No. 829,865. PATENTED AUG. 28, 1906.

H. GEISENHÖNER.

THE MANUFACTURE OF NOZZLES FOR ELASTIC FLUID TURBINES OR OTHER CORED CASTINGS.

APPLICATION FILED FEB. 4, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

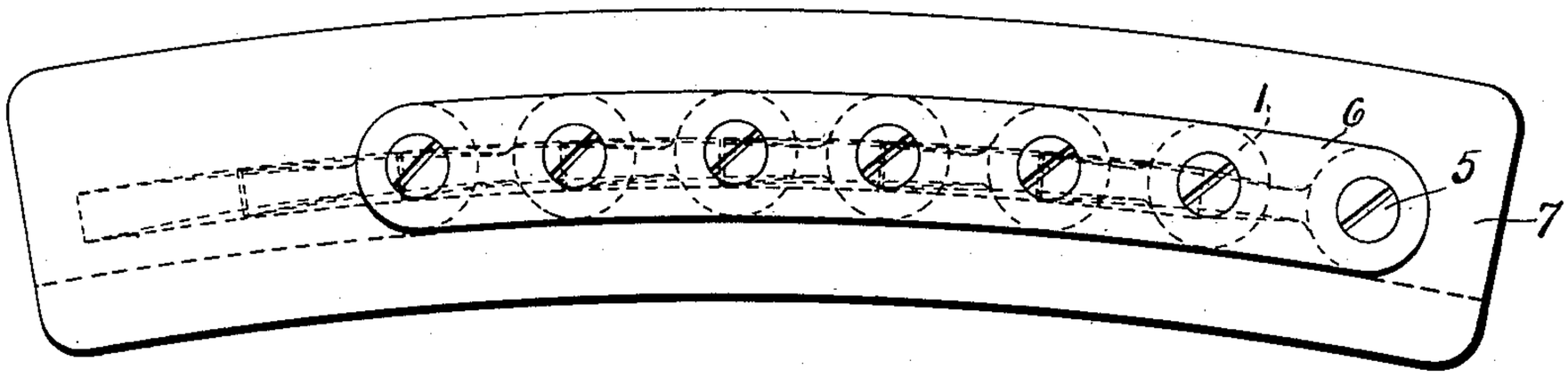


Fig. 2.

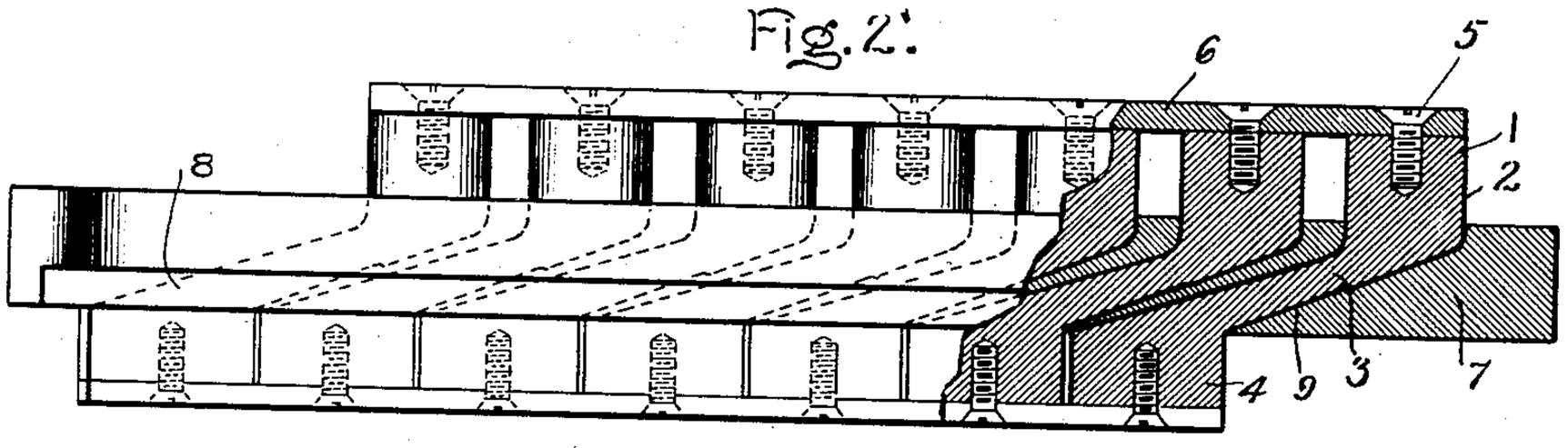
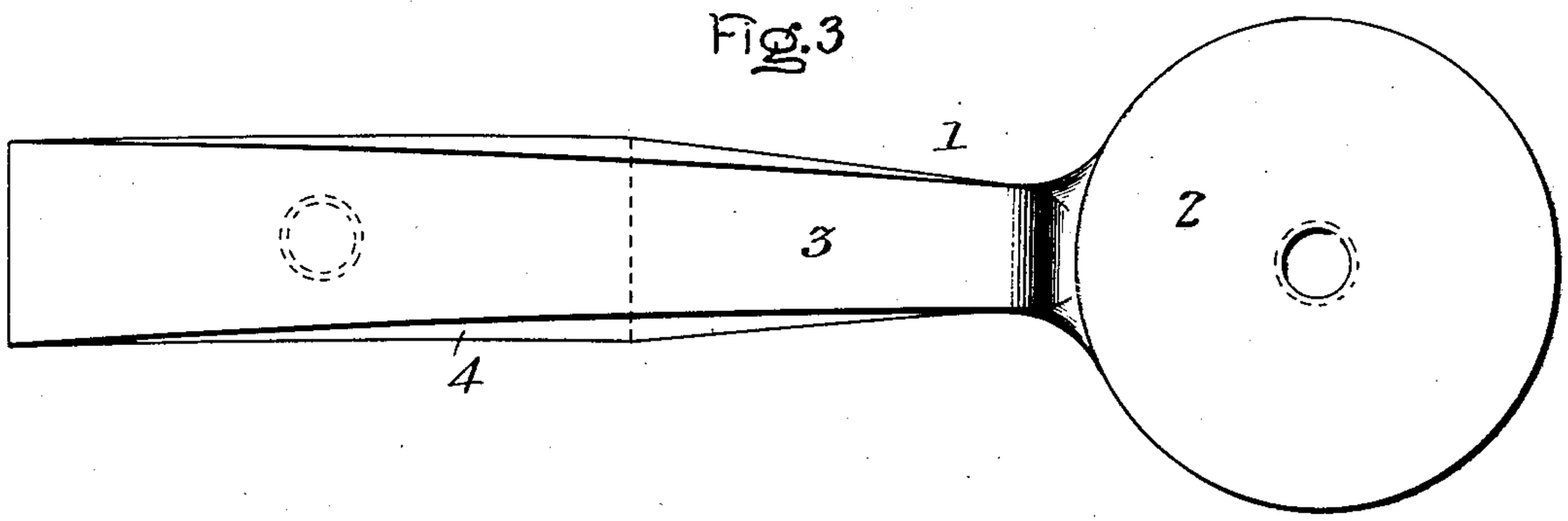


Fig. 3



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2 SHEETS—SHEET 2.

Fig. 4.

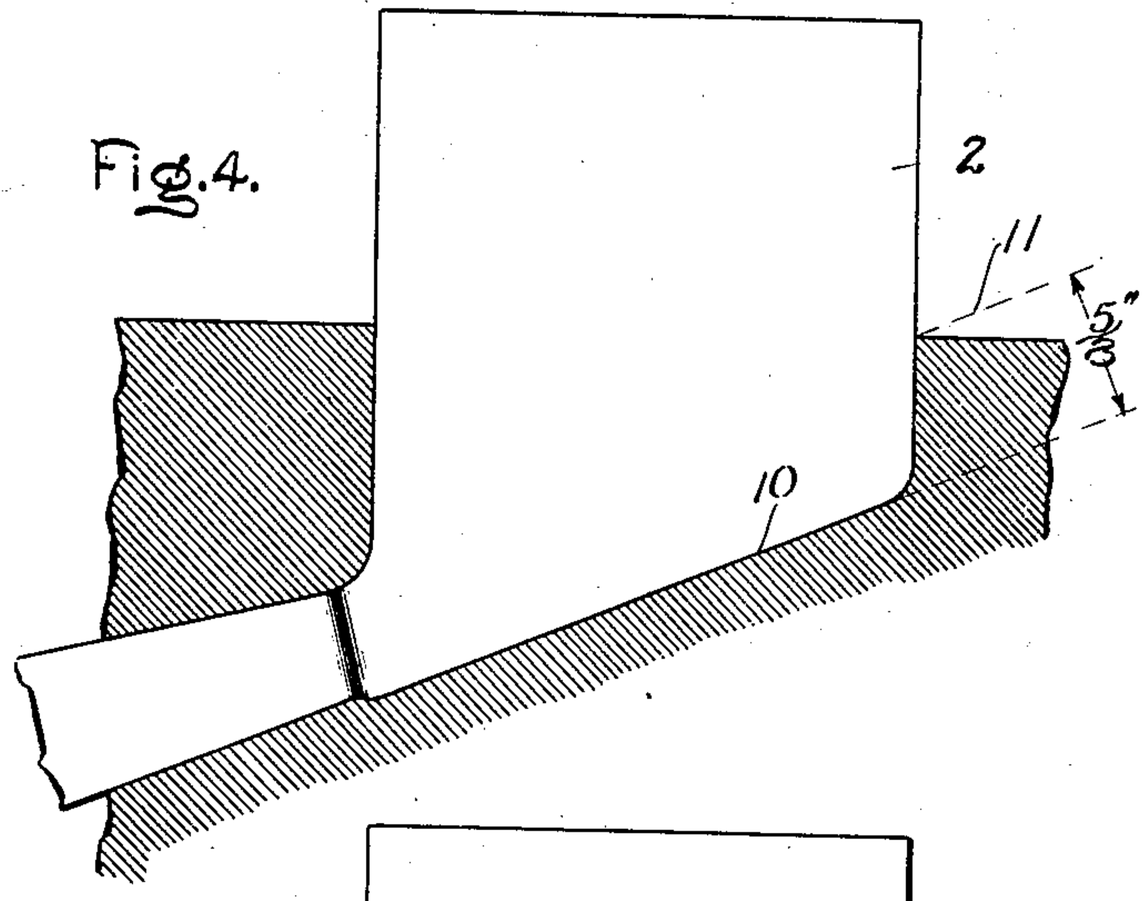


Fig 5.

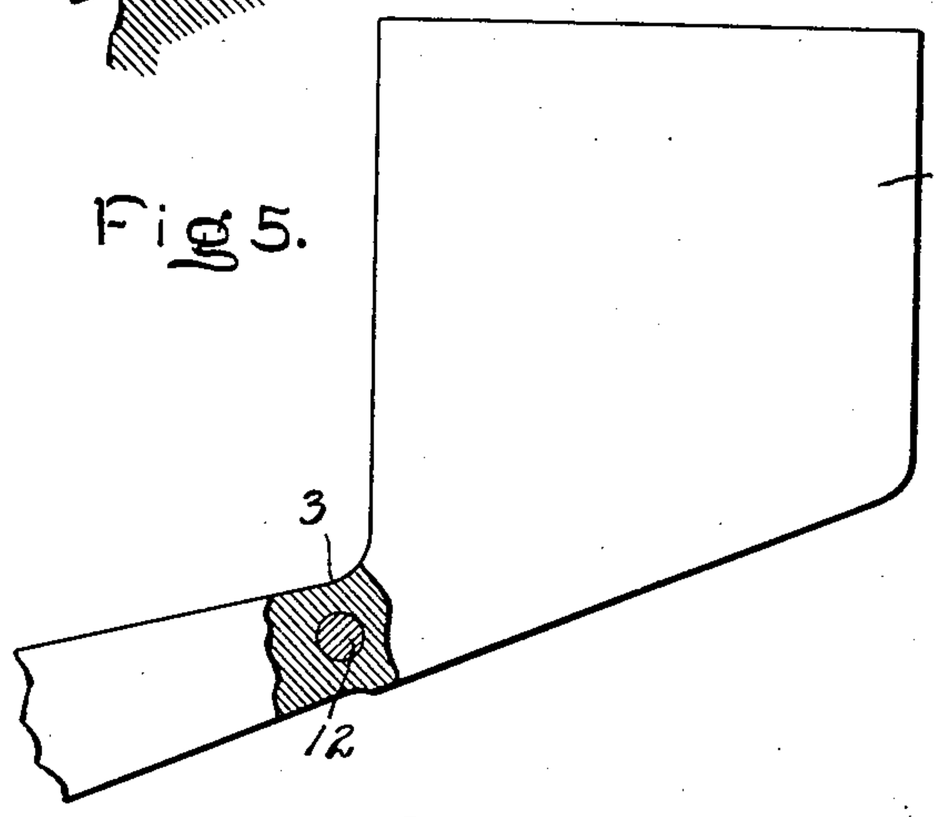


Fig. 6.

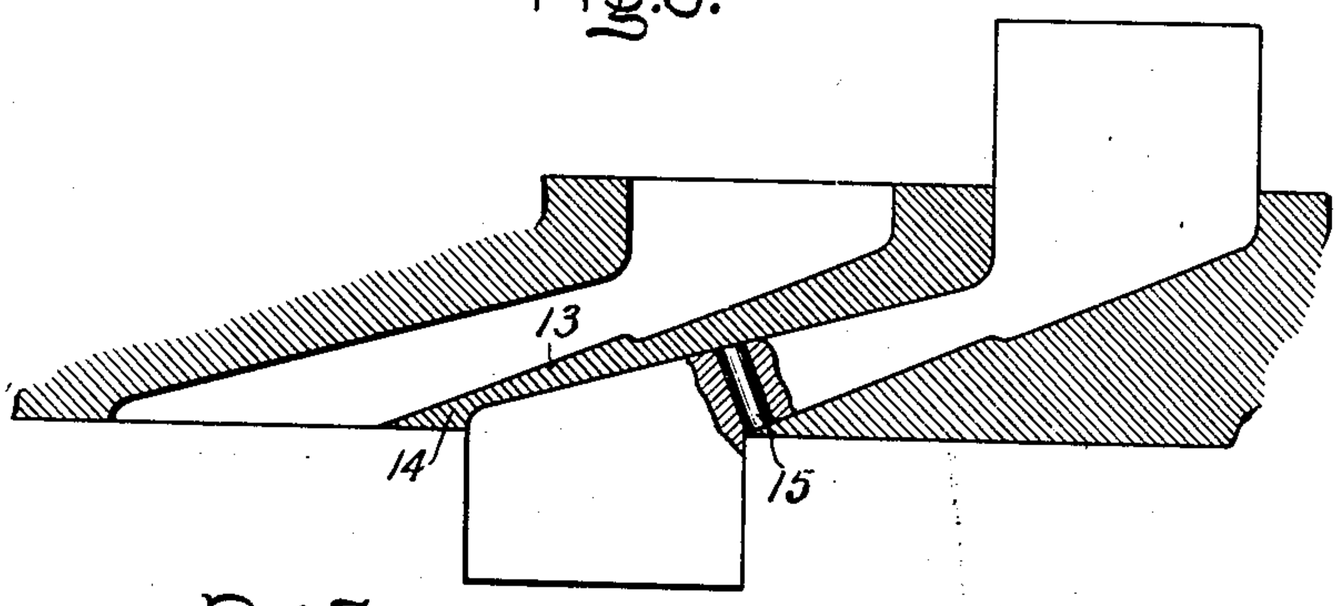
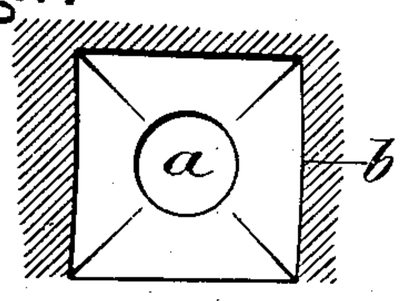


Fig. 7.



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UNITED STATES PATENT OFFICE.

HENRY GEISENHÖNER, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

THE MANUFACTURE OF NOZZLES FOR ELASTIC-FLUID TURBINES OR OTHER CORED CASTINGS.

No. 829,865. Specification of Letters Patent. Patented Aug. 28, 1906.

Application filed February 4, 1904. Serial No. 191,971.

To all whom it may concern:

Be it known that I, HENRY GEISENHÖNER, a citizen of the United States, residing at Schenectady, in the county of Schenectady and State of New York, have invented certain new and useful Improvements in the Manufacture of Nozzles for Elastic-Fluid Turbines or other Cored Castings, of which the following is a specification.

Turbine-nozzles as ordinarily constructed are made of cast metal and are provided with a plurality of closely-associated fluid-discharge passages, each having the same angle of delivery and gradually increasing in cross-section from the throat to the end. In some instances the throats are circular in cross-section and in other cases are rectangular. The discharge end of each passage is preferably rectangular, or substantially so, in order that the shape of the fluid-stream discharged therefrom may conform closely to the shape of the bucket-spaces in the wheel. The nozzle structure as a whole is curved somewhat, so as to conform to the shape of the wheel. Formed anterior to and communicating with each throat is a well-rounded bowl of suitable size.

The nozzles have heretofore been cast in the ordinary way, each nozzle-passage and bowl being formed by a sand core of usual construction. The cores are made in separate structures and are held in place between the parts of the mold by sockets or enlargements formed by the core-prints on the pattern. After the nozzle is cast the cores which are then in a burned and somewhat soft state are removed and the nozzle-passages filed and scraped by hand to gage. Such a nozzle is very costly to make, chiefly because it requires such a long time to finish them. In a certain type of nozzle of large size which came to my attention and having twelve passages it required the time of two workmen for four weeks to file, scrape, and gage them. Since the efficiency of a turbine is dependent to a very great degree upon the accuracy of these nozzles, it is important to make the areas of the throats and discharge-orifices bear a definite relation to each other. It is also of great importance to form the passages in such manner that the increase from the throat to the end is a gradual one and in accordance with certain laws, which need not be here specified. Owing to the fact that the passages are relatively small, the filing and scraping is most difficult. The workman commonly has to place an incandescent lamp so that the light will shine in at one end of a passage while he works at the other. The finishing of a nozzle-passage is particularly arduous where the throat is round and the discharge end rectangular, as will be readily understood.

Another difficulty experienced in manufacture is that the cores being independent and depending upon the sand in the mold for their support are liable to be moved slightly out of line in setting up the mold and also in pouring. Between the passages the walls of the nozzle taper from the throat to the discharge end, the object being to cause all of the fluid-streams to unite in a solid column as soon as they leave the nozzle. Usually the walls approach a knife-edge at the end. Obviously if one of the cores is the least bit out of place it will cause the thickness of the walls or the relation of the passages one to the other to be changed, all of which has to be rectified before the nozzle can be used. If the distortion or inaccuracy is great, the nozzle cannot be used at all.

The object of the present invention is to overcome the objections above pointed out and to form the nozzle-passages so accurately and smoothly that practically no handwork is required thereon after they are removed from the mold.

In carrying out the invention I provide a number of metal cores equal to the number of passages to be formed. The cores may with advantage be made of cast metal on account of small cost; but they may be formed otherwise, if desired. Each core is accurately formed to size and shape and is provided with an enlargement at one end corresponding to and projecting beyond the bowl, and a second enlargement extends beyond the discharge end of the passage. These cores can be so accurately formed by casting that practically no finishing is required. Usually a grinding-wheel or a file will be sufficient to face off the rough spots. One or both of the enlarged ends of the cores are then attached by suitable means to frame-bars, which bars preserve the alinement between the cores and also act as spacers to hold them a fixed distance apart. A simple and satisfactory arrangement for securing

the parts is to tap the enlarged ends of the cores to receive screws, which pass through the frame-bars. After the cores are attached to the bars they can be measured to ascertain whether or not they are correctly arranged with respect to each other, and if not they can be adjusted. This can readily be done by leaving a small space around the screw in the frame-bars. After the cores are properly arranged they are coated with graphite to prevent the metal of which the nozzle is composed from sticking thereto. The mold for the nozzle may be formed in the usual manner, and provision should be made for the reception of the enlarged ends of the cores and the frame-bars attached thereto. Care should be exercised in placing the gate or gates in such manner that the stream of molten metal will not directly strike the thin portions of the core or the frame-bars. After the nozzle is cast the mold is taken down and the frame-bars removed, the enlarged ends of the several cores adjacent to the bowls are struck a heavy blow or blows, which cause them to break within the casting and usually at a point in line with or nearly in line with the throats, after which the remaining portion of the cores can be driven out owing to the tapered formation.

The throat is usually of relatively small diameter and is the weakest part of the core. In those cases where the throat is of substantial proportions it can be further weakened by boring one or more holes therein and filling in the space or spaces thus formed with plugs of steel or other material, so as to present a smooth surface. In order to insure the thin end of the partition between adjacent passages being well formed, I may thicken it slightly by cutting away the core at the point adjacent thereto and afterward cut down this thickened portion.

One of the advantages accruing from the use of my improved method of manufacture is that there is a great saving in labor, both in the point of time and in the character of the labor employed. For example, a twelve-passage nozzle of the character above referred to and made in accordance with my invention required only two days' work on the part of one man, as contrasted with two men working four weeks. With the original method of construction only highly-skilled labor can be employed, while in the latter case men of ordinary ability are satisfactory.

I know that attempts have been made to cast metal around a metal core, which is afterward withdrawn as an entirety; but so far as I know no one prior to my invention has ever made a casting with a metal core of such shape that it had to be broken before it could be removed from the casting, and this without in any way injuring the casting.

I believe that it is also broadly new with me to make a cast-metal nozzle for turbines having a plurality of passages by using removable metal cores which are spaced apart by a suitable frame during the act of casting to preserve the exact relation of parts.

In the accompanying drawings, which represent one type of apparatus for producing my invention, Figure 1 is a plan view of a sectionalized nozzle for an elastic-fluid turbine after its removal from the mold and having the cores still in position. Fig. 2 is a side elevation thereof, partly in section. Fig. 3 is a full-sized plan view of one of the metal cores. Fig. 4 is a detail view drawn to scale and showing the relation between one of the enlarged portions of the core and the nozzle. Fig. 5 is a detail sectional view showing a means for weakening the core at any point where it is desired to break it. Fig. 6 is a slight modification wherein the thin end partition-wall between adjacent nozzles is thickened, and Fig. 7 is a detail view showing in cross-section a nozzle-passage having a round throat and a substantially rectangular discharge end.

For the purpose of illustration the mold has been removed, and the nozzle and cores are shown in the relation which they occupy when removed from the sand.

1 represents one of the metal cores, and since they are all alike a description of one of them will suffice. It is provided with an enlargement 2, which forms the bowl of the nozzle, and a portion of reduced cross-section 3, that forms the throat. From the throat to the discharge end of the nozzle the core gradually increases in cross-section and terminates in an enlargement 4. In Figs. 1 and 3 the throat and discharge end are both rectangular in cross-section, whereas in Fig. 7 the throat *a* is circular and the discharge end *b* rectangular, or substantially so. One or both of the enlarged ends of the core are tapped to receive the screws 5, that secure the frame bar or bars or spacing-pieces 6 in place. 7 represents the main body of the nozzle, which is shouldered at 8 at a point where it engages with the turbine-casing. The pitch between all of the cores is similar, and the cores themselves are counterparts. Therefore the shape and angle of delivery of all the nozzle-passages is the same. Each core before being placed in the mold is given a coat of graphite 9 to prevent the molten metal from sticking thereto. After the nozzle is cast it is removed from the mold and the frame-bars 6 are detached therefrom. The enlargements 2 are then hit one or more heavy blows, which causes them to break at or near the throat 3, after which the enlargement 2 can be removed and the enlargement 4 and piece attached thereto driven out, the one at the left being driven out first and then the next, and so on. In addition to breaking off the enlargement 2 I may also break off the enlargement 4. I have found that the enlarge-

ments forming the bowl can be readily removed in the manner specified when the distance between the line 10 and the top surface of the nozzle, as represented by the line 11, is five-eighths of an inch, the diameter of the enlargement being two and three-eighths inches. I mention these dimensions merely as an illustration, but do not wish to be understood as limiting myself to these or any other dimensions.

In Fig. 5 I have illustrated a construction suitable for very large nozzles wherein the cross-section of the throat 3 is considerably larger than that shown in the other figures. In this case I drill one or more holes wholly or partially through the throat-section or at the particular point where I desire to break the core and fill it with a plug 12, which is arranged to present a smooth surface to the molten metal. As shown, the plug extends at right angles to the vertical plane of the core; but it can be placed elsewhere, if desired.

In Fig. 6 I have shown the core so shaped that the partition 13 between adjacent nozzle-sections can be enlarged for the purpose of insuring a good casting at the end. This is formed by making the core somewhat shorter than in the previous illustrations, so as to form a somewhat thickened portion with a rounded shoulder 14. The core can be drilled and the hole filled with a plug, as indicated at 15. In this case the plug is shown at right angles to that shown in Fig. 5; but either of these arrangements can be employed in either case, as is desired.

In order to insure good castings at all times, it is desirable to heat both the cores and the mold before pouring. Obviously this can be done in a suitable oven.

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. The method of forming cored castings, which consists in securing a number of metal cores together in a predetermined relation, coating the cores with a material to prevent the molten metal from sticking thereto, pouring molten metal around the cores which are held in place when the metal hardens, removing the core-securing means, breaking the cores within the casting, and finally removing the pieces of the cores from the casting.

2. The method of forming a nozzle having a plurality of passages that are enlarged at their ends, which consists in providing carefully-finished and smooth metal cores, securing the cores together in proper position, pouring the molten metal around them, disconnecting the cores, and finally breaking the cores to remove them from the casting after the metal solidifies.

3. The method of forming cored castings, which consists in providing a plurality of integral metal cores of suitable configuration, attaching the cores to a common support to preserve their alinement, pouring molten metal around the cores which holds them in place when the metal hardens, separating the supports and the cores, breaking each of the cores at a point between the ends, and finally removing the pieces of the cores from the casting.

4. The method of forming a nozzle having a passage enlarged at one end and expanding toward the other end, which consists in providing a smooth and accurately-finished metal core, suitably supporting the same, pouring metal around a portion of the core so as to leave an end extending from the casting, breaking the core by striking it upon the end, and removing the parts thereof from the casting.

In witness whereof I have hereunto set my hand this 2d day of February, 1904.

HENRY GEISENHÖNER.

Witnesses:

EDWARD WILLIAMS, Jr.,

HELEN ORFORD.