June 6, 1950 W. K. BODGER 2,510,735

TURBINE ELEMENT

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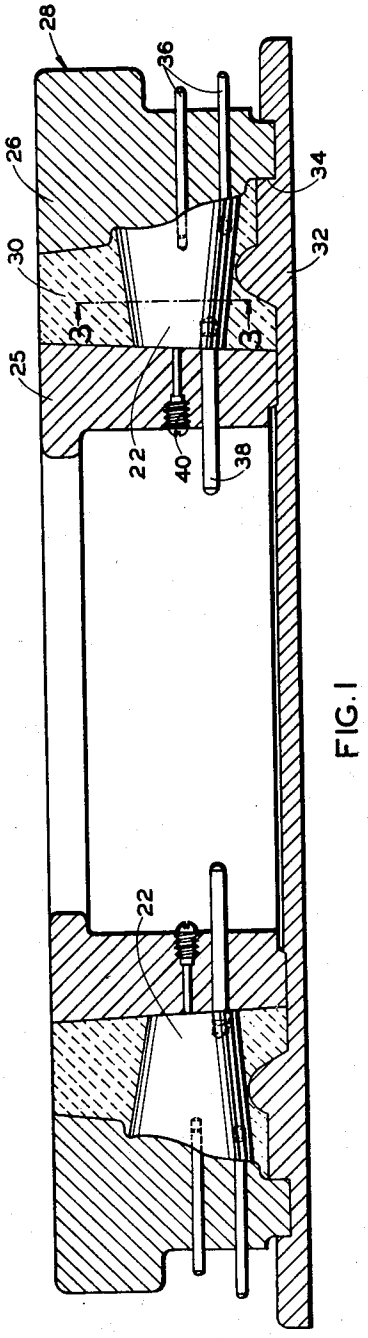


FIG. 1

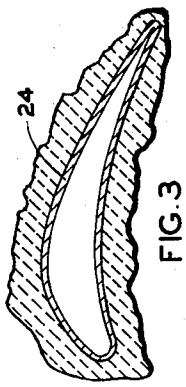


FIG. 3

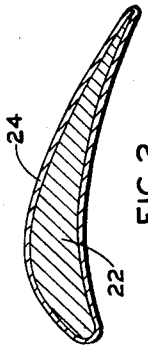


FIG. 2

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TURBINE ELEMENT

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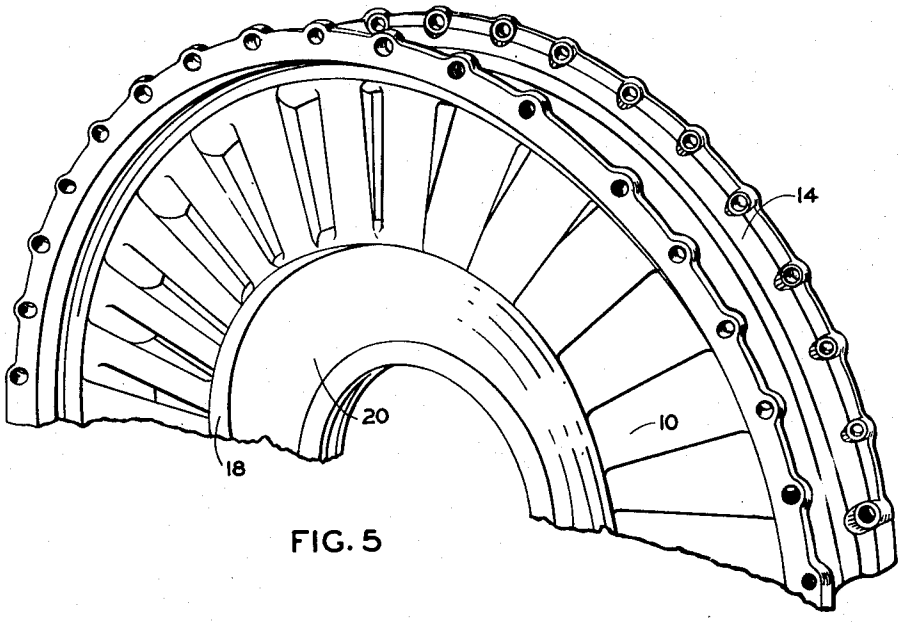


FIG. 5

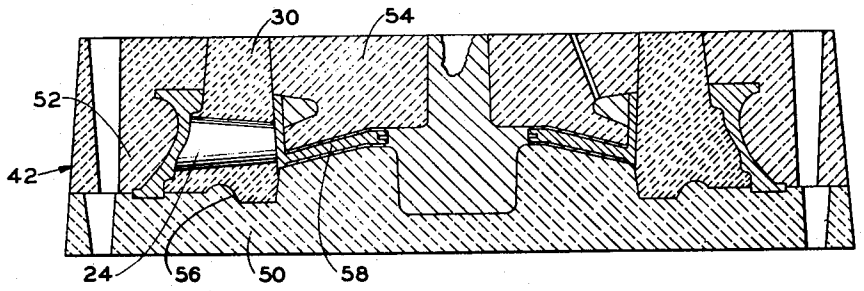


FIG. 4

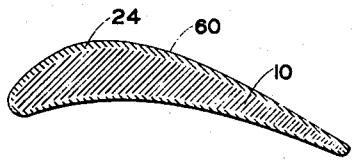


FIG. 6

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2,510,735

TURBINE ELEMENT

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Application April 10, 1946, Serial No. 661,168

1 Claim. (Cl. 253—77)

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This invention relates to investment casting in which the opening in the mold is formed by a pattern that is removed by being melted or evaporated out of the mold.

In casting certain articles, it has been difficult to obtain the desired surface finish, as for example in casting the parts of a turbine over which power fluid passes, such as the blades and nozzle vanes. A feature of this invention is an arrangement for producing the desired surface finish on selected parts of the article being cast. One feature of this invention is the casting of a part of the article within a shell which becomes an integral and permanent part of the article, and which has the desired surface finish on its outer surface and is the desired material.

One feature of the invention is the plating of the pattern used in making the mold so that when the pattern is removed by melting or evaporation, the plated material will remain in the mold to form the outer surface on a part, at least, of the casting. The plated material is thin enough that it will be integrally bonded to the material forming the rest of the cast article when the metal is bonded into the mold, yet thick enough that its surface finish will be maintained.

Other objects and advantages will be apparent from the specification and claims, and from the accompanying drawings which illustrate an embodiment of the invention.

Fig. 1 is a sectional view through a core box in which the investment material for a part of the mold is formed.

Fig. 2 is a sectional view through one of the inserts used in the core box of Fig. 1.

Fig. 3 is a fragmentary sectional view substantially along the line 3—3 after the pattern material has been removed.

Fig. 4 is a sectional view through the mold in which a nozzle ring is cast, showing the invested core of Fig. 1 in position.

Fig. 5 is a perspective view of a completed nozzle ring.

Fig. 6 is a sectional view through one of the vanes of the ring.

The nozzle ring made in accordance with the invention includes a number of vanes 10, defining between adjacent vanes passages through which the fluid for the turbine is discharged against the blades of the rotor. The outer ends of the vanes are integrally connected by an outer ring 14, and the inner ends of the vane are integrally connected by an inner ring 18. A diaphragm 20 extends radially inward from the

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ring. The nozzle ring is cast in a single piece so that the vanes 10 and the inner and outer rings are all integral.

In making the nozzle ring, a number of duplicate vane patterns or inserts 22, Fig. 2 are molded from a material which can be melted or evaporated from the core by heating, such material being, for example, waxes, plastic, or other low-melting-point materials. The insert 22 is covered by a thin outer plate 24 of a material which will form the outer surface of the turbine vanes after the turbine nozzle ring is cast, the material of plate 24 being applied to the insert desirably by electro-deposition. Thus, this material is preferably a material which will not be readily oxidized or attacked by gases in the power fluid and which will not be affected by the high temperatures at which the turbine may operate, this material, for example, being the high-temperature, generally non-ferrous, metals, a number of which are well-known.

A number of inserts 22 are mounted between the inner and outer rings 25 and 26 of a core box 28, Fig.1, in which the core 30 is formed. The rings 25 and 26 may be mounted on a plate 32 which has a groove 34, by which the outer ring 26 may be accurately located. The inserts may be located by pins 36 extending through the outer ring and projecting into the outer end of the insert and one or more pins 38 similarly located in the inner ring. A threaded locking pin 40 in the inner ring clamps each vane element securely in position.

After the core box with the inserts therein has been assembled, core material, preferably of the type used in investment casting, is poured into the space between the inner and outer rings and around the inserts until the spaces are entirely filled. When the core material is set, the pins 36 and 38 are withdrawn, the rings 25 and 26 are removed and the vane inserts are removed by heating the core to a temperature high enough to melt or evaporate the insert material. The finished core thus has passages in it corresponding exactly to the shape of the individual vanes in the finished nozzle ring. Each of the passages is lined with the plated material 24 that was previously applied to the vane insert, since as above stated, this material has a high enough melting point that it would not be melted or evaporated during the removal of the insert itself.

A mold 42, Fig. 4, for the nozzle ring casting is made up of a drag 50, the casting cheeks 52 which define the outer surfaces of the finished

casting and the cope 54. The core 30 is placed in the mold, being located by notch 56 in the drag. The cope and drag define the mold cavity in which the casting is formed and the core is located in this cavity to form the vanes during the casting process. In Fig. 4, the closely spaced crosshatching on the casting 58 in the mold shows the finished shape of the nozzle ring, the more widely spaced crosshatching defining the shape of the casting as formed in the mold.

After the material is cast and the mold material has been removed from the casting, the plate material will be integrally bonded with the cast material which will have flowed through the passages in the core left by the removal of the vane inserts and will have defined on each turbine vane, as shown in Fig. 6, an outer surface which will have the desired surface finish and will be a permanent and integral part of the casting.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claim.

I claim:

A cast turbine element having vanes over which the power gas passes, and inner and outer arcuate supporting rings for said vanes and between which a plurality of vanes extend, said rings being concentric to each other and defining the inner and outer walls of the gas path, said vanes and rings being integrally cast, each of said vanes having a thin outer shell of a different material forming a smooth outer surface and integrally bonded to the vane over substantially the entire area of the shell, each of said shells extending only over the vanes, the remainder of the element, including the inner and outer supporting rings being free of such shells.

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