My invention relates to nozzles and nozzle units for elastic-fluid turbines; and it aims to improve their construction and to lessen the cost of manufacture. To realize these objects, I have devised a method by which the individual nozzles are made from tubular stock and are then mounted in supporting-plates to form units, which are adapted to be removably assembled in the turbine.

The invention has to do more particularly with that type of nozzle which converts the pressure energy of the motive fluid into velocity; but it is not limited altogether to such nozzles. This type of nozzle usually comprises a passage formed with a bowl or enlargement at the receiving end and an expanding discharge portion that connects with the bowl through a contracted throat.

In forming the nozzles I employ a tubular blank of the required length, diameter, and thickness and mill or otherwise form a longitudinal slot at the end where the bowl is to be shaped. The blank is then placed in a suitable die and the slotted portion expanded and offset to shape the bottom of the bowl. In a second die or in another portion of the first die the remaining part of the blank is expanded to form a passage whose area increases from the point adjacent to the partially-formed bowl, where the original size and shape of the blank is preserved to form the contracted throat to the outer end to constitute the discharge portion of the nozzle. If the nozzle is to be of the non-expanding type, the second die will merely give it the desired shape and size. The cross-section of the throat and discharge portion may be square, rectangular, or of any desired shape. The blank is next placed in another die and the bowl completed by forming the wall thereof. The wall is preferably cylindrical and is disposed at an angle to the axis of the discharge portion of the nozzle. It may, however, be any other shape and the bowl be arranged coaxially with the discharge portion. The former arrangement is best, however, since it enables the nozzles to be more closely nested. After the shaping of the bowl the ends of the nozzles are dressed off at the proper angle. Thereby the nozzle is completed and ready for mounting in its support.

It may be desirable to heat the blanks for certain or all of the steps in the drawing process, or the nozzle may be formed cold, depending largely upon the character of metal employed. Making the nozzles by drawing as described necessitates very little finishing, as the surfaces which guide and direct the fluid are perfectly smooth. It is to be noted, furthermore, that the fiber of the metal lies parallel with the direction of flow of the motive fluid. Hence any wear of the surfaces in contact with the motive fluid tends to keep them smooth, and thereby maintaining the friction between the fluid and the walls of the nozzles at a minimum.

After the formation of the nozzles they are mounted in supporting-plates, which latter, together with the nozzles, constitute the nozzle units. Each unit may include a single nozzle, or it may, and preferably does, include a group of nozzles, constituting what is commonly termed a "sectionalized" nozzle. The supporting-plate is preferably a segment having a curvature corresponding substantially to that of the circumference of the bucket-wheel; but, if desired, the plate may form a ring extending entirely around the wheel. Again, the nozzles may be mounted in a suitable part or parts of the casing-wall and in the diaphragms of the turbine. Nozzle-orifices are provided in the plate corresponding in number to that of the nozzles intended to comprise the unit. Extending from one side of each orifice is a groove whose walls are shaped to closely fit around or engage the exterior of the nozzle at the throat and serve to hold the nozzle in a fixed position. The center lines of the throat-engaging grooves extend in the same direction and substantially tangential to the wheel-buckets, so that when the nozzles are in position the column of fluid discharged through them will impinge against the buckets at the proper angle.

To secure a nozzle in the supporting-plate, the bowl is inserted into the nozzle-receiving orifice in such a manner that the throat will enter the throat-engaging groove. The ori-

fice may be tapered so as to be wider at the end opposite the groove, so that by expanding the bowl in the orifice to fit the tapered wall thereof the nozzle will be held securely in place, or the wall of the bowl may be made of such .. length that when the nozzle is inserted in position the upper end thereof will project somewhat beyond the plate. The projecting end of the wall is then expanded or flanged against the surface of the plate. If desired, each orifice may be slightly counterbored, so as to form a recess or depression into which the expanded portion or flange is firmly pressed. According to either method the nozzle or nozzles are securely held in place both at the bowl and the throat.

In the accompanying drawings, which illustrate one embodiment of the invention, Figure 1 is a side elevation of a tubular blank from which a nozzle is to be made. Fig. 2 is a similar view showing the first step of the process—namely, that of slotting the end of the blank where the bowl is to be formed. Figs. 3 and 4 are longitudinal sections taken at right angles to each other of the die for forming and offsetting the bottom of the bowl and showing the blank therein. Fig. 5 is a longitudinal section of the die shown in Figs. 3 and 4, the same being inverted for shaping the discharge portion of the nozzle. Fig. 6 is a section of the die for completing the shaping of the bowl. Fig. 7 is a transverse section on line 7 7, Fig. 6. Figs. 8 and 9 are respectively a side elevation and a longitudinal section of the finished nozzle. Figs. 10 and 11 are transverse sections of a discharge portion of the nozzle, taken on lines 10 10 and 11 11 of Fig. 9. Fig. 12 is a fragmentary sectional view of a turbine structure, showing a nozzle unit, one of the sections or nozzles being removed from the supporting-plate, the section being taken on line 12 12 of Fig. 13. Fig. 13 is a section taken on line 13 13 of Fig. 12, and Fig. 14 is a longitudinal section of a modified form of nozzle unit.

I have elected to illustrate the method of drawing nozzles as employed for making a nozzle whose bowl is disposed with its axis at an angle to that of the discharge portion. It is to be understood, however, that nozzles of that type wherein the bowl and discharge portion are coaxial may also be made according to my method.

Referring to Fig. 1 of the drawings, the blank 1 is a drawn tube of any suitable metal and of the required size. In order to form the bowl of the nozzle, a longitudinal slot 2 is milled or otherwise formed in the blank 1 at one end, Fig. 2, which is cut away or enlarged at its inner end 3 to enable the proper spreading of the metal in the punching operation. The bowl of the nozzle is shaped in two operations, during the first of which the bottom is formed and during the second the cylinder-wall. For the first step I employ a die 4 and a punch 5, Figs. 3 and 4. The die consists of two parts 6 and 7, correspondingly grooved and recessed to constitute a blank-receiving bore 8 and a bowl-forming depression 9. The parts are removably secured in proper alinement by dowels 10 and are clamped together by a ring 11, in which they wedge. The depression 9 and the punch may be of any desired configuration. In the present instance they are substantially elliptical in cross-section. The portion 12, Fig. 3, which constitutes the effective part of the die for forming the bottom of the bowl, is more or less flat and is slightly offset from the bore 8. The length of the depression is somewhat longer than the slot 2 in the blank, so that that portion of the blank adjacent the cut-away part 3 can be spread by the punch simultaneously with the shaping of the bottom 13 to form the portion 14 of the wall of the bowl. In order to prevent the thin wall of the blank from being crushed and deformed during the process of shaping the bowl, a pilot 15 is formed on the punch, which is adapted to extend down through the bore of the blank, and thereby maintain the proper shape of that portion of the blank which is not acted on by the punch proper. The lower end of the pilot extends below the end of the blank, which latter rests on the platen or table 17 of the punching-machine and enters a socket 16 in the table.

I prefer to employ the same die for expanding and shaping the discharge portion of the nozzle as is used for forming the bottom of the bowl. For this purpose the bore 8 is made according to the desired configuration, expanding from the point adjacent the depression 9 to its outer end and quadrilateral in section. After the blank is shaped, as shown in Figs. 3 and 4, the die with the blank therein is inverted and placed on the table 17 of the punching-machine in the position shown in Fig. 5 for the operation of forming the discharge portion of the nozzle. The punch 18 for this operation is provided with a shank 19 of square or rectangular cross-section, which tapers from its root to the tip 20, where it emerges into a cylindrical section. The punch when depressed into the die operates, by means of its taper, to progressively expand the blank to form the discharge portion 21 of the nozzle, while the tip 20 preserves the original size and stock at the portion 22, which constitutes the contracted throat of the nozzle. After the shaping of the discharge portion 21 the partially-formed nozzle is next placed in a die 23, Figs. 6 and 7, for the second or final part of the bowl-forming operation. This die comprises a block having a cylindrical depression 24 in its upper surface of suitable depth and inclined at its bottom. Extending laterally from the depression and in the upper surface of the block is a slot 25, provided with side

guide-walls 26, which extend in one direction parallel with the axis of the depression. The walls are parallel or flaring, as the case may be, to correspond to the shape of the discharge portion 21 of nozzle, which snugly, but movably, fits between them. The bottom of the slot is also inclined and offset from the bottom of the depression to correspond to the offset portion of the nozzle between the discharge portion and the bottom of the bowl 13, as formed in the two previous operations. A plug 27 is fitted into the discharge portion to give rigidity thereto and to serve as a means for the operator to hold the nozzle during the punching operation. The partially-formed blank is placed in the die in an inclined position, with the discharge portion 21 disposed in the guide-slot 25, as shown in dotted lines, Fig. 6, and the outer end of the bottom 13 held against a guide or abutment 28, formed on the back of the die. The punch 29, which corresponds in configuration to the depression, is next operated and presses the bowl into the depression, completing thereby the shaping of the cylindrical wall 30. Under the movement of the punch the blank moves bodily downward into the die, and the walls of the slot 25 engaging with the discharge portion 21 of the blank guide the latter so that the wall 30 of the bowl is formed at the desired angle and in proper relation to the discharge portion. After the forming of the bowl the ends of the nozzles are finished, as by milling or otherwise. It has been found best in practice to finish these ends perpendicular or substantially perpendicular to the axis of the bowl, as shown in Fig. 8.

Nozzles formed in the manner described are comparatively smooth and require little or no polishing, and as the fiber of the metal extends in the general direction of the flow of the motive fluid any wear tends to keep the walls smooth.

The completed nozzles are next mounted in their supports, which may be suitable fixed parts of the turbine structure. I prefer to employ removable plates, which, with the nozzles, constitute what I term the "nozzle units." A unit may include a single nozzle, or, as shown in Figs. 12 and 13, it may include a greater number of nozzles. The nozzles are mounted in the supporting-plate 31, which is secured by bolts 32 to the stationary part 33 of the turbine, the latter being a head, a diaphragm, or any other part. The plate is usually segmental and extends a short distance around the periphery of the bucket-wheel 34 at one side thereof. It may, however, be larger and even a ring carrying a complete circle of nozzles. The nozzles are disposed in an arc adjacent to the buckets 35 of the wheel, so as to discharge motive fluid against them.

In order to support the nozzles in the plate 31, the latter is provided with orifices or openings 36, the right-hand one in Figs. 12 and 13 being shown empty. Extending from one side of the orifices are corresponding grooves 37 or other equivalent means which engage with the throat portion of the nozzles. The nozzle at the left is mounted in the supporting-plate first and the others follow successively. To mount a nozzle, the bowl is inserted into one of the orifices 36, and the throat into the groove, and when in this position the upper end of the cylindrical wall 30 of the nozzle projects a slight distance beyond the surface of the plate. The projecting end is then expanded, so as to form a retaining-flange 38. The orifices 36 are slightly counterbored to provide depressions 39, into which the flanges are tightly pressed. The nozzles are thus securely held in the supporting-plate, both at the bowls and the throats, the throat-engaging grooves serving also to prevent the nozzles from turning in the nozzle-receiving orifices. Another way of securing the nozzles in the supporting-plate is to provide each nozzle-receiving orifice with a slight taper, so as to be of larger diameter at its upper end, and after the nozzle is assembled in the orifice the cylindrical wall of the bowl is merely expanded to closely fit the opening, thereby holding the nozzle in place.

In Fig. 14 I have shown a modified form of nozzle unit. This comprises a supporting-plate 40, in which the bowls 41 of the nozzles are formed. Hence the drawn part of the nozzles comprises simply the discharge portions 42 and the contracted throats 43. The nozzles are received in orifices 44 in the supporting-plate into which the throat ends of the nozzles are inserted and then expanded into recesses 45 at the inner ends of the bowls, thus securely holding them in position. The portion of the nozzle expanded into the recess 45 forms a part of the nozzle-bowl. Since the drawn part of the nozzle lacks the bowl, the process of making it is much simpler than in the form previously described.

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. As an article of manufacture, a nozzle for elastic-fluid turbines comprising a tube having an expanded bowl, and a discharge portion, the wall of the nozzle being of substantial uniform thickness.

2. As an article of manufacture, a nozzle for elastic-fluid turbines comprising a tube having an expanded bowl, and an expanded

discharge portion, the wall of the nozzle being of substantially uniform thickness.

3. As an article of manufacture, a nozzle for elastic-fluid turbines comprising a tube having an enlarged bowl, an expanded discharge portion, and a contracted throat connecting them, the wall of the nozzle being of substantially uniform thickness.

4. As an article of manufacture, a nozzle unit for elastic-fluid turbines, comprising one or more tube-nozzles each having a properly-shaped discharge portion, and a supporting-plate adapted to be removably mounted in the turbine in which the nozzle or nozzles are secured by expanding.

5. As an article of manufacture, a nozzle unit for elastic-fluid turbines, comprising tube-nozzles each adapted to be removably mounted in the turbine and provided with a bowl portion, and a supporting-plate having orifices for receiving the bowl portion of the nozzles and in which the said portions are secured by expanding.

6. As an article of manufacture, a nozzle unit for elastic-fluid turbines, comprising tube-nozzles each having a bowl and an expanding discharge portion connected by a contracted throat, and a plate adapted to be removably mounted in the turbine and provided with orifices in which the bowls are secured by flanging.

7. As an article of manufacture, a nozzle unit for elastic-fluid turbines, comprising tube-nozzles each having a bowl, and an expanding discharge portion disposed at an angle thereto and connected by a throat, a supporting-plate provided with bowl-receiving orifices, throat-engaging means on the plate which prevent the nozzles from turning in the orifices, and flanges on the bowls which coöperate with said means for holding the nozzles in position.

8. As an article of manufacture, a nozzle unit for elastic-fluid turbines, comprising tube-nozzles each having a bowl, a discharge portion disposed at an angle thereto and connected by a throat, a supporting-plate provided with bowl-receiving orifices, and angularly-disposed throat-engaging grooves, and securing flanges formed on the bowls to secure the nozzles in place in the orifices and grooves.

9. In a nozzle for elastic-fluid turbines, a segmental plate provided with transversely-extending nozzle-receiving openings and throat-engaging slots which extend in the same direction one from each opening.

In witness whereof I have hereunto set my hand this 1st day of March, 1905.

HENRY S. BALDWIN.

Witnesses:

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JOHN A. McMANUS, Jr