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(54) **A rolling process for the manufacture of pulleys and equipment used in this process**

Walzverfahren zur Herstellung von Riemenscheiben und Anlage für dieses Verfahren

Procédé de laminage pour la fabrication des poulies et installation pour la mise en oeuvre du procédé

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Description

[0001] The present invention relates to a rolling process for the manufacture of pulleys having at least one V-shaped peripheral groove, and also a rolling implement.

[0002] In the known processes, pulleys of the said type are manufactured by successive rolling steps: more particularly, the cylindrical outer surface of a semi-finished product obtained by rolling or drawing from a flat disc is gradually subjected to plastic deformation by means of rolls having annular projections adapted to form the profiles of the grooves by cold-heading. The various rolling steps are effected by different operating heads, each of which has a respective roll.

[0003] This process has various disadvantages however.

[0004] Specifically, the use of a single roll for each rolling step means that that roll must exert the entire load needed to achieve the desired deformation alone and acting on a single zone of contact of limited area. This causes the material to creep suddenly from the centre towards the ends of the zone of contact which leads to very high loads on the sides of the roll projections. This thus causes rapid wear and, in some cases, fracture of the roll itself. Moreover any small divergence of the straight line of action of the roll from the axis of the piece results in undesirable transverse components of the load being exerted on the roll itself and on the operating head.

To what has been stated must be added the fact that pulleys made by means of the known processes often have unsatisfactorily precise dimensions due to irregularities in the flow of material during the plastic deformation.

FR-A-2 527 957 (closest prior art for claim 1) discloses a rolling process in which two identical rolls are simultaneously used for each rolling operation. The load needed to achieve the desired deformation is therefore divided between the two rolls; however, since each of the rolls has a working profile which is complementary to the workpiece profile to be obtained in the corresponding rolling operation, no further advantage, but load reduction, is obtained with respect to the use of a single roll.

Therefore, the aforesaid problems are only solved to a limited extent.

The object of the present invention is to provide a rolling process for the manufacture of pulleys having peripheral grooves which is free from the disadvantages of the known processes specified above.

This object is achieved by a rolling process as claimed in claim 1.

The invention also relates to a rolling implement. Such an implement, according to the preamble of claim 7, is known, for example, from US-A-5 031 296.

For a better understanding of the present invention, two preferred embodiments thereof will now be described, purely by way of example, with reference to the appended drawings, in which;

Figure 1 is an axial section through a pulley which can be made by a rolling process according to the present invention;

Figure 2 is a schematic side-elevational view of a rolling machine for carrying out the process of the present invention, with parts removed for clarity;

Figure 3 is a schematic side-elevational view of a rolling implement operating on a semi-finished product to carry out the process of the present invention;

Figures 4a, 4b, 4c and 4d illustrate, in radial section, the rolls used in each step of a first rolling process according to the present invention, and the profile of the pulley being manufactured at the end of each step;

Figures 5a, 5b and 5c illustrate, in radial section, the rolls used in each step of a second rolling process of the present invention and the profile of the pulley being manufactured at the end of each step.

[0005] With reference to Figure 1, a pulley manufactured by the process according to the invention is indicated 1.

[0006] The pulley 1 includes a central portion 2 of flat, disc shape having a through-hole 3 with an axis of symmetry 4 and a substantially cylindrical peripheral portion 5 in the outer surface of which is formed a plurality of V-shaped grooves 6. More particularly, in the non-limitative example described and illustrated here, there are five grooves 6.

[0007] With reference to Figure 2, a rolling machine for implementing the process of the present invention is generally indicated 7.

[0008] The machine 7 comprises essentially a base 8 from the opposite ends of which a first head support structure 9 and a second head support structure 10 project upwardly.

[0009] The head support structure 9 supports a chuck 11 which is axially fixed but rotatable about its axis 12 which is horizontal, the chuck being coupled for rotation with drive means not illustrated through conventional transmission means.

[0010] The head support structure 10 supports an hydraulic cylinder 13 coaxial with the chuck 11 and having an axially slidable shaft 14; the shaft 14, at its end facing the chuck 11, carries a second chuck 15 which is movable axially with the shaft 14 and mounted for free rotation thereon.

[0011] A slide 16 is also rigidly fixed to the shaft 14 and is slidable axially along three guide rods 17 parallel to the axis of the cylinder 13 and supported at their ends by the head support structures 9 and 10. These rods 17, disposed one below the cylinder 13 and two above it and on opposite sides thereof, constitute a guide for the shaft 14 and absorb the radial loads bearing thereon as

a result of its own weight and the working as will be clarified below.

[0012] The head support structure 9 also supports a plurality of operating heads 18 disposed in a radial array around the chuck 11 and of which only one is illustrated; conveniently there are four of these heads 18. Each operating head 18 includes a respective carriage 19 movable radially (with respect to the axis 12) by drive means not illustrated; a respective implement 20 of the type illustrated in Figure 3 may be mounted on each carriage 19.

[0013] The implement 20 comprises essentially a forked support 21 and two rolls 22 and 23 adapted to act on a semi-finished product, that is on the pulley 1 being manufactured.

[0014] The forked support 21 has a tapered rear attachment portion 24 which is adapted to be pivoted on its carriage 19 about an axis 25 parallel, in use, to the axis 12 and, for this purpose, has a hole 26 for housing a pivot pin, not illustrated. The forked support 21 further includes a front portion 27 for supporting the rolls 22, 23, constituted by a pair of spaced parallel plates 28 which project from the portion 24 and support between them, close to respective corners, respective pins 29 of the rolls themselves. More particularly, the pins 29 have respective axes 30 which are parallel to the axes 25 and 12 and are disposed symmetrically on opposite sides of a plane M of symmetry through the implement 20 containing the axis 25 and, in use, the direction of advance R of the tool 20.

[0015] The rolls 22, 23 are mounted so as to project partly from the front edges of the plates 28 and may thus cooperate with a peripheral portion of the semi-finished product mounted between the chucks 11, 15 of the rolling machine 7.

[0016] The rolls 22 and 23 are substantially cylindrical in shape and have respective working profiles 31 and 32 adapted to generate a profile 33 on the outer surface of the peripheral portion 5 of the pulley 1 similar to that illustrated.

[0017] Since the process of the present invention is carried out in successive steps, several implements 20 are needed in the machine 7 to complete the manufacture and the machine 7 has an equal number of operating heads 18 to support them. More particularly, according to the present invention, four implements 20 are needed for reasons which will be clarified below, each including two rolls 22, 23 with respective working profiles 31, 32 illustrated in the drawings 4a, 4b, 4c, 4d.

[0018] In use, a semi-finished product 1' in the form of a flat disc (Figure 3) intended to be converted into the pulley 1 by the process of the present invention is supplied to the machine 7 by a handling device (not shown) and is positioned on the chuck 11 so that its axis of symmetry is coincident with the axis 12; then the semi-finished product is gripped fictionally between the chucks 11 and 15 by the action of the hydraulic cylinder 13.

[0019] The chuck 11 is rotated and, with the advance of one of the carriages 19 along its own straight line of action R, an implement 20, which is different in each of the four successive steps of the present process, is brought into contact with the peripheral portion of the semi-finished product intended to constitute the peripheral portion 5 of the finished pulley 1.

[0020] For reasons linked to the balancing of the forces in play, when the implement 20 carries the rolls 22 and 23 into contact with the piece being worked, the forked support 21 centres itself automatically so as to dispose the rolls 22 and 23 symmetrically on opposite sides of the straight line of action R (Figure 3).

[0021] In the first step of the process, a first implement 20 supports rolls 22 and 23 having working profiles 31 and 32 as shown in Figure 4a. More particularly, the profile 31 of the roll 22 is straight while the profile 32 of the roll 23 is undulate, being constituted by a plurality of slight adjacent, interconnected, annular projections 34. The simultaneous and synergic action of the rolls 22 and 23 is such as to deform a peripheral portion 5' of the semi-finished product (illustrated in broken outline) plastically to form the cylindrical peripheral portion 5 of the pulley 1 and to generate rounded grooves 6, of limited depth, complementary with the projections 32 of the working profile and spaced by portions 6' with a straight profile.

[0022] In the second and third working steps which are implemented next, second and third implements 20 are used which are equipped with rolls 22, 23 the profiles 31, 32 of which are illustrated in Figures 4b and 4c respectively.

[0023] The rolls 22, 23 have projections 34 with twice the axial spacing of the spacing of the grooves 6, the projections of one roll being staggered axially relative to the projections of the other roll operating simultaneously and the projections being separated from each other by portions 35 with straight profiles. The rolls 22, 23 of each working pair thus work alternate grooves in the semi-finished product; moreover, for each pair of rolls 22 and 23, each projection 34 of the working profile 31 corresponds in radial section to a straight portion of the working profile 32, and vice versa.

[0024] In the fourth and last step (Figure 4d) a fourth implement 20 is activated, the rolls 22, 23 of which have the same working profile and this being complementary to the profile of the finished pulley 1.

[0025] In moving from the second to the fourth step (from Figure 4b to Figure 4d), the rolls 22, 23 used have projections 34 which become gradually more pronounced, that is, have a greater height and a less rounded head profile so that the grooves 6 produced in the pulley 1 become gradually deeper and more defined, the process changing, in practice, during the course of the various steps, from a roughing operation, in which the grooves 6 are roughly formed, to an operation in which the grooves are finished.

[0026] Figure 5 illustrates the working profiles 31, 32 of rolls 22, 23 used in a second embodiment of the proc-

ess of the present invention.

[0027] More particularly, this embodiment of the process, although also usable to start from a semi-finished product in the form of a flat disc, is particularly adapted to the case in which the semi-finished product is of cup shape achieved by a preliminary drawing operation, not illustrated, and which thus already has a cylindrical wall 5 in which the grooves 6 are formed.

[0028] This process conveniently includes three steps, the working profiles 31, 32 of the rolls 22, 23 used in the first, second and third steps being illustrated in Figures 5a, 5b, 5c respectively. The pairs of rolls 22, 23 in the first two steps have projections 34 which are staggered axially relative to each other as described with reference to Figures 4b, 4c; in the first step, the rolls 22, 23 have projections 34 of limited height and interconnected profiles while, in the second step, the projections 34 are more pronounced. In the third step two rolls 22, 23 are used which are identical and have working profiles complementary to that of the finished pulley.

[0029] From an examination of the processes described, according to the present invention, the advantages achieved thereby are clear.

[0030] Above all, the use of the operating heads with pairs of rolls instead of single rolls means that, for a given deformation of the product during working, the stresses on the rolls are smaller.

[0031] Furthermore, the fact that the working profiles of the rolls which act in the initial working steps, in which there is the greatest deformation of the material, differ from each other and are designed to obstruct the transverse flow of the material as little as possible, considerably reduces the loads acting on the sides of the teeth, limiting their wear and considerably reducing the risk of fracture.

[0032] The absence of exaggerated stresses in the material, also due to the use of pairs of rolls having working profiles which become gradually more pronounced during the course of the various steps, ensures the dimensions and surface finishing of the grooves are very precise.

[0033] Finally, the use of a pivoted fork as the support for the rolls ensures that the implement is centred automatically on the pulley being worked and compensates for any misalignment between the straight line of action of the working head and the axis of symmetry of the piece which, in conventional processes, causes dangerous transverse forces to act on the drive means of the head, and ensures that the deformation load is distributed uniformly.

[0034] Finally it is clear that modifications and variations may be made to the process described without thereby departing from the protective scope of the present invention.

[0035] It should, in fact, be remembered that the number of steps by which the present process may be achieved is dependent on the type of semi-finished product used to start with, whether this is flat or drawn, the material of which it is made as well as the number and profile of the grooves it is wished to obtain.

[0036] Finally in some cases it may be convenient to use pairs of rolls with identical working profiles, as in the final finishing step, even in the preceding steps in the working of the pulley.

Claims

1. A rolling process for the manufacture of a pulley(1) having at least one peripheral groove (6), in which a circular semi-finished product is rotated about its own axis and subjected to successive steps of plastic deformation by means of rolls (22, 23) having working profiles (31, 32), at least one of the steps being implemented by means of two rolls (22, 23) operating simultaneously on the same peripheral portion (5) of the semi-finished product intended to have the said groove (6), **characterised in that** said two rolls (22, 23) operating simultaneously have respective working profiles (31, 32) which differ from each other.

2. A process as claimed in Claim 1, **characterised in that** said two rolls (22, 23) are mounted on a movable support (21) which is pivotable about a first pivot axis (25) parallel to the axis of rotation (12) of the semi-finished product and to the respective axes (30) of the rolls (22, 23).

3. A process as claimed in claim 1 or 2, **characterised in that**, in at least one other of the rolling steps, two further rolls (22, 23) operating simultaneously are employed, which have respective working profiles (31, 32) which are the same as each other.

4. A process as claimed in any one of the preceding claims, **characterised by** including a first roughing step in which the grooves (6) are roughly formed by a first roll (22) having a substantially straight working profile (31) and a second roll (23) having a plurality of rounded annular projections.

5. A process as claimed in any one of the preceding claims, **characterised by** including at least one step implemented by means of a pair of rolls (22, 23) having respective pluralities of annular projections (34), the projections of the rolls (22, 23) being staggered axially of each other.

6. A process according to Claim 5, **characterised in that** the projections (34) of the rolls (22, 23) are separated by portions with a straight profile.

7. A rolling implement (20) adapted to be installed in an operating head (18) of a rolling machine (7) for the manufacture of pulleys (1) having at least one

peripheral groove (6), said implement including a support (21) adapted to be mounted on the operating head and a pair of idle rolls (22, 23) having parallel axes and carried by the support (21) **characterised in that** the idle rolls (22, 23) are fixedly mounted or said support (21), such that, in use, they simultaneously contact the workpiece, said rolls (22, 23) having respective working profiles (31, 32) which differ from each other.

8. An implement according to Claim 8, **characterised in that** the support (21) is pivotable about an axis parallel to the axes of the rolls (22, 23).

Patentansprüche

1. Walzverfahren zur Herstellung einer Riemenscheibe (1) mit wenigstens einer Umfangsnut (6), in welcher ein rundes halbfertiges Produkt um seine eigene Achse gedreht und in aufeinanderfolgenden Schritte der plastischen Verformung durch Vorrichtungen aus Walzen (22, 23) mit Arbeitsprofilen (31, 32) unterworfen wird, wobei wenigstens einer der Schritte mittels Vorrichtungen aus zwei solcher gleichzeitig auf dem gleichen Umfangsteil (5) des halbfertigen Produktes betriebenen Walzen (22, 23) durchgeführt wird, um die Nut (6) zu erhalten, **dadurch gekennzeichnet, daß** die beiden gleichzeitig arbeitenden Walzen (22,23) zugeordnete Arbeitsprofile aufweisen, die voneinander verschieden sind.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** die Walzen (22, 23) an einem beweglichen Träger (21) befestigt sind, der um eine erste Schwenkachse (25) parallel zu der Drehbewegungsachse (12) des halbfertigen Produktes und zu den zugeordneten Achsen (30) der Walzen (22, 23) schwenkbar ist.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** in wenigstens einem anderen der Walzschritte zwei weitere gleichzeitig betriebene Walzen (22, 23) eingesetzt werden, die zugeordnete Arbeitsprofile (31, 32) aufweisen, die jeweils gleich sind.

4. Verfahren nach einem der vorangegangenen Ansprüche, **dadurch gekennzeichnet, daß** es einen ersten groben Schritt beinhaltet, in welchem die Nuten (6) grob durch eine ersten Walze (22) mit einem im wesentlichen geradlinigen Arbeitsprofil (31) und einer zweiten Walze (23) mit einer Vielzahl von gerundeten ringförmigen Vorsprüngen geformt werden.

5. Verfahren nach einem der vorangegangenen Ansprüche, **dadurch gekennzeichnet, daß** wenigstens ein Schritt durch Vorrichtungen aus einem Paar aus Walzen (22, 23) mit zugeordneten Vielzahlen ringförmiger Vorsprünge (34) vorgesehen ist, wobei die Vorsprünge der Walzen (22, 23) axial zueinander gestaffelt angeordnet sind.

6. Verfahren nach Anspruch 5, **dadurch gekennzeichnet, daß** die Vorsprünge (34) der Walzen (22, 23) durch Abschnitte mit einem geradlinigen Profil beabstandet sind.

7. Walzvorrichtung (20) angepaßt, um in einen Arbeitskopf (18) einer Walzmaschine (7) zur Herstellung von Riemenscheiben (1) mit wenigstens einer Umfangsnut (6) installiert zu werden, mit einem Träger (21), angepaßt zur Befestigung an dem Arbeitskopf und einem Paar aus leerlaufenden und parallele Achsen (30) aufweisenden von dem Träger (21) getragenen Walzen (22, 23), **dadurch gekennzeichnet, daß** die leerlaufenden Walzen (22, 23) fest an dem Träger (21) befestigt sind, so daß sie beim Betrieb gleichzeitig das Werkstück berühren, wobei die Walzen zugeordnete Arbeitsprofile (31,32) aufweisen, die voneinander verschieden sind.

8. Vorrichtung nach Anspruch 7, **dadurch gekennzeichnet, daß** der Träger (21) um eine Achse parallel zu den Achsen der Walzen (22, 23) schwenkbar ist.

Revendications

1. Procédé de laminage pour la fabrication d'une poulie (1) comportant au moins une rainure périphérique (6), dans lequel un produit semi-fini circulaire est mis en rotation autour de son propre axe et soumis à des étapes successives de déformation plastique par des rouleaux (22, 23) qui présentent des profils de travail (31, 32), l'une au moins des étapes étant exécutée par deux rouleaux (22, 23) agissant simultanément sur la même partie périphérique (5) du produit semi-fini destinée à comporter ladite rainure (6), **caractérisé par** le fait que lesdits deux rouleaux (22, 23) agissant simultanément présentent des profils de travail respectifs (31, 32) qui diffèrent l'un de l'autre.

2. Procédé selon la revendication 1, **caractérisé par** le fait que lesdits deux rouleaux (22, 23) sont montés sur un support mobile (21) susceptible de pivoter autour d'un premier axe de pivotement (25) parallèle à l'axe de rotation (12) du produit semi-fini et aux axes respectifs (30) des rouleaux (22, 23).

3. Procédé selon la revendication 1 ou 2, **caractérisé**

par le fait que, dans au moins une autre des étapes de laminage, on utilise deux autres rouleaux (22, 23) agissant simultanément et qui présentent des profils de travail respectifs (31, 32) qui sont les mêmes.

4. Procédé selon l'une quelconque des revendications précédentes, **caractérisé par** l'inclusion d'une première étape de dégrossissage dans laquelle les rainures (6) sont formées grossièrement par un premier rouleau (22) qui presente un profil de travail (31) sensiblement rectiligne et un second rouleau (23) qui comporte un ensemble de saillies annulaires arrondies.

5. Procédé selon l'une quelconque des étapes précédentes, **caractérisé par** l'inclusion d'au moins une étape exécutée par une paire de rouleaux (22, 23) qui comportent des ensembles respectifs de saillies annulaires (34), les saillies des rouleaux (22, 23) étant décalées axialement les unes des autres.

6. Procédé selon la revendication 5, **caractérisé par** le fait que les saillies (34) des rouleaux (22, 23) sont séparées par des parties à profil rectiligne.

7. Outil de laminage (20) apte à être installé dans une tête d'actionnement (18) d'un laminoir (7) pour la fabrication de poulies (1) comportant au moins une rainure périphérique (6), ledit outil incluant un support (21) apte à être monté sur la tête d'actionnement et une paire de rouleaux presseurs (22, 23) qui possèdent des axes parallèles et sont portés par le support (21), **caractérisé par** le fait que les rouleaux presseurs (22, 23) sont montés fixement sur ledit support (21) de façon que, en service, ils entrent simultanément en contact avec la pièce façonnée, lesdits rouleaux (22, 23) présentant des profils de travail respectifs (31, 32) qui différent l'un de l'autre.

8. Outil selon la revendication 7, **caractérisée par** le fait que le support (21) est susceptible de tourner autour d'un axe parallèle aux axes des rouleaux (22, 23).

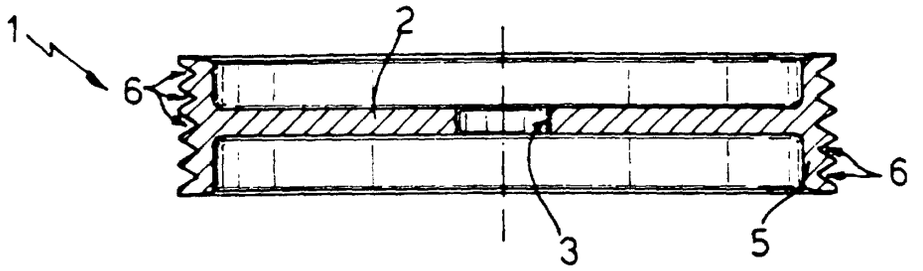

Fig. 1

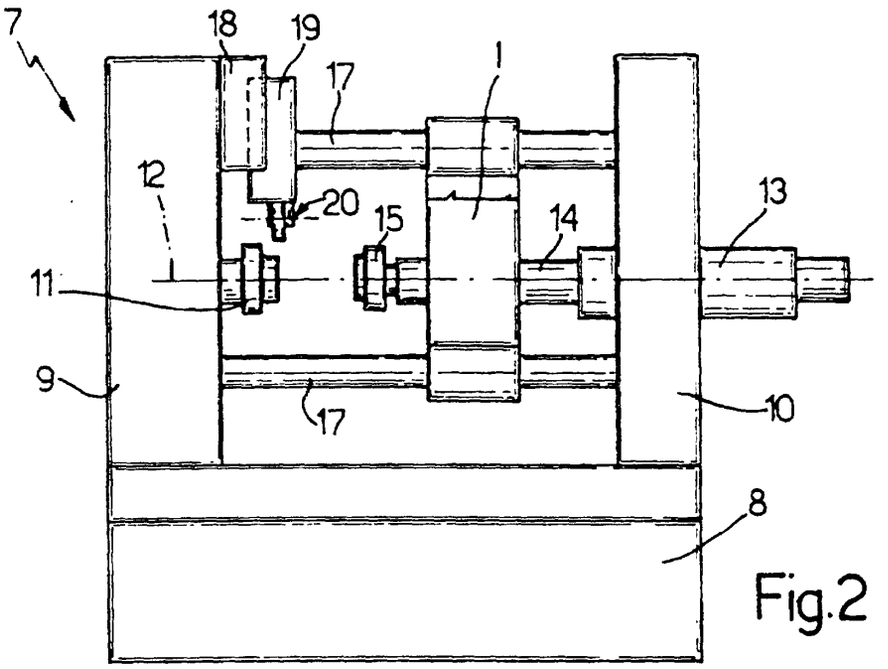

Fig.2

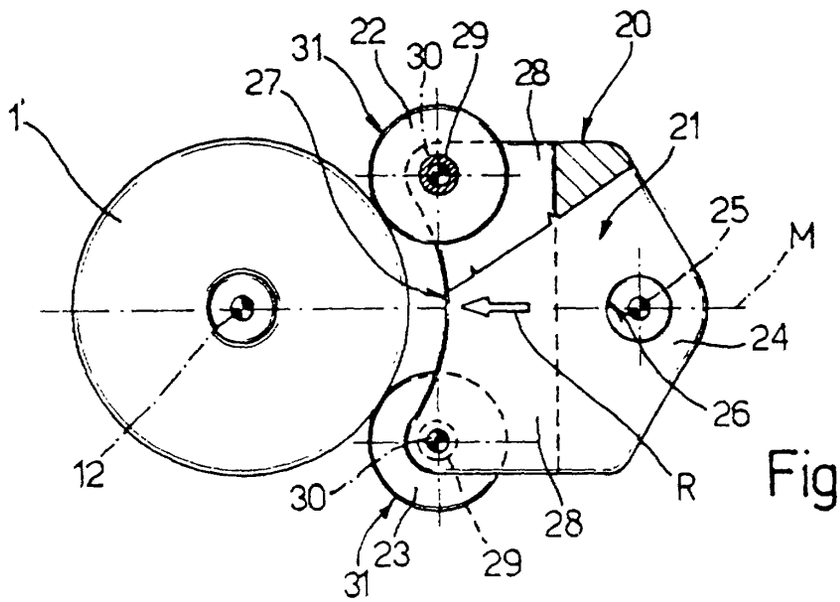

Fig.3

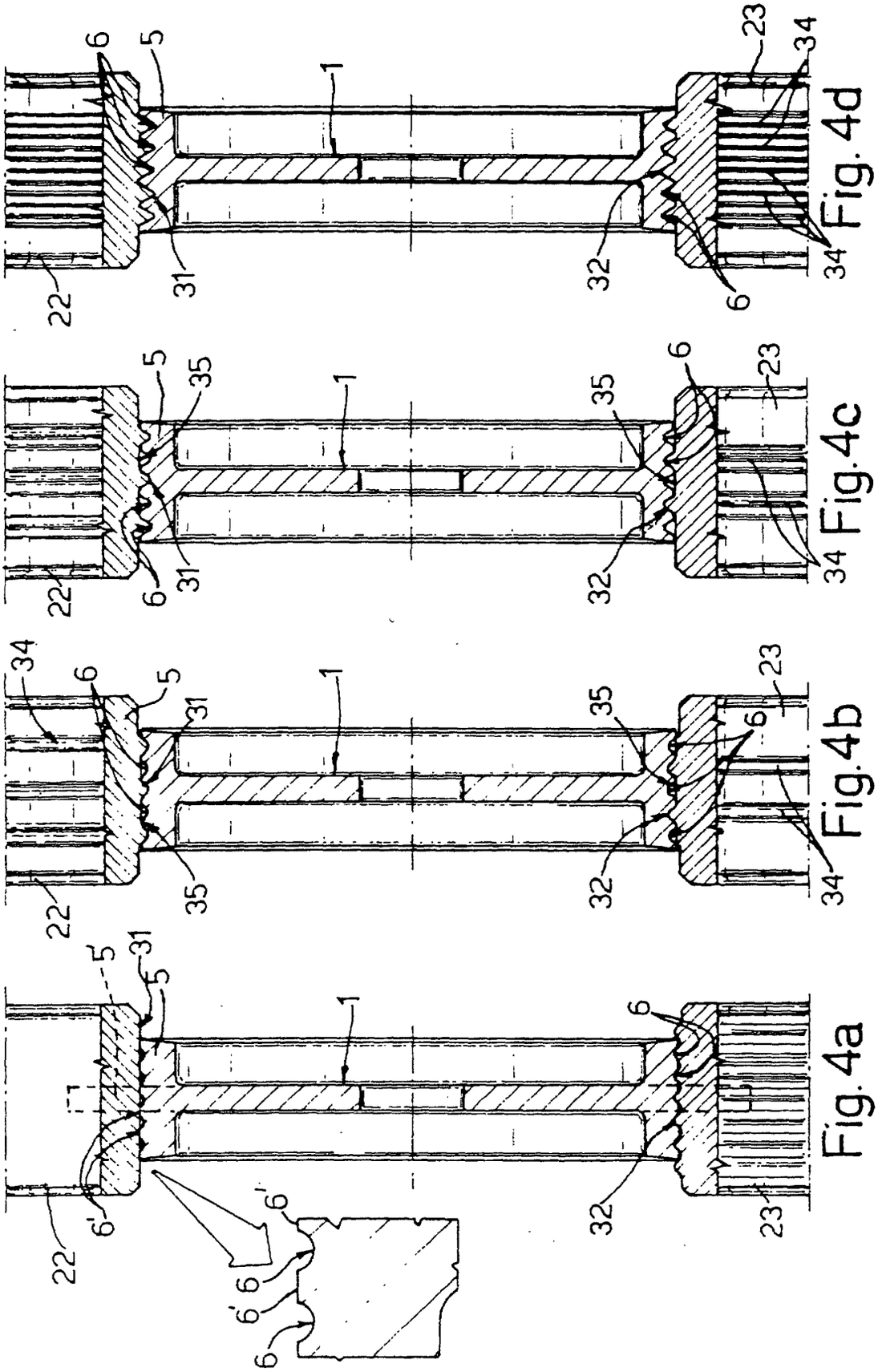
6
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Fig. 4d
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1
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34
Fig. 4c
34
6
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Fig. 4b
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Fig. 4a

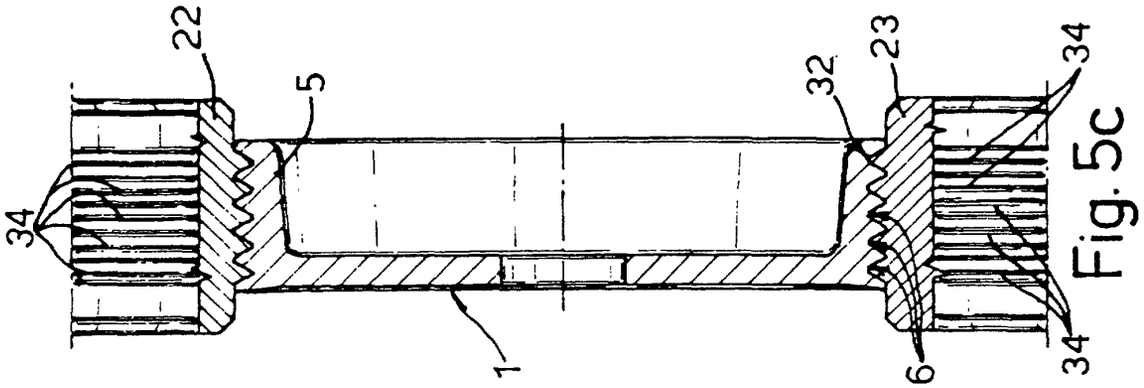

Fig. 5c

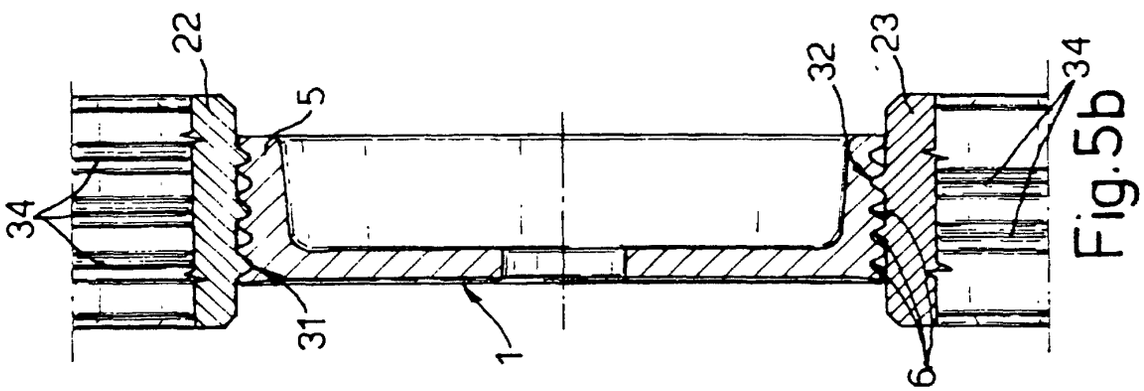

Fig.5b

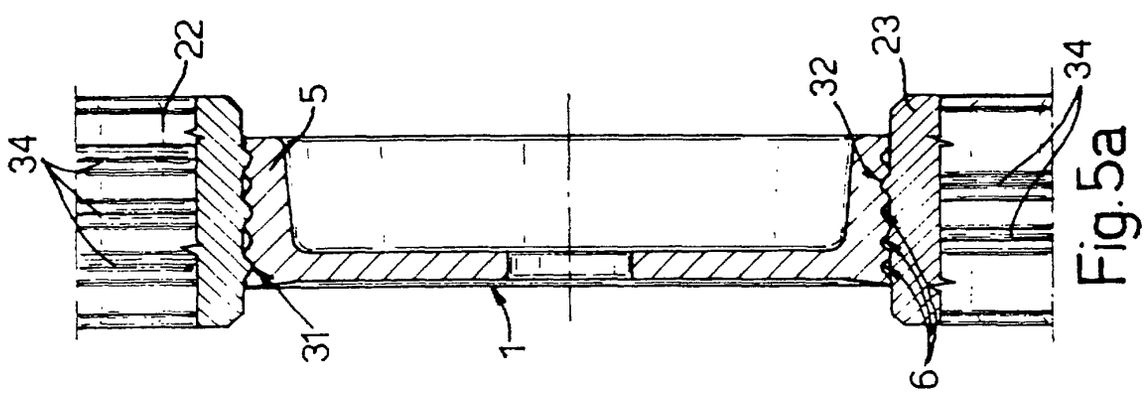

Fig.5a