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(54) **HEALD FRAME CROSSBAR WITH IMPROVED RIGIDITY FOR WEAVING LOOMS**

(57) Heald frame crossbar for weaving looms consisting of a metal extruded profile which comprises a hollow body (B) ending with an appendix (C) at the inner longitudinal edge of the crossbar (H), said appendix (C) being arranged for attaching healds (L). The crossbar (H) further comprises stiffening elements consisting of bars (1), fixed within cavities formed at least at the outer edge of the hollow body (B), and sheets (2) which coat said bars (1) and at least part of the corresponding outer sides of the hollow body (B) of the crossbar (H). Said stiffening elements are made of composite materials exhibiting a high elastic modulus.

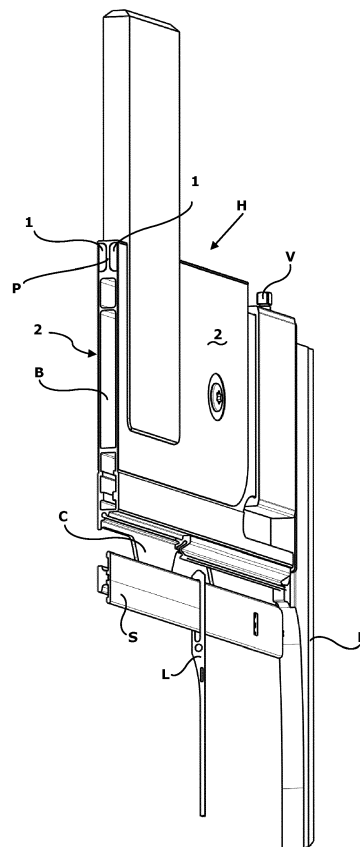


Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention is related to a heald frame crossbar with improved rigidity for weaving looms, in particular for high-speed looms such as air looms. In particular, the invention is related to a heald frame crossbar comprising stiffening elements arranged in such a way as to improve its flexural and shear rigidity in the plane of movement of the heald frame, so as to optimize its operative performances and to guarantee its structural integrity for an extended period of time.

STATE OF THE PRIOR ART

[0002] As known, heald frames are devices used in weaving looms where - through their alternate movement, controlled by a weaving machine, along a plane perpendicular to the weaving plane - they control the movement of groups of warp threads in order to form the shed wherein the weft thread is synchronically inserted. When manufacturing the simplest fabric, the so-called cloth, the heald frames are two and the warp threads are alternately linked to one or the other of said heald frames. For fabrics with a more complex pattern, there are more heald frames, e.g., up to the number of 24 heald frames, each operating on a smaller number of warp threads in order to create more complex patterns, also by using warp threads and weft threads of different quality or colour.

[0003] The heald frames slide within suitable lateral guides, between an upper and a lower position with respect to the plane of fabric formation, and they are controlled in this movement by actuating tie rods hooked to the heald frame. A weaving machine imparts the movement to said tie rods in a known manner, in order to form a desired and predetermined fabric pattern.

[0004] Among the nowadays various types of weaving looms, the present invention has been conceived in particular for air weaving looms, wherein jets of compressed air are used to insert the weft through the shed formed between the warp threads during the alternate movements of the heald frames. Thanks to the absence of moving mechanical members which insert the weft, in the air looms it is possible to reach higher operating speeds than in the gripper or projectile looms; consequently, due to the high stresses caused by such higher operating speeds, currently existing heald frames show an excessively short service life when used in air looms.

[0005] Each heald frame consists of two parallel crossbars - on which thin rods of steel or other materials (the "healds" indeed) are inserted with a certain play and which are provided with a central eyelet through which one or more warp threads run - and two sidepieces laterally connecting the opposite ends of the crossbars. Furthermore, the sidepieces cooperate with the above-mentioned side guides to determine the alternate movement

of the heald frame. With the aim to have a steady frame structure, sidepieces and crossbars are mutually fixed at the four corners of the frame by suitable coupling joints. Said upper and lower crossbars must have a reduced thickness and weight, to limit the heald frame overall inertial mass, and then to require lower thrust and tensile stresses by the actuating tie rods, during operation. Therefore, crossbars are usually made as hollow extruded profiles of low specific gravity materials, typically aluminium or aluminium alloys. On the other hand, however, the structure of the heald frame crossbars must have such a rigidity to adequately bear the high stresses occurring during the very rapid alternate movements of the heald frame. As a matter of fact, the very high operational speed of the air weaving looms lead to high peak stresses on the crossbars in the phases of motion reversal during the alternate movement of the heald frames, due to the warp threads tension and to the overall inertia of the healds and the crossbars.. The above said peak stresses cause a warped configuration of the crossbars, on the plane of movement of the heald frame, the maximum warping height thereof being at the central point of the crossbars.

[0006] However, this local warping must not reach such an extent to nullify the normal play of the healds on the crossbars, because this would cause in turn the healds to stick on the crossbars and cause a possible uneven distribution of the healds along the heald frame and thus the consequent onset of defects in the fabric and, over time, even the deformation/breakage of the healds.

[0007] Therefore, it has been finally found that a light-alloy thin-wall hollow profile - which offers a significantly low inertia and therefore satisfactorily addresses the severe requirements of an high-speed alternate movement of the heald frames - is not sufficient, alone, to provide such a crossbar rigidity to optimally and stably bear over time the extremely high peak stresses arising on the crossbars as a consequence of the high operational speeds which are typical of air jet looms.

[0008] Therefore, there is an increasing market need in the recent times for providing heald frame crossbars which exhibit an adequate flexural rigidity in the plane of movement of the heald frame, which is useful for containing within acceptable limits the local warping under the peak stresses, nevertheless maintaining a reduced weight, in order to offer an overall better stability of the crossbar during high speed operation, a better protection of the mechanical integrity of the healds and a longer service life of the heald frame.

[0009] US-3754577 (1973) discloses a heald frame structure wherein two opposite elongated stiffening elements are provided on the outer edge of the crossbar and possibly also on the inner edge thereof, such stiffening elements being glued with adhesives in corresponding cavities provided in the profile with which the crossbar body is made of. Said stiffening elements are made of materials having a high elastic modulus, such

as for example steel or carbon fibre-based laminates, in order to increase the flexural rigidity of the crossbar, and their thickness and length are sized according to the desired increase of the crossbar flexural rigidity. An essential feature for obtaining a product showing the desired performance is that of a stable bonding of the stiffening elements to the light alloy profile with which the crossbar body is made of; however, this feature cannot be satisfactorily achieved in the crossbar structure disclosed in this patent, due to the small contact surface between the stiffening element and the profile with which the crossbar body is made of.

[0010] EP-1528130 (2005) discloses a heald frame structure which is very similar to the one described in US-3754577, wherein, however, the bonding surface of the stiffening elements is considerably increased. A single stiffening element is inserted, indeed, at each edge of the crossbar, and this stiffening element is as thick as the profile with which the crossbar body is made of. This design allows a much more stable bonding of the stiffening elements to the crossbar, thanks to the stiffening elements being larger and therefore more deeply included within the structure of the profile with which the crossbar body is made of. However, this structure necessarily requires that said profile has a non-symmetrical structure, since the closing wall of the cavity which houses the stiffening elements can be arranged only in a lateral position of the profile itself. Such non-symmetrical structure of the profile with which the crossbar body is made of, however, is not preferred, since it can facilitate the onset of warping and twisting of the crossbar under an extended use of the heald frame.

[0011] The above described know crossbars therefore represents two different solutions to the above set forth technical problem, which solutions however introduced other drawbacks which have currently not been addressed yet. Specifically: a potentially unstable and therefore ineffective bonding of the stiffening elements, in the solution disclosed by the US-3754577 patent; and a non-symmetrical structure of the profile with which the crossbar body is made of, in the solution disclosed by the EP-1528130 patent.

[0012] A technical problem is therefore still existing, which is not completely solved, namely the one of providing a heald frame crossbar with an improved flexural and shear rigidity, so as to be suitable for use in high-speed air looms, but at the same time which is free from critical issues in bonding the stiffening elements to the profile with which the crossbar body is made of, and wherein said profile furthermore exhibits a fully symmetrical structure, so as to maintain a perfectly balanced behaviour under stress.

[0013] Within the scope of this problem, a first object of the invention is to provide a heald frame crossbar wherein the bonding surface of the stiffening elements is significantly increased with respect to the surface area of said stiffening elements directly in contact with the profile with which the crossbar body is made of, so as to

improve the conditions of mutual bonding between said profile and the stiffening elements.

[0014] A further object of the invention is then to increase also the shear rigidity of the crossbar body, without significantly increasing its weight, particularly in the end portions of the crossbar, where high concentrated stresses arise at the coupling joint between crossbars and sidepieces.

SUMMARY OF THE INVENTION

[0015] This problem is solved, and these objects achieved by means of a heald frame crossbar for weaving looms having the features defined in the claim 1. Other preferred features of said crossbar are defined in the secondary claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Further features and advantages of the heald frame crossbar according to the present invention will however become more evident from the following detailed description of a preferred embodiment thereof, given as a mere and non-restrictive example and illustrated in the attached drawings, wherein:

Fig. 1 is a perspective view of an angular portion of a heald frame comprising a crossbar according to the present invention; and

Fig. 2 is a cross-section view, taken along a vertical plane of the upper portion of the crossbar of Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] Fig. 1 schematically shows the general configuration of a heald frame comprising the crossbar according to the present invention; for ease of illustration only an angular portion of the heald frame is shown in the drawing. Said heald frame comprises, in a per se known manner, two sidepieces F and two crossbars H - i.e. an upper and a lower crossbar - mutually fixed at square angles, at the four corners of the heald frame, by means of suitable coupling joints locked by tightening a screw V. Each crossbar H consists of a metal extruded profile, preferably made of aluminium alloy, or possibly also of a composite material, comprising a hollow main body B, ending with a flat appendix C at the inner longitudinal edge of the crossbar, said flat appendix C being suitably arranged for the attachment of the healds L.

[0018] According to the present invention, as clearly shown in Figs. 1 and 2, in order to solve the above described problem, the crossbar H exhibits, at its own longitudinal outer edge, an edge portion P having an I-shaped cross-section. The wings of said I-shaped portion are as large as the hollow body B, while the core of said I-shaped portion is arranged along the vertical median plane of the crossbar H. Two opposite longitudinal cav-

ities are thus formed - symmetrical with respect to the vertical median plane of the crossbar H - each of said cavities having an opening facing toward a respective side of the crossbar H.

[0019] According to the present invention, a solution allowing to achieve the desired objects can be reached by using, in a crossbar structure of the type described above, two different stiffening elements. Specifically, a first stiffening element consists of a pair of bars 1, each fixed within a respective one of the opposite cavities formed in the edge portion P of the crossbar. A second stiffening element then consists of a pair of sheets 2, each fixed on one of the two opposite sides of the main body B or on at least a portion thereof, and anyway extending to also coat completely a corresponding bar 1.

[0020] The aforementioned stiffening elements, i.e. the bars 1 and the sheets 2, are made of pultruded or laminated composite materials with high elastic modulus, particularly composite materials based on standard carbon fibres for general uses (GP) having an elastic modulus of about 200 GPa, or based on high modulus carbon fibres (HM and UHM) having an elastic modulus ranging from 300 to over 600 GPa. The bars 1 and the sheets 2 preferably consist for example of a layer of carbon fibres impregnated with epoxy resin, the fibres being arranged unidirectionally along the length of the crossbars H. Alternatively, the sheets 2 preferably consist of a carbon fibre fabric impregnated with epoxy resin, the carbon fibres being arranged in two overlapping layers, along directions at right angles to each other and at an angle of about 45° with respect to the longitudinal direction of the crossbar H; this last, more expensive, pattern is particularly useful for better distributing and absorbing the shear loads on the crossbar H, especially when its vertical walls are very thin in view of reducing the overall mass of the crossbar. As an alternative to epoxy resin, polyester resin, vinyl ester resin or other thermosetting polymeric materials can also be used.

[0021] The bars 1 and the sheets 2 are fixed to each other and to the respective supporting surfaces of the crossbar by adhesives bonding as known in the art. The above described arrangement of the stiffening elements makes it possible to obtain a particularly strong and stable bonding of the bars 1 to the profile with which the crossbar H is made of, due to the fact that the bonding between the bars 1 and the sheets 2 is very strong because these two components have a shared polymeric matrix, so that the two stiffening elements behave under stress as a single element. Therefore, the bonding surface of the bars 1 to the crossbar H is no longer limited only to the surface of said bars which is directly in contact with the crossbar H, but now extends over at least part of the outer side of the crossbar H and it is therefore significantly wider than the stiffening bar bonding surface used in the prior art crossbars above illustrated.

[0022] The maximum extent of the sheets 2 on the outer sides of the crossbar H can then be suitably optimized, in consideration of the composite material high cost, so

as to obtain just the bonding increase which is sufficient to hold stably in position the bars 1 for the intended service life of the heald frame, or also to have a specific stiffening effect of the crossbar 2, which stiffening effect is particularly useful when the crossbar is made of a very thin metal material. As an alternative to mutually bond the bars 1 with the respective sheets 2 by means of adhesives, it is also possible to make in advance a simultaneous lamination of these two components, so that they share the polymeric matrix and therefore actually behave as a single continuous element.

[0023] As clearly understood from the above description, the stiffening elements consisting of the bars 1 and the sheets 2, provided in the heald frame crossbar H according to the present invention, make it possible to perfectly achieve the intended objects.

[0024] The stiffening bars 1, arranged inside the corresponding cavities of the edge portion P of the crossbar H, increase indeed the flexural rigidity of the crossbar H in the plane of movement of the heald frame, significantly reducing warping of the crossbar H in use, and therefore the maximum warping height in the central zone thereof, during the high-speed alternate motion of the heald frame. Thanks to their extended bonding surface on the profile with which the crossbars H are made of - by means of the sheets 2 of composite material - said bars 1 remain then perfectly integral with the crossbar H even after a long period of work. It is thus possible to avoid the known phenomena of sticking, deformation and breakage of the healds, which occur instead when the maximum warping height of the crossbars becomes greater than the desired set play of the healds on the crossbars H, as it instead occurs, after an unsatisfactorily short period of use, in the known type crossbars, when subjected to particularly high working speeds.

[0025] The innovative structure of the stiffening bars 1, as described and shown above in relation to the outer edge of the crossbar H, can obviously be identically repeated also at the inner edge of the crossbar H, so as to have a perfectly symmetrical structure of the crossbar, as regards the flexural behaviour. Alternatively, in a preferred embodiment illustrated in Fig. 1, a comparable stiffening of the crossbar H inner edge has been achieved by using, as a device for hooking the healds L on the crossbar H inner longitudinal edge, a heald-holding plate S, preferably made of steel, of the type disclosed in EP-1790761 patent, by the present Applicant. Thanks indeed to the interference fit of the steel plate S with the corresponding rib of the appendix C of the crossbar H, such steel plate S is rigidly coupled to the body of the crossbar H and therefore acts as a lower stiffening element thereof, as regards the flexural stresses in the plane of movement of the heald frame.

[0026] The stiffening sheets 2 perform therefore two different functions. According to a first function, essential for achieving the objects of the present invention, the stiffening sheets 2 extend the bonding area of the bars 1 to part or all the side of the profile forming the crossbar

H, making this anchorage much more stable over time. Furthermore, when the sheets 2 further extend over a significant part of the outer sides of the crossbar H, or over their entire side surface, they also perform a second additional function by increasing the structural resistance of the crossbar H vertical walls with respect to shear stresses, when considering that these vertical walls have necessarily a very low thickness for reducing the overall mass and therefore the inertia of the crossbar H. In particular, the stiffening sheets 2 are able to distribute and withstand, with greater effectiveness and durability, the concentrated stresses arising at the opposite ends of the crossbars H, where the vertical walls of the crossbars H receive very high shear-stresses by the joints coupling the crossbar H with the sidepieces F, during each reversal of the heald frame alternate motion. In order to save composite material, which is expensive, it is possible to provide that the sheets 2 coat the outer sides of the hollow body B of the crossbar at a different extent according to the strength of local stresses in different portion of the crossbar H. In particular, it may be convenient to adopt a full coating of said outer sides only at the opposite end portions of the crossbar H, where high localized stresses are caused by the sidepiece/crossbar joint, and instead just a partial coating in the remaining part of the crossbar H where the stresses are more evenly distributed.

[0027] Finally, it should be noted that, thanks to the specific properties of the composite materials they are made of, said stiffening elements 1 and 2 further provide a satisfactory dampening effect of the crossbars H vibrations on the respective lateral guides, consequently limiting the noise levels originating from the impacts of the healds onto the crossbars, during the heald frame movement, which is one of the main sources of noise in weaving looms.

[0028] It is understood, however, that the invention should not be considered as limited to the particular embodiments illustrated above, which are only exemplary embodiments thereof, but that different variants are possible, all within the reach of a person skilled in the art, without departing from the scope of the invention, which is only defined by the following claims.

Claims

1. Heald frame crossbar for weaving looms consisting of a profile which comprises a hollow body (B) ending with an appendix (C) at the inner longitudinal edge of the crossbar (H), said appendix (C) being arranged for attaching the healds (L), **characterized in that** it further comprises stiffening elements consisting of bars (1), fixed within cavities formed at least at the outer edge of said hollow body (B), and sheets (2) which coat said bars (1) and at least part of the corresponding outer sides of the hollow body (B), **and in that** said stiffening elements (1, 2) are made of composite materials exhibiting a high elastic modulus.

ulus.

2. Heald frame crossbar according to claim 1, wherein said cavities are symmetrically formed in an edge portion (P) of the hollow body (B), having an I-shaped cross-section, in which the wings of said I-shaped portion are as large as the width of the hollow body (B), and the core of said I-shaped portion is arranged along the crossbar (H) median plane.
3. A heald frame crossbar according to claim 1 or claim 2, wherein said composite materials exhibiting a high elastic modulus are made of carbon fibre pultruded or laminated composite materials in a polymeric matrix.
4. Heald frame crossbar according to claim 3, wherein the carbon fibres of at least one of said stiffening elements (1, 2) are unidirectionally arranged, parallel to the longitudinal direction of the crossbar (H).
5. Heald frame crossbar according to claim 3, wherein the carbon fibres of said bars (1) are unidirectionally arranged, parallel to the longitudinal direction of the crossbar (H), while the carbon fibres of said sheets (2) are arranged in overlapped layers, along mutually perpendicular directions forming an angle of about 45° with respect to the longitudinal direction of the crossbar (H).
6. Heald frame crossbar according to any one of claims 1 to 5, wherein said bars (1) and said sheets (2) are fixed to the hollow body (B) of the crossbar (H), and one to the other, by means of adhesives.
7. Heald frame crossbar according to any one of the preceding claims 1 to 5, wherein each of said bars (1) is integrally pre-formed together with a corresponding sheet (2) in a single element having a shared polymeric matrix, and this single element is fixed to the hollow body (B) of the crossbar (H) by means of adhesives.
8. Heald frame crossbar according to any one of the preceding claims, wherein said metal profile is made of a light alloy, preferably an aluminium alloy.
9. Heald frame crossbar according to any one of the preceding claims, wherein the polymeric matrix of said composite material is based on epoxy resin, polyester resin, vinyl ester resin or other thermosetting polymeric materials.
10. Heald frame crossbar according to any one of the preceding claims 1 to 7, wherein said bars (1) are also provided at the inner edge of said hollow body (B) of the crossbar.

11. Heald frame crossbar according to any one of the preceding claims 1 to 7, wherein a steel heald-holding plate (S) is fixed to said appendix (C), through an interference fit with a corresponding rib of said appendix (C). 5
12. Heald frame crossbar according to any one of the preceding claims 1 to 7, wherein said sheets (2) coat the entire surface of the outer faces of said hollow body (B), at the opposite end portions of the crossbar (H), and only part of said surface in the remaining part of the crossbar (H). 10

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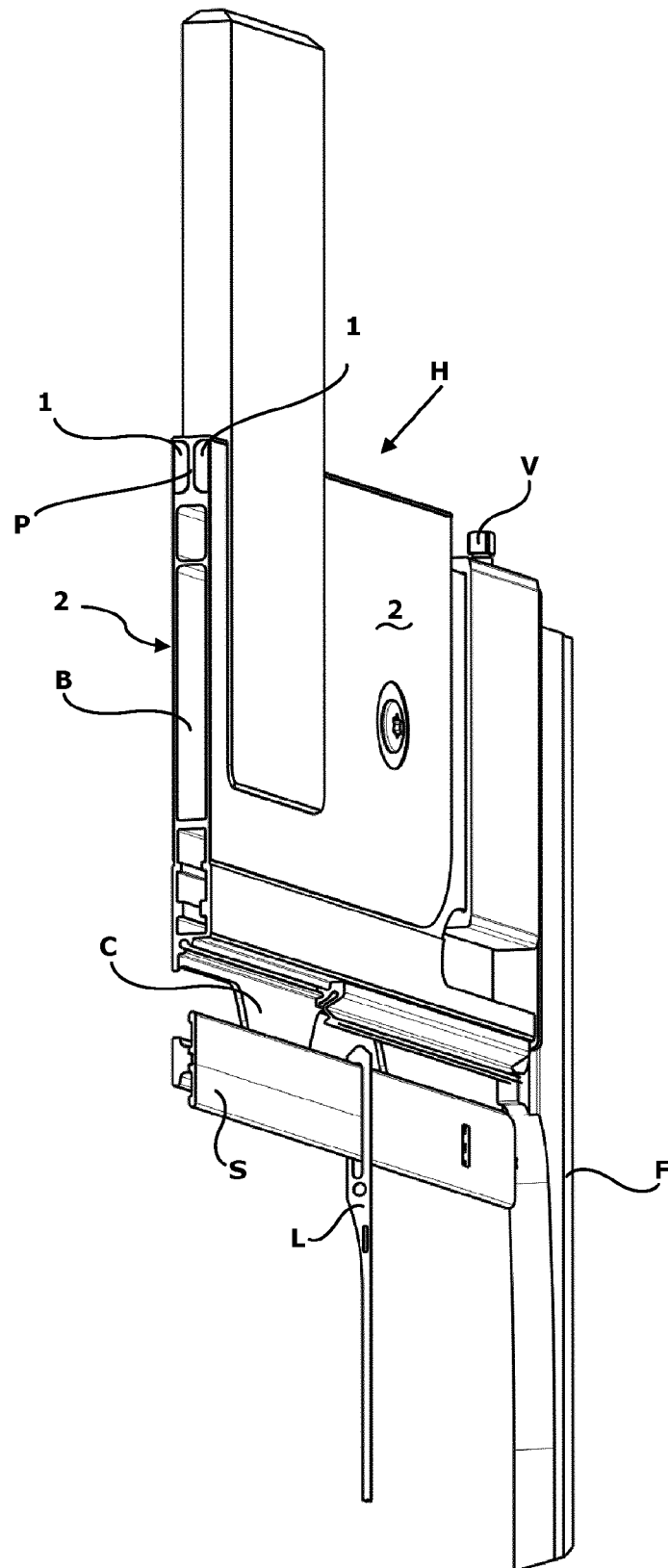


Fig. 1

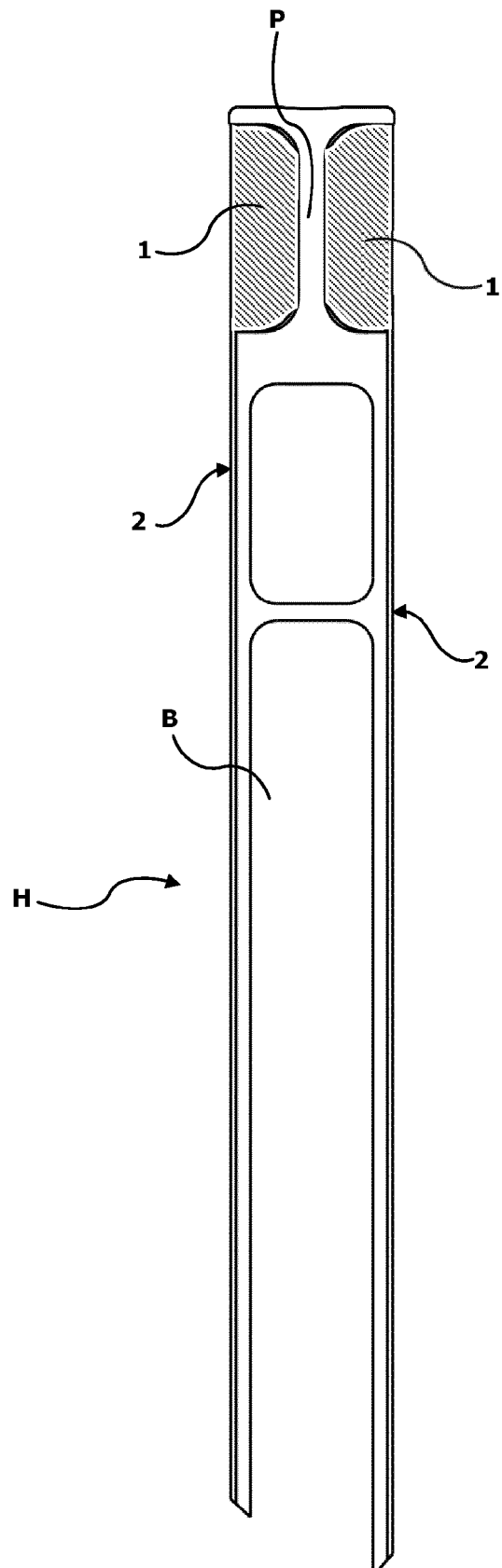


Fig. 2



EUROPEAN SEARCH REPORT

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EPO FORM 1503 03.82 (P04C01)

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X,D	US 3 754 577 A (HELLER R) 28 August 1973 (1973-08-28) * abstract * * claims 1-4,10,11,17,18,20 * * figures 1-4,6 * * column 1, line 1 - line 55 * * column 2, line 9 - line 21 * * column 4, line 34 - column 5, line 31 * * column 5, line 50 - column 6, line 5 * * column 7, line 25 - line 54 * -----	1-12	INV. D03C9/06
A	CN 107 541 832 A (HANGZHOU TANPU NEW MATERIAL TECH CO LTD) 5 January 2018 (2018-01-05) * abstract * * claims 1-6,9 * * figures 1-6 * * paragraphs [0001] - [0010], [0014] - [0016], [0033] - [0040], [0044] - [0046], [0049] - [0051], [0058] - [0060] * -----	1-12	TECHNICAL FIELDS SEARCHED (IPC)
A	US 6 994 123 B2 (GROB HORGEN AG [CH]) 7 February 2006 (2006-02-07) * abstract * * claims 1-4,78,12-15,18,19 * * figure 1 * * column 1, line 5 - line 41 * * column 1, line 58 - column 2, line 46 * * column 3, line 30 - line 35 * * column 4, line 8 - line 28 * -----	1-12	D03C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 October 2020	Examiner Heinzelmann, Eric
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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