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(54) **Refractory metal core for integrally cast exit trench**

(57) A refractory metal core (10') for use in casting a turbine engine part (12') has a main portion (16') and a plurality of tabs (18') extending from the main portion (16'). An end portion (22') has a first edge which joins together the plurality of tabs (18') and a second edge, opposed to the first edge, located internally of an exterior boundary (14') of the cast part (12').

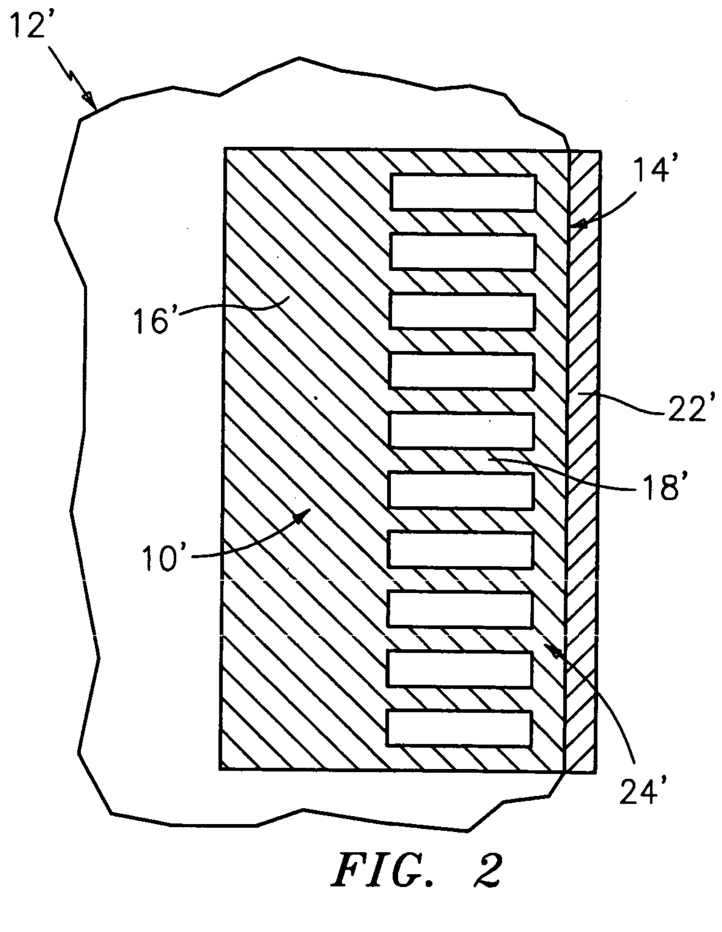

FIG. 2

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Description

BACKGROUND

[0001] The present disclosure relates to a refractory metal core having separate exit tabs which are ganged together within the exterior boundary of a finished cast part and to a turbine engine part formed using the refractory metal core.

[0002] Refractory metal cores have been used to form cooling passages in turbine engine components such as blades and vanes. The main portion of the refractory metal core may be configured to create a cooling air passage internal to the component. Small tabs extending from the refractory metal core are used to form exit holes associated with the cooling air passage. These individual exit tabs are sometimes connected together outside the envelope of the finished casting to improve the casting process.

[0003] The exit holes formed in this manner can restrict the types of coatings that can be subsequently applied or significantly increase the cost of forming the coatings since very thick coatings will cover the holes. In addition, the cast holes are subject to occasional partial clogging or bending over of edges from handling or contamination, leading to an undesirable decrease in passage cooling flow.

SUMMARY OF THE INVENTION

[0004] The present disclosure relates to a refractory metal core for use in casting turbine engine part. The refractory metal core broadly comprises a main portion, a plurality of tabs extending from said main portion, and an end portion which at one end joins together some or all of said plurality of tabs. The end portion has an opposite edge located prior to an exterior boundary of the part.

[0005] The present disclosure also relates to a turbine engine part having an airfoil portion with a cooling passage formed therein or a part without an airfoil portion which forms the inner or outer gaspath endwalls. The cooling passage has a plurality of exit holes and an exit trench which receives cooling fluid from said exit holes.

[0006] The disclosure also covers a turbine engine part having a core of the disclosure therein and a method of forming a cast part comprising placing a core of the disclosure in a mold or die, forming the cast part from a molten metal and removing the core.

[0007] Other details of the refractory metal core integrally cast exit trench, as well as advantages attendant thereto, are set forth in the following detailed description and the accompanying drawings wherein like reference numerals depict like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 is a schematic representation of a refractory metal core used to form a cast part;

FIG. 2 is a schematic representation of a refractory metal core which may be used to form an integral cast exit trench;

FIG. 3 illustrates a vane outer wall edge having a cast cooling exit trench formed using the refractory metal core of FIG. 2;

FIG. 4 is a sectional view taken along lines 4-4 of Fig. 3;

FIG. 5 is a schematic representation of an alternative refractory metal core which can also be used.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0009] As shown in FIG. 1, a refractory metal core 10 which may be used to form a cooling passage in a cast part 12, such as a turbine engine component, is illustrated. As can be seen from FIG. 1, the cast part 12 has a boundary 14. The refractory metal core 10 has a main portion 16 with a plurality of tabs 18 extending therefrom. The tabs 18 are used to form a series of discrete cast exit holes 20 in the finished casting of the part. As can be seen from FIG. 1, the tabs 18 extend beyond the boundary 14. The tabs 18 may have unjoined ends or one or more sets of joined or ganged ends. The tabs 18 may be joined together by a piece 22 of refractory metal material which is located outside the boundary 14. The use of this type of refractory metal core produces small holes which can be subject to contaminant buildup in the corners of the individual exit hole openings. The individual holes may also require extensive individual masking prior to the application of subsequent coatings to prevent blockage of the hole by the coating.

[0010] To alleviate the foregoing issues, the refractory metal core 10' of FIG. 2 may be used to form the cast part 12'. The cast part 12' has an exterior boundary 14'. The refractory metal core 10' has a main portion 16' which may be configured to form at least one desired cooling passage in the cast part 12'. For example, the main portion 16' may be machined so as to form a cooling passage with heat transfer ribs or pedestals, or make a joint to connect to a ceramic core with a serpentine cooling passage. A plurality of tabs 18' extend from the main portion 16' and are used to form an array of exit holes 104 for the cooling fluid which exits the cooling passage. As can be seen from FIG. 2, the tabs 18' do not extend beyond an exterior or outer boundary 14'. The outer boundary 14' could be an exterior surface of the part, such as a pressure sidewall or a suction side wall. The outer boundary 14' could also be a trailing edge of an airfoil portion of the part. Still further, the outer boundary 14' could be the intersegment edge of an endwall in a blade outer air seal or shroud. The tabs 18' are joined together by a piece 22' of refractory metal material. The piece 22' of refractory metal material forms an exit trench 106 in the final cast part.

[0011] The main portion 16', the tabs 18', and the piece 22' may be integrally formed from a refractory metal material such as molybdenum or a molybdenum alloy.

[0012] The exit trench 106 protects the exit holes 104 from external contamination and handling damage by keeping the terminus of each exit hole 104 inboard of the exterior boundary or edge 14' of the cast part. The exit trench 106 creates enough flow area to be much more tolerant of any contaminant buildup in the corners of the opening 26' of the exit trench 106 than individual holes such as those created by the refractory metal core of FIG. 1 would be. The slot in the cast part which forms the opening 26' is usefully a single long opening that can be masked in one step for subsequent application of thick external coatings. It can also be more than one long opening formed by ganging together groups of exit tabs. Benefits include reduced variability in actual part flow, reduced cost of coating, and expansion of the variety of coatings that are feasible to use.

[0013] To form the cast part 12', the refractory metal core 10' is placed into a mold or die. After the part 12' has been formed from a molten metal material, the refractory metal core 10' may be removed using any suitable leaching technique known in the art. After the refractory metal core 10' is removed, as shown in FIG. 3, the cast part 100, such as a vane, is left with at least one cast cooling passage 102, a plurality of cast exit holes 104 cooperating with said at least one cooling passage, and an exit trench 106 for receiving cooling fluid from the exit holes 104. The exit holes 104 may be positioned within the trench 106 so that the terminal end of each hole is spaced from an exterior boundary of the part. The exit trench 106 may be on an outer endwall edge 108. The trench 106 can also be on the forward or aft edge of the platform.

[0014] The exit trench 106 has at least one slot 110 through which cooling fluid is discharged over an exterior section of part 100.

[0015] Turbine engine components which could take advantage of the geometry created by the refractory metal core of FIG. 2 include vane platforms and blade outer air seals or shrouds.

[0016] FIG. 5 illustrates another embodiment of a refractory metal core 10" which may be used to form a cast part with a trench. The refractory metal core 10" has main portion 16" with a plurality of tabs 18" connected to the main portion 16" by arms 30". Each tab 18" is called a hammerhead tab because the tab 18" has a width greater than the width of the arm 30" to which it is attached. The main portion 16" may be configured to form at least one cooling passage in the cast part 12". The main portion 16", the arms 30" and the tabs 18" may be integrally formed for a refractory metal or metal alloy using any suitable technique known in the art. As can be seen in FIG. 5, each of the tabs 18" has a length which causes it to extend beyond the exterior or outer boundary 14". The arms 30" form cooling passages in the cast part 12" which allows cooling fluid to flow from the cooling passage(s) formed by the main portion 16" and the trenches formed by the tabs 18". Using the refractory metal core 10", the cast part will have one hole per short trench segment.

[0017] It is advantageous to cast cooled turbine gaspath hardware with complete cooling passages including exit holes. The integral cast exit holes result in reduced cost due to the elimination of machining operations and provide support to the small cores used for local or in-wall cooling passages.

[0018] In accordance with the present disclosure, there has been described an integral cast cooling flow exit trench. While the integral cast cooling flow exit trench has been described in the context of specific embodiments thereof, other unforeseeable alternatives, modifications and variations may become apparent to those skilled in the art having read the foregoing description. Accordingly, it is intended to embrace those alternatives, modifications, and variations as fall within the broad scope of the appended claims.

Claims

1. A refractory metal core (10') for use in casting a turbine engine part (12') which comprises a main portion (16'), a plurality of tabs (18') extending from said main portion (16'), and an end portion (22') having a first edge which joins together said plurality of tabs (18') and a second edge, opposed to the first edge, located internally of an exterior boundary (14') of the cast part (12').

2. The refractory metal core of claim 1, wherein said main portion (16') is configured to form at least one cooling passage in said cast part (12').

3. The refractory metal core of claim 2, wherein said plurality of tabs (18') are configured to form a plurality of exit holes (104) which cooperate with said at least one cooling passage.

4. The refractory metal core of claim 3, wherein said end portion (22') is configured to form an exit trench (106) in said cast part (12').

5. The refractory metal core of any preceding claim, wherein said main portion (16'), said plurality of tabs (18'), and said end portion (22') are integrally formed.

6. The refractory metal core of any preceding claim, wherein said main portion (16'), said plurality of tabs (18'), and said end portion (22') are formed from a material selected from the group of molybdenum and a molybdenum alloy.

7. A turbine engine part (12';12")comprising at least one internal cooling passage, a plurality of exit holes

(104) connected to said at least one cooling passage for receiving a cooling fluid, and an exit trench (106) for receiving said cooling fluid from said exit holes (104).

8. The turbine engine part according to claim 7, wherein said exit holes (104) have a terminal end spaced from an exterior boundary (14';14") of the part (12'; 12").

9. The turbine engine part of claim 8, further comprising said trench (106) being located between said terminal end of said exit holes (104) and said exterior boundary (14';14").

10. The turbine engine part of any of claims 7 to 9, wherein said exit trench (106) has at least one slot (110) associated therewith through which said cooling fluid is discharged over an exterior surface of said turbine engine part (12';12").

11. A refractory metal core (10") for use in casting a turbine engine part (12") which comprises a main portion (16"), a plurality of arms (30") extending from said main portion (16"), and a plurality of hammerhead tabs (18") attached to said arms (30").

12. The refractory metal core of claim 11, wherein said main portion (16") is configured to form at least one cooling passage in said cast part (12").

13. The refractory metal core of claim 11 or 12, wherein said main portion (16"), said arms (30"), and said tabs (18") are integrally formed.

14. The refractory metal core of claim 11, 12 or 13 wherein said main portion (16"), said arms (30"), and said tabs (18") are formed from a refractory metal or metal alloy.

15. A turbine engine part (12';12") comprising a refractory metal core (10';10") of any of claims 1 to 6 or 11 to 14 cast thereinto.

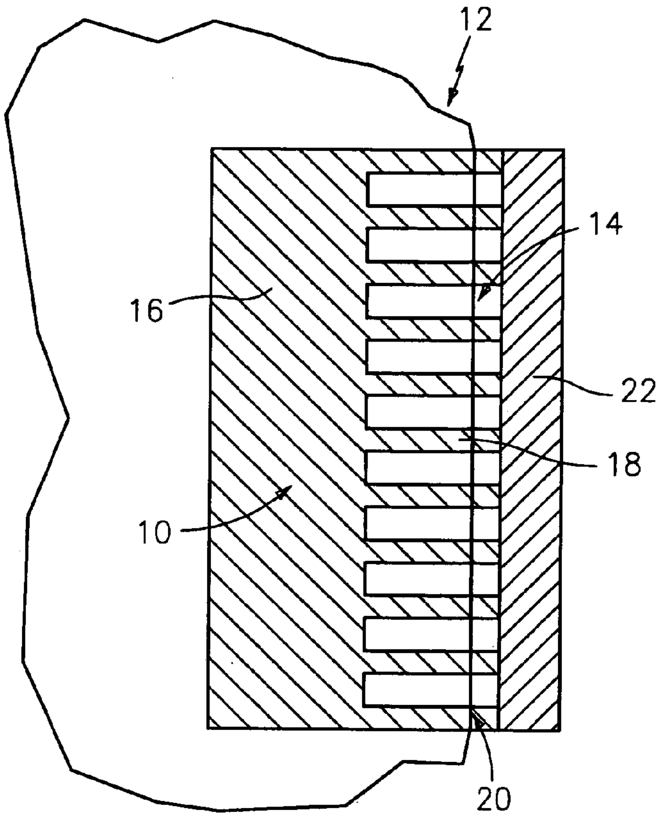

FIG. 1

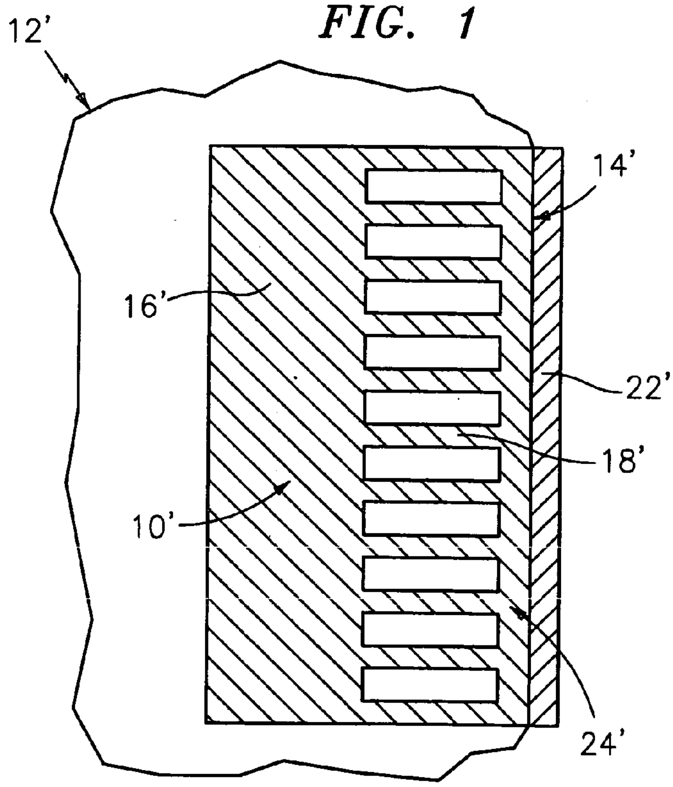

FIG. 2

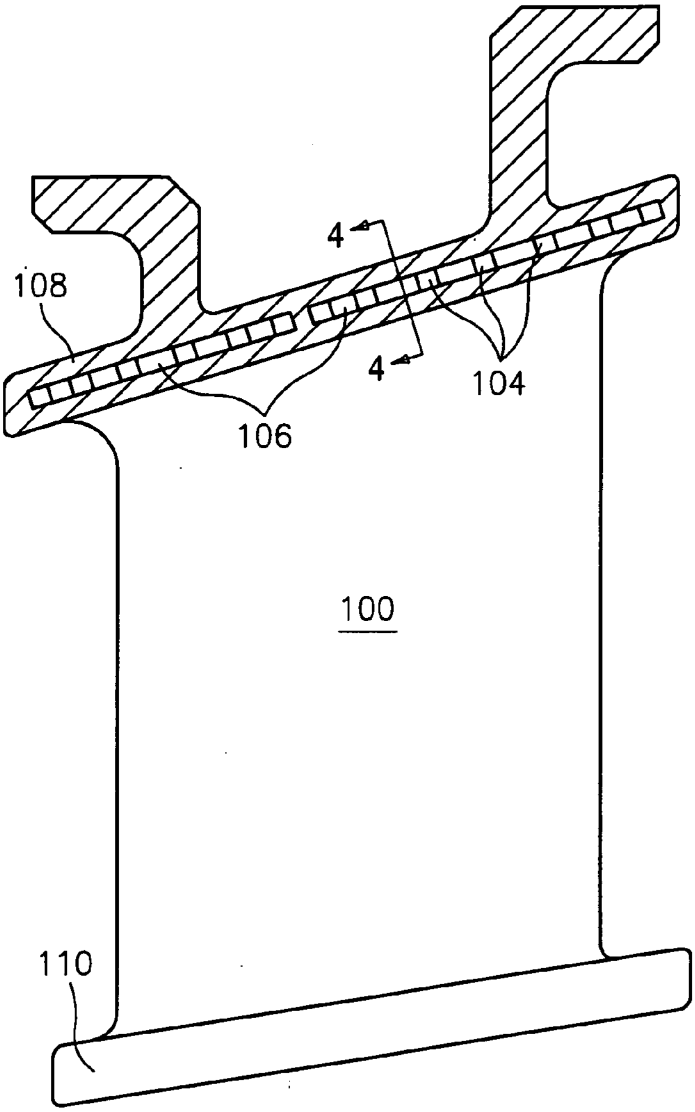

FIG. 3

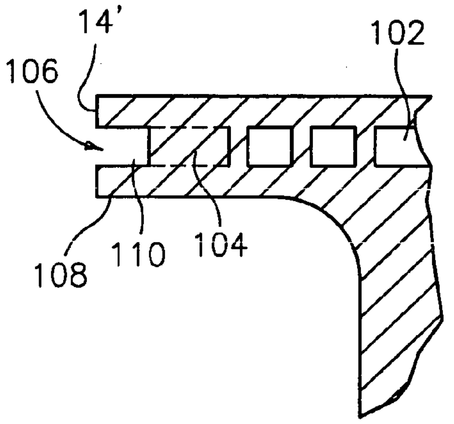

FIG. 4

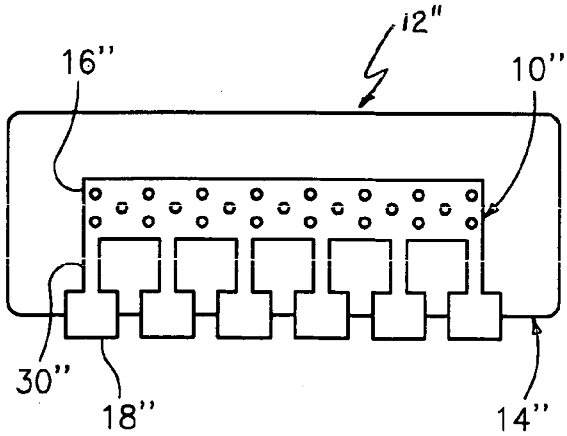

FIG. 5