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(54) Title: NICKEL-BASED ALLOY COMPOSITION FOR HIGH THERMAL RESISTANCE ELEMENTS, IN PARTICULAR FOR HOT DEFORMATION PROCESS TOOLS AND FOR HIGH TEMPERATURE WORKING

(57) Abstract: Nickel-based composition particularly suitable for high thermal resistance elements, in particular for hot deformation process tools and for high temperature working, like, e.g. dies for isothermal forming, comprising: a Nickel (Ni) content ranging from 57.0 % to 62.0 %; a maximum Tungsten (W) content of 10.0 % and a maximum Iron (Fe) content of 1.5 %. in Fig. a die for high temperature applications made of said composition is shown.

NICKEL-BASED ALLOY COMPOSITION FOR HIGH THERMAL RESISTANCE ELEMENTS, IN PARTICULAR FOR HOT DEFORMATION PROCESS TOOLS AND FOR HIGH TEMPERATURE WORKING

DESCRIPTION

The present invention relates to a Nickel-based composition for high thermal resistance elements, in particular for hot deformation tools and for high-temperature working. Specifically, this composition is suitable to the forming of tools apt to work under extremely onerous thermal conditions, liable to be subjected to thermal cycles of wide thermal ranges.

Analogous tools are, e.g., dies, cutting tools and the like.

A field requiring high-performance compositions, combined with a satisfactory machinability, is represented by forging, in which the die and the forged piece have the same temperature.

This technique enables to hot-roll products characterised by low thicknesses and volumes, yet exhibiting stable and uniform mechanic properties.

In several technological fields, tools and dies made of high-performance materials enable quicker and more accurate working. In the case of the dies, a low-wear holder block complex suffering from minimum thermomechanical distortions can substantially speed up the related manufacturing processes, dispensing with burdensome finishing interventions like grinding, shaping, etc.

Moreover, reproduction accuracy is enhanced, even after a high number of uses. These advantages become particularly important in the case of large-scale productions.

An example of a composition for tools and dies as abovementioned is taught in US Pat. No.5,505,798 (Nelson).

Notable known compositions are the high Nickel ones (refer to "*Development of a Die Material for Isothermal*

Forging of Superalloys in air", Ohno, Watanabe, Nonomura, 110th ISIJ Meeting, October 1985) yet the performances attained are still unsatisfactory.

A further example of Nickel-based composition is that of US Pat. No.5,538,683 (Pinnow et al.).

The technical problem underlying the present invention is to provide a Nickel-based composition for high thermal resistance elements allowing to attain improved performances, with respect to the known art.

This problem is solved by a composition for high thermal resistance elements, in particular for hot deformation tools and for high temperature working, characterised in that it comprises: a Nickel (Ni) content ranging from 57.0% to 62.0%; a maximum Tungsten (W) content of 10.0%; and a maximum Iron (Fe) content of 1.5%.

The present invention further relates to a tool formed with the composition as hereto set forth, and in particular to such a forging die.

Hereinafter, reference will be made to some preferred embodiments of the composition, by way of example and not for limitative purposes, and to the attached drawings, wherein:

* Fig. 1 is a schematic sectional view of a die-die block complex made with the composition according to the invention; and
* Fig. 2 is a schematic elevational view of a press employing the die of Fig. 1.

In Fig. 1, a forging-type die is indicated with 1.

Such a die, when it is employed in the forming of metal workpieces, should be capable of being subjected to extremely elevated heating of up to 1100°C and above, to be subsequently cooled down with an optimum distortion control.

In the case of plastics workpieces the temperatures are lower, yet the working conditions are equally severe, also in light of the fact that for this type of

workpieces an elevated manufacturing speed and the utmost accuracy, sometimes such as to dispense with further finishing steps, are expected.

In the present embodiment, as it is shown in Fig. 1, a die 1 comprises a (male) top counter plunger 2, housed in a suitable die block 3, and a bottom die block 4, housing a (female) matrix die 5. Through the matrix die 5 two guide grooves 6 for inserting ejection tools, and at least one injection runner 7 having a profile divergent towards the inside of the former, are formed.

The counter plunger 2 and the matrix die 5 are connected by screw-type fastening means (not shown in Fig.) and dowel pins 8.

The entire complex hereto disclosed is employed in a press 10 of the type depicted in Fig. 2, provided with suitable pressing and lifting means 11 apt to implement an adequate pressure inside of the die 1 during injection.

The press adjusting, cooling and injecting means 11 are of traditional type, and therefore a further description thereof will be omitted.

The matrix die 5, i.e. that section of the die 1 which contains the hot-injected material to be pressed, is made of a composition which, in its most general form, comprises: a Nickel (Ni) content ranging from 57.0% to 62.0%; A maximum Tungsten (W) content of 10.0%; and a maximum Iron (Fe) content of 1.5%.

According to a preferred embodiment of the composition, it has a Chromium (Cr) content of above 6%, moreover comprising Manganese (Mn), Silica (Si), Carbon (C) and Molybdenum (Mo).

Two embodiments of the abovedisclosed composition, of course by way of example and not for limitative purposes example, will hereinafter be disclosed.

Example 1

The composition disclosed in the present example is used in order to obtain a material of elevated purity, of

highly refined structure, and remarkable isotropic properties, the latter being particularly useful in dies subjected to remarkable mechanical stresses and in particular to thermal fatigue (e.g., dies for pressure die-casting, dies for hot-pressing and matrix dies for aluminium and copper alloy extrusions).

Cr	16.5
Mn	0.30
Si	0.15
C	0.20
Mo	18.5
Ni	57
W	4.5
Fe	1.5

Example 2

The composition disclosed in the present example is used in order to obtain a material enabling a decreased friction coefficient, also avoiding deformation and stress during ejection, in particular decreasing the sliding friction, important for an easy filling up of the cavities even at low temperatures and with a low pressure, and for an anticipated and easier post-solidification ejection.

This entails a shortening of the pressing cycle, and the attainment of an enhanced quality and of an increase of the maintenance interval.

Cr	10
Mn	0.35
Si	0.20
C	0.10
Mo	16.5
Ni	60
W	5
Fe	1.5

* * *

To the abovedescribed composition a person skilled

in the art, in order to satisfy further and contingent needs, may effect several further modifications and variants, all however encompassed by the protective scope of the present invention, as set forth in the appended claims.

CLAIMS

1. A Nickel-based composition for high thermal resistance elements, in particular for hot deformation tools and for high temperature working, characterised in that it comprises: a Nickel (Ni) content ranging from 57.0% to 62.0%; a maximum Tungsten (W) content of 10.0%; and a maximum Iron (Fe) content of 1.5%.

2. The composition according to claim 1, comprising a Chromium (Cr) content of above 6%.

3. The composition according to claim 1, comprising Iron (Fe), Manganese (Mn), Chrome (Cr), Silica (Si), Carbon (C), Nickel (Ni), Molybdenum (Mo), Tungsten (W).

4. The composition according to claim 2, having percents as resumed in the following table:

	min (% b/w)	**max (% b/w)**
Chrome (Cr)	10	16.5
Manganese (Mn)	0.30	0.40
Silica (Si)	0.15	0.20
Carbon (C)	0.10	0.20
Molybdenum (Mo)	16.5	18.5
Nickel (Ni)	57.0	62.0
Tungsten (W)	4.5	5.0
(continuation)	**min(% b/w)**	**max (% b/w)**
Iron (Fe)	max 1.5%	

5. A tool (1), comprising a composition as set forth in any one of the claims 1 to 4

6. A die (1), in particular for forging, comprising a composition as set forth in any one of the claims 1 to 4.

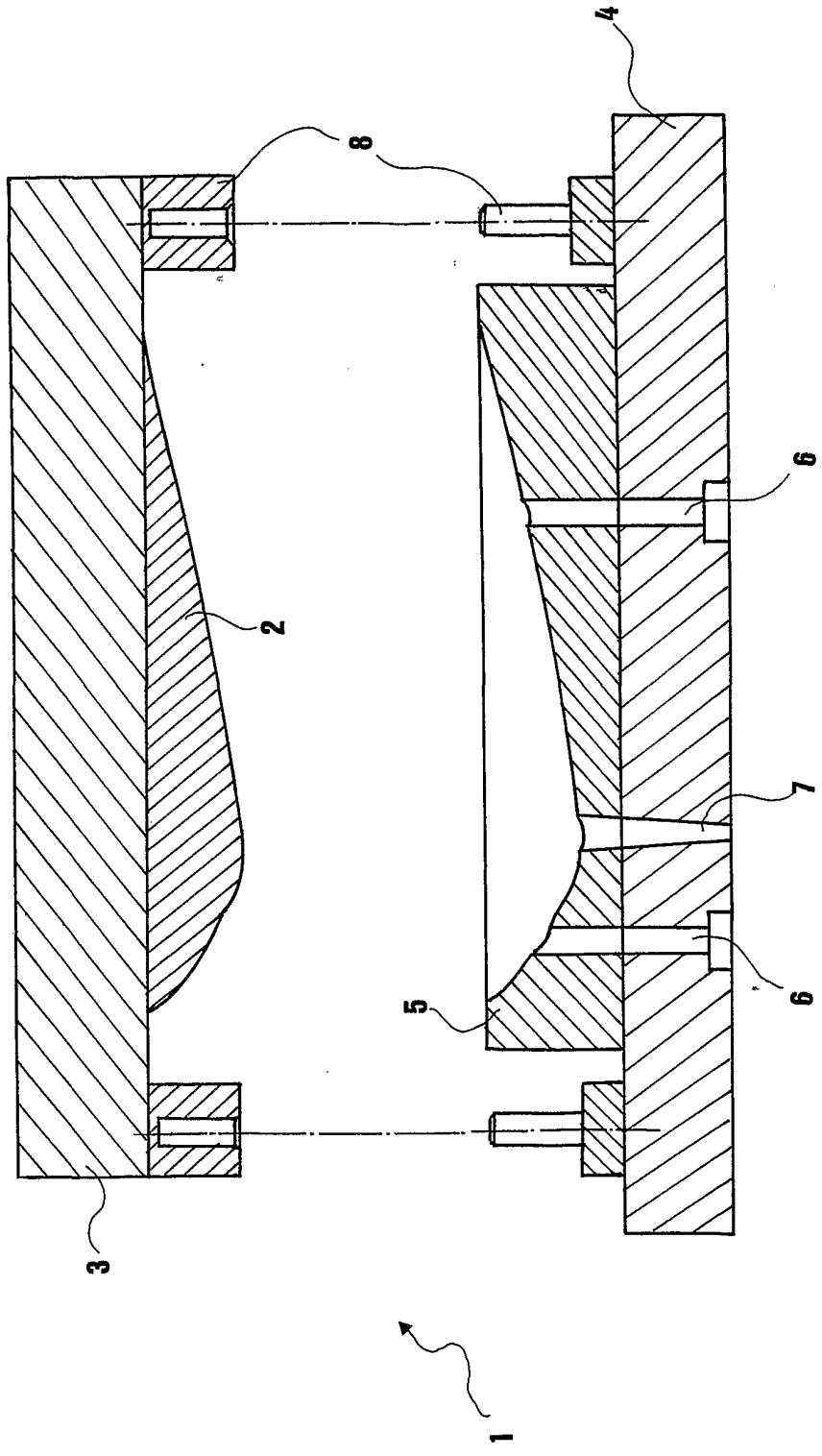

fig.1

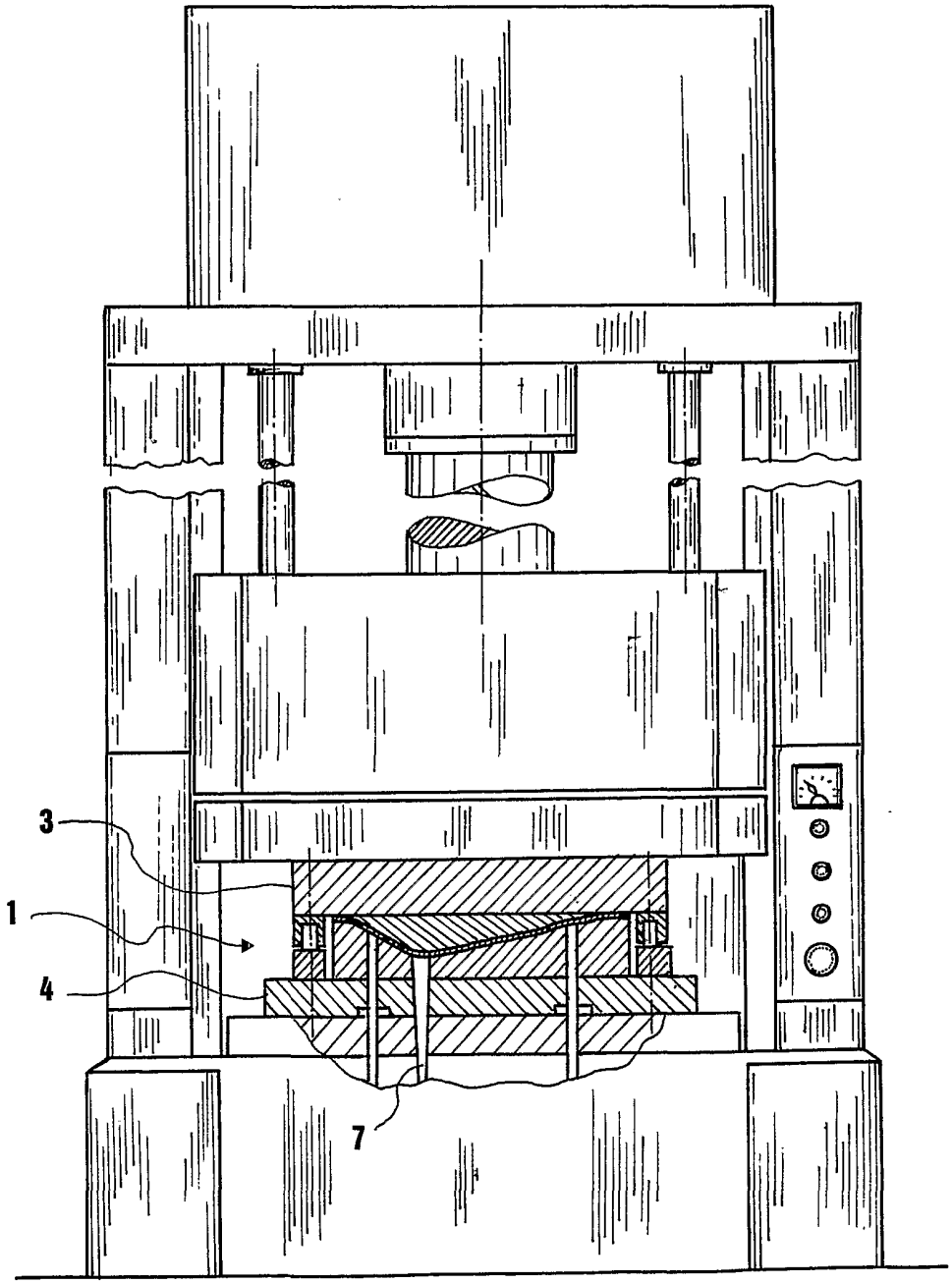

fig.2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 01/00621

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C22C19/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
CHEM ABS Data, EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 05, 31 May 1996 (1996-05-31) -& JP 08 003665 A (MITSUBISHI MATERIALS CORP), 9 January 1996 (1996-01-09) abstract page 5; examples 3,10-12,16,18; table 1 page 5; examples 21,22,24,25,28,30-32,34-36,38; table 2 page 6; examples 40,44,47,49,51-56; table 3 page 6; examples 59,61,63; table 4 page 6; examples 1,2,4,5,9,14,15; table 5 --- -/--	1-3,5,6

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 April 2002	16/04/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Patton, G

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 05, 31 May 1999 (1999-05-31) -& JP 11 050821 A (N Z K:KK;DAIDO STEEL CO LTD), 23 February 1999 (1999-02-23) abstract page 6; examples 1-3; table 1 page 6; examples 3,4; table 2	1-3
X	PATENT ABSTRACTS OF JAPAN vol. 016, no. 061 (C-0910), 17 February 1992 (1992-02-17) -& JP 03 257131 A (MITSUBISHI MATERIALS CORP), 15 November 1991 (1991-11-15) abstract page 3; example 8; table 1	1-3
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X	EP 0 787 815 A (GEN ELECTRIC) 6 August 1997 (1997-08-06) page 4; examples RENE88,RENE95,IN100,WASPALOY; table 1	1-3
A	US 4 118 223 A (ACUNCIUS DENNIS S ET AL) 3 October 1978 (1978-10-03) column 2; table 1 claims	4-6
A	US 3 880 436 A (CANAL JOSE ROBERTO) 29 April 1975 (1975-04-29) column 7; table 1 claims	4,5

Continuation of Box I.2

Present claim 1 is directed to an alloy composition per se and relates to an extremely large number of possible compositions. Indeed, claim 1 only specifies an amount of Ni and is silent on the rest of the alloy composition. In claim 1 from 38 to 43 weight% of the claimed alloy is unknown and undefined taking into consideration that W and Fe are optional elements in the claimed alloy.

Therefore, claim 1 contains so many options, variables, possible permutations and provisos, including for instance all binary alloy compositions of Ni with an other element, that a lack of clarity within the meaning of Article 6 PCT arises to such an extent as to render a meaningful search of the claim impossible.

In fact, taking into consideration the above objection of lack of clairity, the initial phase of the search revealed a very large number of documents relevant to the issue of novelty. So many documents were retrieved that it is impossible to determine which parts of the claim may be said to define subject-matter for which protection might legitimately be sought (Article 6 PCT). For these reasons, a meaningful search over the whole breadth of the claim is impossible.

The same applies to claim 2 which only defines a minimum amount of Cr but does not specify the rest of the alloy composition and, to claim 3 which does not specify any amount of the elements mentioned (Art. 6 PCT).

Consequently, in view of the above, incomplete search has been carried out for claims 1-3.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

INTERNATIONAL SEARCH REPORT

nformation on patent family members

In ional Application No
Pct/IT 01/00621

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