



(51) International Patent Classification:

B23C 5/28 (2006.01)

B23C 5/26 (2006.01)

B23C 5/20 (2006.01)

(21) International Application Number:

PCT/CZ2022/000050

(22) International Filing Date:

08 December 2022 (08.12.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

PV 2022-124

18 March 2022 (18.03.2022)

CZ

(71) Applicant: ZAPADOCESKA UNIVERZITA V PLZNI

[CZ/CZ]; Univerzitni 2732/8, 301 00 Plzeň (CZ).

(72) Inventors: MAŘÍK, Tomáš; Neuslužice 18, 387 01

Volyně (CZ). ZETEK, Miroslav; Karla Steinera 875/26,

301 00 Plzeň (CZ).

(74) Agent: POLÁČEK, Jiří; Poláček a kol., Dominikánská

287/6, 301 00 Plzeň (CZ).

(81) Designated States (unless otherwise indicated, for every

kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM,

DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,

HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every

kind of regional protection available): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: ROTARY TOOL WITH INTERNAL COOLING

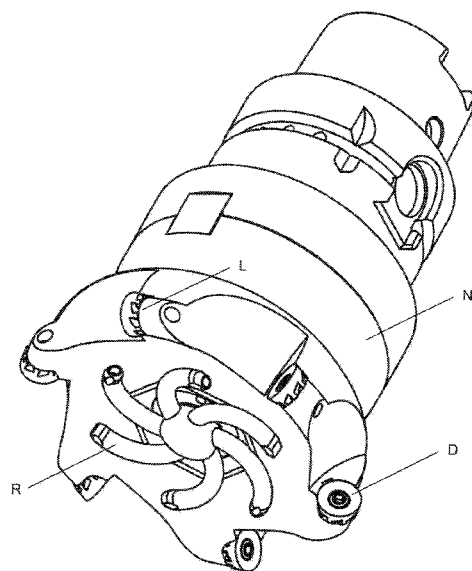


Fig. 1

(57) Abstract: The invention is rotary tool with internal cooling consisting of a carrier (N) and at least one cutting insert (D) fixed in the bed (L) of the carrier (N), where a clamping screw (U) that can be fixed to the machining spindle passes through the central hole (O) of the carrier (N) machine, whereby the clamping screw (U) is provided with a head (H) that exceeds the diameter of the central hole (O) in the carrier (N). The clamping screw (U) is hollow, while the head of the clamping screw (U) is provided with channels (K), the outlet of which is directed from the head of the clamping screw (U) to the back of the cutting insert (D).



Rotary tool with internal cooling

Technical Field

The invention is a rotary tool with internal cooling consisting of a carrier and at least one cutting insert fixed in the carrier bed, where a clamping screw that can be fixed to the spindle of a machine tool passes through the central hole of the carrier, and the clamping screw is provided with a head that exceeds the diameter of the central hole in the carrier.

Background Art

When machining most common structural materials with tools with replaceable inserts, it is essential to use cooling/lubrication during the cutting process. The worse the physical and chemical properties of the machined material relative to its machinability, the greater the importance of the effect of cooling, while heat is generated during cutting generally due to the friction of the tool surfaces against the machined material and further plastic deformation at the point of chip formation. Then, its removal has a crucial effect on the durability of the tool and on the quality of the machined surface, especially in terms of its integrity. The cooling system has positive effects on the one hand in terms of cutting itself, lubrication, cleaning, etc.

The medium, usually a liquid, is supplied under standard or increased pressure. In practice, the latter is referred to as high-pressure cooling, during which there is better penetration of the liquid between the chip and the cutting edge of the tool. It is known from the state of the art to cool a turning tool with a liquid; one of the possibilities is internal cooling, where the cutting liquid is fed through the spindle or turret of the machine tool through a suitable channel system in the tool to the cutting edges, often through holes in the tooth gaps, through which the process medium

is fed directly to the tip of the tool to the cutting edge of the tool, especially the holes in the carrier of the replaceable cutting insert so that it is directed directly to the cutting edge in the place of the cut. Replaceable cutting parts are currently most often in the form of so-called replaceable cutting inserts. The plates have different geometrical characteristics and are usually made of solid material with a hole in the middle used for clamping into the holder. The inserts are most often made of cemented carbides, CBN, PCBN or PCD and are provided with a thin layer. However, other materials are also used, from which the entire plate or only the cutting edge is formed.

The cutting insert can be cooled on its face and/or on its back. The cooling of both the forehead and the back is considered the most complex alternative, while the execution of the cooling depends on the structural arrangement of the carrier. Solutions are known from the state of the art which implement cooling of both the face and the back with the help of additional nozzles that connect to the supply of the cooling medium and direct the flow of this medium to the face or back of the cutting insert or to both parts at the same time. Such solutions are known, for example, from document CZ2020594 or EP2873477A1. Some designs are based on the documents WO2012070046A1, US20160158855A1 or CZ2020159, where the direction of the cooling liquid is defined by the design of the cutting insert itself, equipped with a system of internal distributions, which lead to the face, the back or both parts of the cutting insert at the same time.

There are also solutions with the supply of process liquid solved with the help of internal channels that point to the edge of the tool, or with the help of articulated hoses that are mounted firmly on the spindle of the machine. However, the liquid is not completely efficiently supplied to the cutting site, and often there is cooling of the chips rather than cooling of

the tool edge, because the resulting chip covers the tool edge. Moreover, these solutions are expensive to produce due to interference with standard carrier structures, which entails high production costs and a significant modification of the production technology. These disadvantages are eliminated by the solution in the present application of the invention.

Disclosure of Invention

The essence of the invention is a rotary tool with internal cooling consisting of a carrier and at least one cutting insert. The insert is fixed in the carrier bed, where a clamping screw fixed to the spindle of the machine tool passes through the central hole of the carrier, while the clamping screw is equipped with a head that exceeds the diameter of the central hole in the carrier. The clamping screw is hollow, while its head is equipped with channels, the outlet of which is directed from the clamping screw head to the back of the cutting insert. This solution brings usage for different cooling environments and different diameters and types of rotary tools clamped by the center screw. This ensures the universality of this cooling system depending on the cooling medium, tool design and type of material being machined. Moreover, it can be used for new future tools as well as for existing tools, thanks to easy integration with the machining tool.

There are several ways how to increase the efficiency of this invention. Firstly, it is advantageous if the internal channels are brought out of the head of the clamping screw by external arms. Thus, the distance between the coolant outlets and the cutting inserts is shortened. This ensures an even supply of the cooling liquid to the back of the tool and precise cooling at the cut point without large velocity and pressure losses of the flowing liquid.

Secondly, a cap can be connected to the head of the clamping screw, from which at least one outer arm protrudes, and the cap is equipped with a channel connected to the outlet of the channel from the head of the clamping screw, while the channel exits through the outer arm to the back of the cutting insert. This ensures the supply of a sufficient amount of liquid to the cutting site at the appropriate pressure, and at the same time chips are removed from the cutting site.

Next, it is advantageous if the outer arms are brought out of the disk rotatably stored in the lid. The rotation of the lid, and thus the cooling of the ridges of the cutting edge plates, occurs due to the pressure of the liquid, the disc is placed in the bearing, which is located in the disc between the disc and the bearing.

Next, the arm can be curved in the form of a helix at a small angle, so that the disk is rotated with the help of the coolant pressure with sufficient intensity at the outlet.

Next, it is advantageous if the arms are connected to each other by struts, thereby strengthening the structure, as the arms can be damaged by chips arising during machining.

Next, a coolant reservoir can be placed in the head of the clamping screw and/or cap. This ensures the accumulation of the cooling emulsion in the cap and subsequently the even distribution of the cooling liquid to the individual channels.

Last but not least, it is advantageous if the outlet of the channel narrows in the direction of the flow of the coolant, because under a stable pressure with a decreasing diameter, the coolant acquires a higher kinetic speed, and thanks to this, a targeted flow of the cutting fluid for a specific operation with a specific tool is ensured.

Description of drawings

In Fig. 1 is an overall isometric view of a rotary machining tool, Fig. 2 shows a section of a rotary tool. Fig. 3 shows a view of the tool from below, in Fig. 4 is an isometric view of the clamping screw in an alternative with a cap, in which the disk with arms is stored. In Fig. 5 is a sectional view of the same clamping screw. Fig. 6 shows the embodiment of the clamping screw tool in an alternative with a cap in which the disk with arms is stored.

Description of exemple embodiment

Description of exemple embodiment I

The rotary tool with internal cooling consists of a carrier N and six evenly spaced cutting inserts D. The cutting inserts D are fixed in individual beds L located in the carrier N. The clamping screw U passes through the central hole Q of the carrier N. The clamping screw U is fixed in the thread of the holder d connecting the carrier N to the spindle of the machine tool. The clamping screw U is equipped with a head H. The head H exceeds the diameter of the central hole Q in the carrier N. The clamping screw U is hollow, while the head H of the clamping screw U is equipped with internal channels K, the outlet of which is directed from the head H of the clamping screw U to the back of the cutting insert D. Internal channels K are led out of the head H of the clamping screw by external arms R led out of the plug D' rotatably mounted in the cap V. The head H of the clamping screw U is provided with an external thread, the cap V, on the other hand, is provided with an internal thread. Between the cap V and the plug D' there is a radial bearing X. The outer arms R of the cap V are curved in the shape of a helix. The outer arms R are further interconnected by struts V'. In the plug D' there is a reservoir Z of cooling liquid, which in its lower part is equipped with a cone k, which facilitates the directing of the cooling

medium into the individual channels K and K'. Channels K and K' are designed in a clockwise direction in this exemplary embodiment. The outlet of the inner channel K or the inner channel K' narrows in the direction of the coolant flow. The cutting fluid passes through the center of the holder d through the clamping screw U passing through the central hole O of the carrier N of the cutting insert D through the outlets of the cooling medium directed to the back of the cutting insert D from the outlets of the arms R of the plug Z. As a result of the pressure of the cooling liquid passing through the channels K and K', rotation occurs plug Z with arms R and coolant splash on the back of the cutting inserts D.

Description of exemple embodiment II

The rotary tool for machining with internal cooling consists of a carrier N and four cutting inserts D placed equally at 90 °. The cutting inserts D are fixed in individual beds L located in the carrier N. The clamping screw U passes through the central hole O of the carrier N. The clamping screw U is fixed in the holder d connecting the carrier N with the clamping mandrel. The clamping screw U is equipped with a head H. The head H exceeds the diameter of the central hole O in the carrier N. The clamping screw U is hollow, while the head H of the clamping screw U is equipped with internal channels K, the outlet of which is directed from the head H of the clamping screw U to the back of the cutting insert D. The inner channels K are led out of the head H of the clamping screw by the outer arms R. The outer arms R are curved in the shape of a helix. The outer arms R are further interconnected by struts V'. The K channels in this exemplary embodiment are designed in a left-handed direction. The outlet of the inner channel K narrows in the direction of the coolant flow.

The cutting fluid passes through the center of the holder d through the clamping screw U passing through the central hole O of the carrier N of the

cutting insert D through the outlets of the cooling medium directed to the back of the cutting insert D from the outlets of the arms R brought out from the head H of the clamping screw U.

Industrial applicability

The tool described according to the technical solution finds its application mainly in the construction of chip machining tools.

CLAIMS

1. Rotary tool with internal cooling consisting of a carrier (N) and at least one cutting insert (D) fixed in the bed (L) of the carrier (N), where a clamping screw (U) that can be fixed to the machining spindle passes through the central hole (O) of the carrier (N) machine, wherein the clamping screw (U) is provided with a head (H) that exceeds the diameter of the central hole (O) in the carrier (N) **characterized in that the clamping screw (U) is hollow**, while the head (H) of the clamping screw (U) is equipped with internal channels (K), whose outlet points from the head (H) of the clamping screw (U) to the back of the cutting insert (D).

2. Rotary tool according to claim 1, characterized in that the inner channels (K) are led out of the head (H) of the clamping screw by the outer arms (R).

3. Rotary tool according to claim 1, **characterized in that a cap (V)** is connected to the head (H) of the clamping screw (U), from which at least one outer arm (R) protrudes, while the cap (V) is provided with a channel (K') following the outlet of the channel (K) from the head (H) of the clamping screw (U), while the channel (K') exits through the outer arm (R) to the back of the cutting insert (D).

4. Rotary tool according to claim 3, **characterized in that** the outer arms (R) are brought out of the plug (D') rotatably mounted in the cap (V).

5. Rotary tool according to claim 4, **characterized in that the outer arms (R) of the lid (V) are curved**.

6. Rotary tool according to claim 5, **characterized in that the outer arms (R) are connected to each other by struts (V')**.

7. A rotary tool according to claim 1, 2, 3, 4, 5 or 6, characterized in that a cooling reservoir (Z) is located in the head (H) of the clamping screw (U), the cap (V) and/or the plug (D') liquids.

8. Rotary tool according to claim 1, 2, 3, 4, 5, 6 or 7, characterized in that the outlet of the inner channel (K) or the inner channel (K') narrows in the direction of the coolant flow.

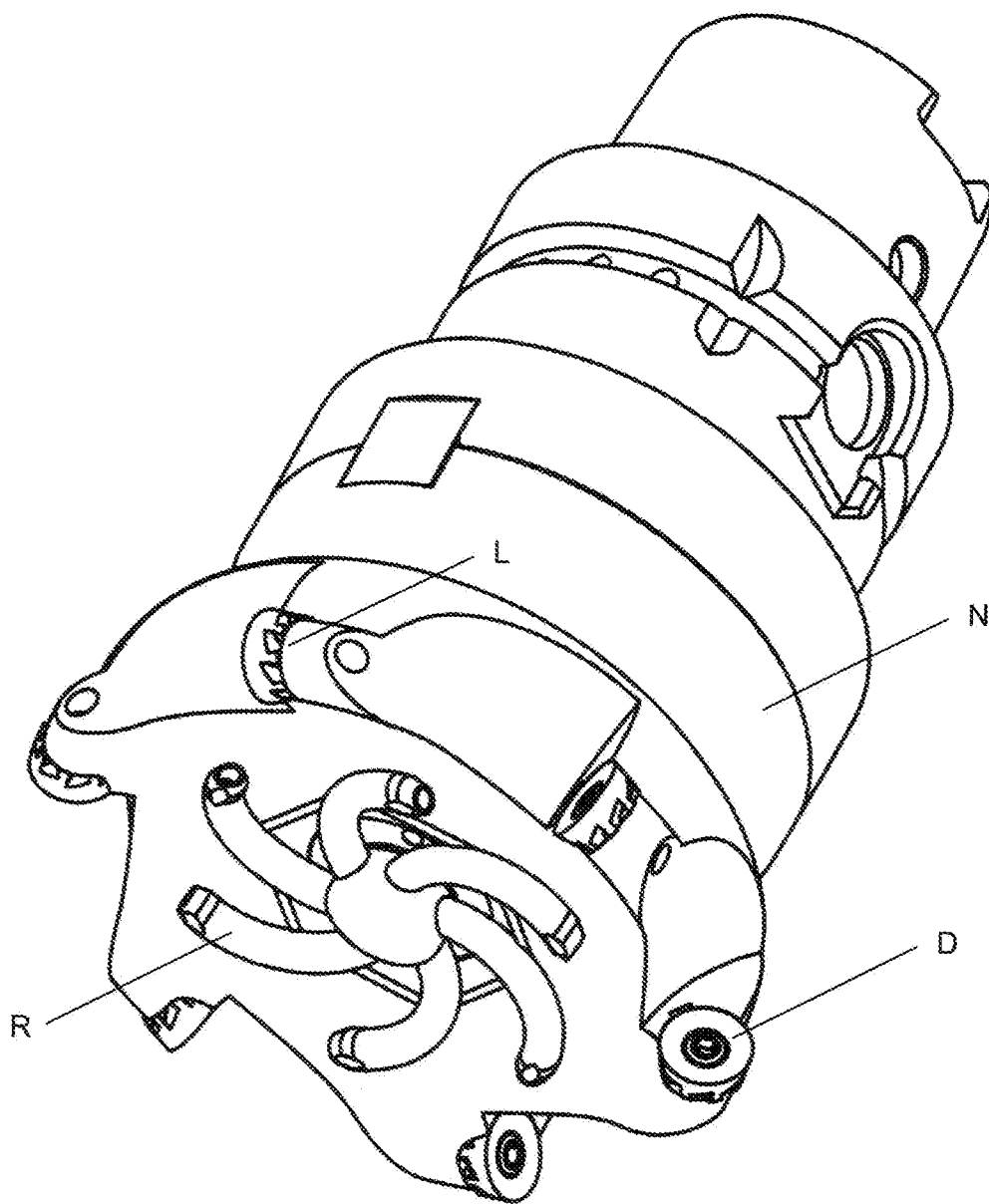


Fig. 1

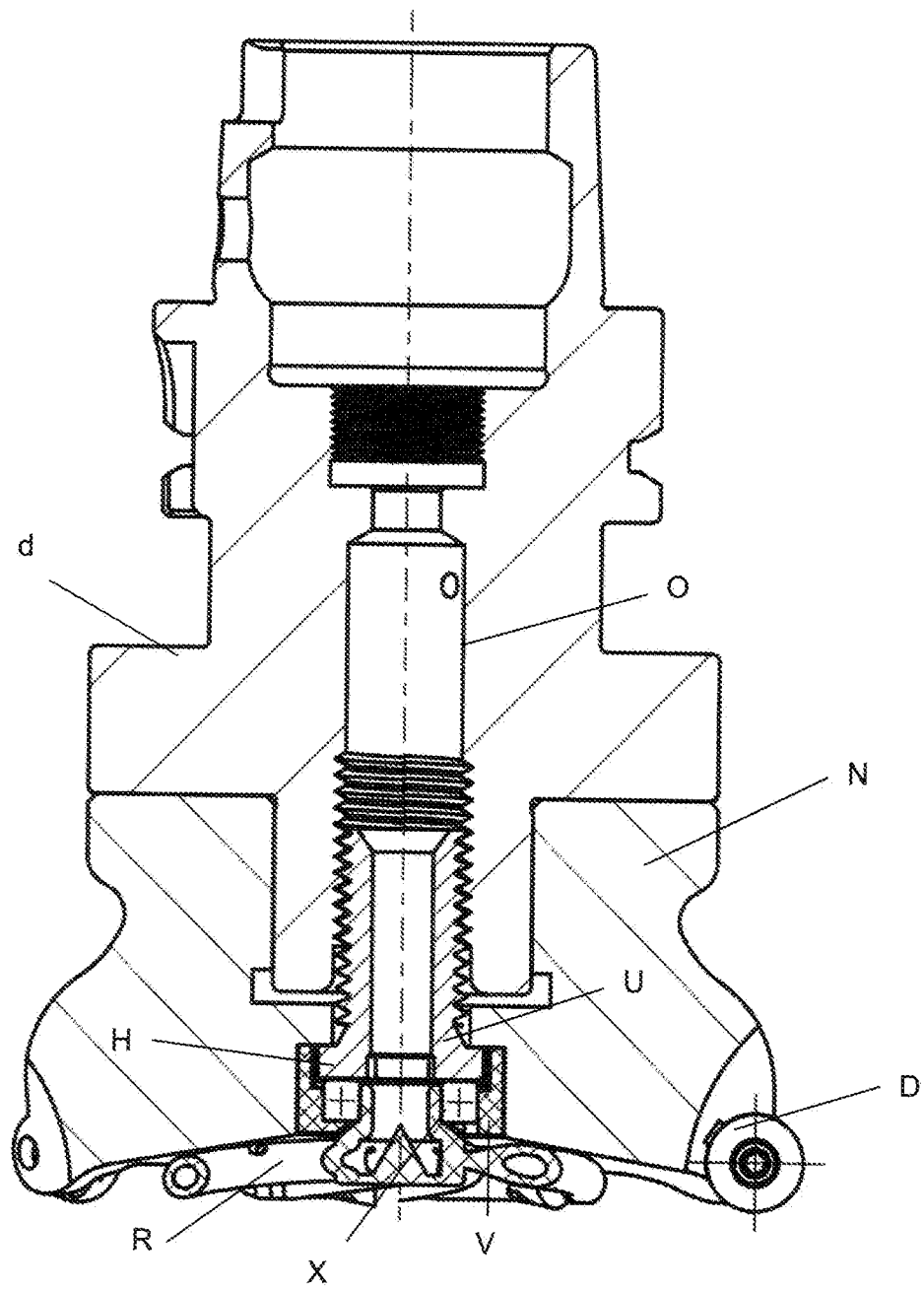


Fig. 2

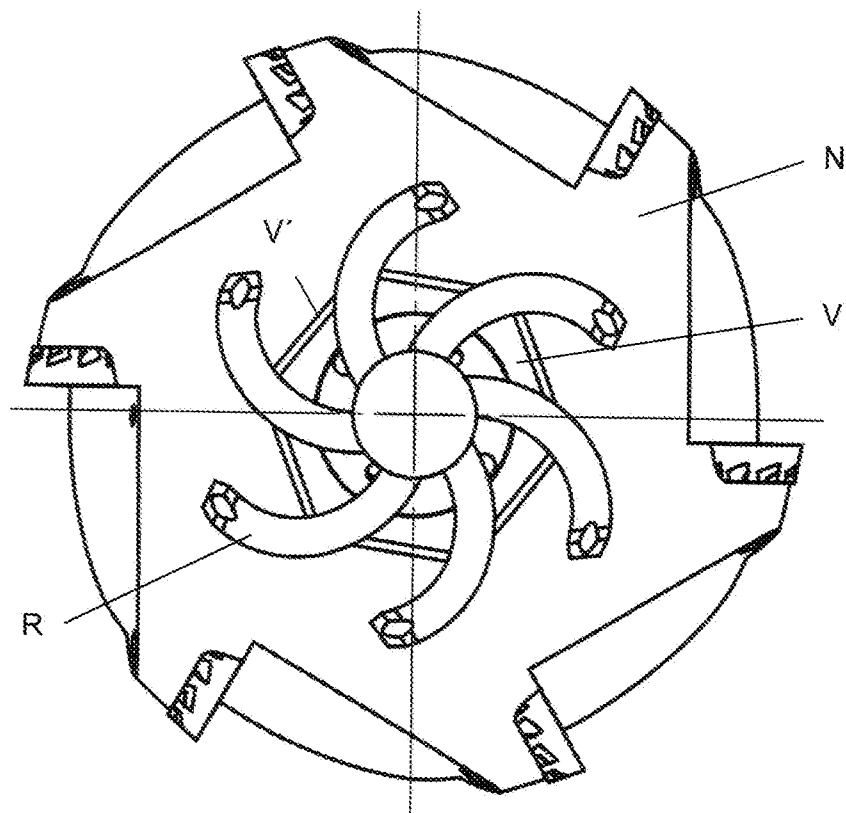


Fig. 3

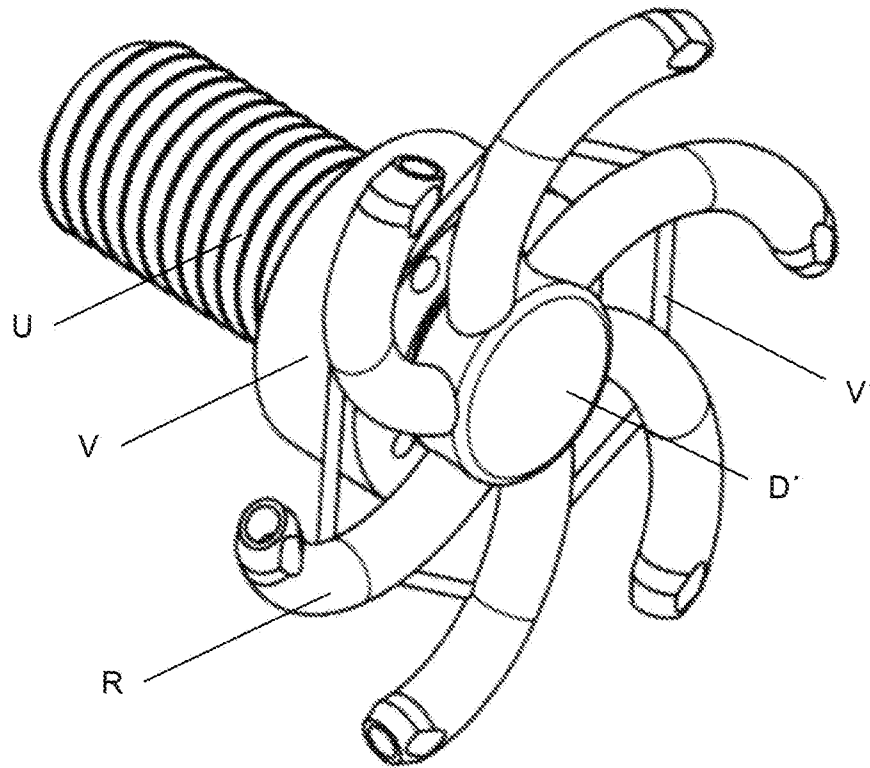


Fig. 4

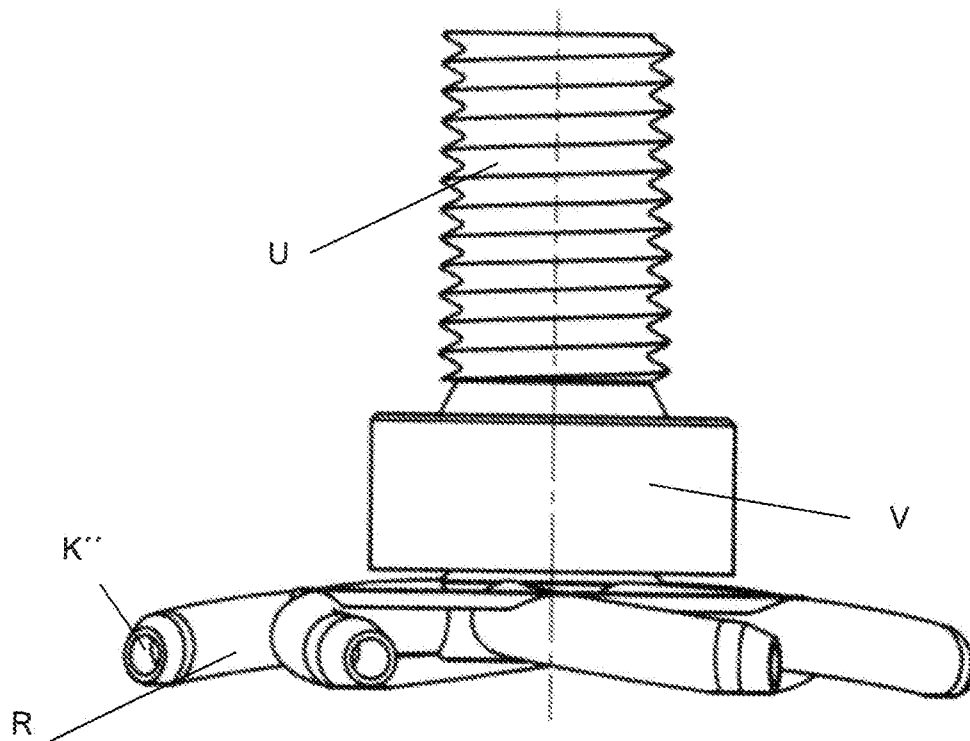
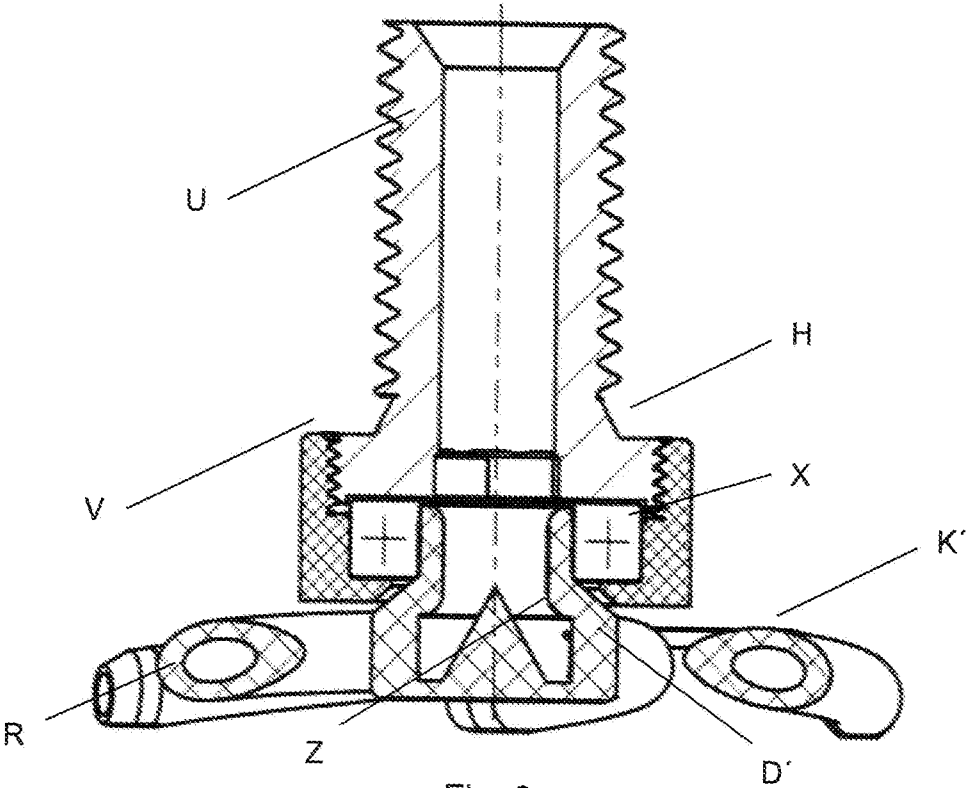


Fig. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/CZ2022/000050

A. CLASSIFICATION OF SUBJECT MATTER		
B 23 C 5/28, B 23 C 5/20, B 23 C 5/26		
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)		
B 23 C		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Database JPO CZ		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPOQUE (PATENW)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2015 078 851 A1 (GLEASON-PFAUTER MASCHINENFABRIK GMBH) 19 March 2015 (2015-03-19) *claims, description*	1, 6-8 1, 2-5
Y	US 4 322 189 A (BRIESE LEONARD A.) 30 March 1982 (1982-03-30) *Fig. 3, col. 3, lines 25-32*	1, 4, 5
Y	JP 2001 138 107 A (KOMATSU MFG. CO. LTD.) 22 May 2001 (2001-05-22) * claims, description*	1-4
P, X	CZ 36 052 U1 (ZAPADOČESKÁ UNIVERZITA V PLZNI) 26 May 2022 (2022-05-26) *the whole document*	1-8
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: "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) "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "E" earlier application or patent but published on or after the international filing date "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 07.03.2023 (07 March 2023)		Date of mailing of the international search report 10. 03. 2023
Name and mailing address of the ISA/ VISEGRAD PATENT INSTITUTE Branch Office CZ Antonína Čermáka 2a 160 68 Praha 6 Czech Republic Facsimile No. +420 224 324 718		Authorized officer Pavel Matoušek Telephone No. +420 226 383 403

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CZ2022/000050

US 2015 078 851 A1	WO 2015 036 098 A2	2015-03-19
	EP 3 043 946 A2	2016-07-20
	DE 10 2013 015 252 A1	2015-03-19
	JP 2016 533 913 A	2016-11-04
	KR 2016 0 053 954 A	2016-05-13
	CN 105 555 450 A	2016-05-04
US 4 322 189 A	NONE	
JP 2001 138 107 A	NONE	
CZ 36 052 U1	NONE	