(19) DANMARK

(10) **DK/EP 3916449 T3**

Patent- og Varemærkestyrelsen

(12) # Oversættelse af europæisk patentskrift

(51) Int.Cl.: ***G 02 B 6/44 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2023-11-06**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2023-10-04**

(86) Europæisk ansøgning nr.: **20177459.3**

(86) Europæisk indleveringsdag: **2020-05-29**

(87) Den europæiske ansøgnings publiceringsdag: **2021-12-01**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(54) Benævnelse: **SPLEJSEMODULSTAK MED FORBEDRET KABELFØRING**

(56) Fremdragne publikationer:
EP-A1- 2 725 397
WO-A2-2016/042018
US-A- 5 946 440
US-A1- 2009 067 802
US-A1- 2009 148 117

Splice module stack with improved cable routing

The invention relates to a stack of splice modules for fibre optical cables Such fibre optical cables are also known as waveguide cables.

Fibre optic cables are used for signal transmission with high transmission rates and/or high spatial ranges and are being used more and more. In particular, fibre optic cable networks are increasingly being laid all the way to the consumer or even to the end device in the home or office. With the expansion of fibre optic cable networks, the task of connecting fibre optic cables to each other is becoming more and more frequent.

In this process, the individual fibres are joined together using a technology known per se, and these so-called splice and patch points are accommodated in a manner that is also known per se, in an organized, accessible and protected manner. One speaks of splice modules in which typically a plurality (e.g. twelve or a multiple of twelve) of optical fibres are spliced in cables with a single optical fibre each in respective splice cassettes and are guided with short connecting cables (pigtails) onto terminating elements (such as plugs and couplings). Fibre optic cables with connecting elements (such as plugs), especially patch cables, can then be used there to continue the fibre optic connections. In the following, the term fibre optic cable refers to a type of cable in the area of such a splice module and not to a "fibre optic cable" buried under a road, for example, with a thick and diverse bundle of individual fibres.

For accessibility to the individual splice and patch points, known splice modules typically have a moving drawer-like tray and a stationary support. In particular variants, the tray is not translationally extendable, but is pivotable about a pivot axis, typically near the corner of the support. In the following, this is referred to as a pivot module (i.e. quasi a pivot drawer instead of a drawer). By way of example, reference can be made to EP 2 221 650 A1.

The translatory drawer movements lead to movements of the so-called patch cables, which are connected to the connecting elements of the connecting fibres. Such movements can lead to undesired tensile or bending loads on individual fibre optic cables (patch cables). In particular, it must be taken into account that the fibre optic cables should not fall below certain bending radii in order to avoid undesired attenuation. Accordingly, in the state of the art, e.g. guide constructions are already known in which the patch cables concerned are supported by elements when a drawer is pulled out or pushed in translationally, which are moved along e.g. at half the speed of the drawer, i.e. with a gear ratio.

Furthermore, reference is made to EP 3 511 753 A1, which deals with an improved solution for pivot modules. Here, fibre optic cables are brought into an S-shape by a guide, which essentially determines the course of the cable in the area closest to the pivot axis on the pivot modules. Damaging effects of the pivoting movements of the pivot modules on cable areas further away are thus reduced.

WO 2016/042018 A2 shows storage modules, each with a shelf for mounting within a housing 10 via its own respective support arm. This is the basis of the preamble of claim 1.

US 2009/067802 A1 shows a splice module stack with cassettes as storage for fibre optical cables, wherein the respective cassettes have a groove with which they can be attached to an axle of a holder. The cassette is fixed to the shaft by means of a knurled screw.

EP 2 725 397 A1 shows storage units for fibre optic cables, each with two segments perpendicular to each other. One shelf is rotatably mounted on a free end of the second segment by means of a pivot joint.

Based on the described state of the art, the present invention is based on the task of providing a further improved solution with regard to the mechanical load on the fibre optic cables in pivoting splice modules.

This task is solved by the subject-matter of claim 1 and, in improved embodiments, by the various dependent claims.

First of all, the invention starts from a very analogous situation as in the cited prior art EP 3 511 753 A1, in particular from a stack of a plurality of fibre optic splice modules, each of which has splice point receivers and is stacked along the geometric pivot axis. The geometric pivot axis is the abstract (i.e. mathematical) axis of the mobility implemented for the respective pivotable splice modules. In the cited prior art, this implementation is realised by an axial rod passing through the respective splice modules (namely at the reference sign A in the Figures), which completely and integrally engages through the modules of a stack. (In the following, we will refer generally to a pivot axis body, which in the cited example is the rod mentioned). The individual splice modules have respective adapted openings and these openings, together with the rod, form pivot joints.

This design is simple and (apart from the cable routing) in principle also common beyond the cited document. In particular, it has the great advantage of relatively good stability as a result of the one-piece design of the rod being extended beyond the height of each individual splice module.

However, the present invention, which is defined in claim 1, takes a different approach and creates free spaces for each of the stacked splice modules directly at the geometric pivot axis, which is blocked by the pivot axis body (rod) in the cited document. The pivot axis body thus leaves out these free spaces, at least (and preferably exactly) one per splice module, so that (at least) one fibre optic cable can pass through the geometric pivot axis, i.e. it is not blocked for the cable to pass through. Accordingly, in contrast to the solution presented in the cited document, cable routing is possible directly through the geometric pivot axis or at least in the immediate vicinity of it. With a usually larger number of fibre optic cables per splice module, the respective cable bundle is typically somewhat too thick to actually allow all fibre optic cables to pass directly through the geometric axis. In any case, the "radial" distance between the fibre optic cables and the geometric pivot axis can be reduced or avoided.

Accordingly, the pivot movements of the splice modules have a much smaller effect on the fibre optic cables. Specifically, the movement component along the cable direction essentially scales with the radial distance from the pivot axis. The angular changes that naturally occur as a result of the pivot movements can in turn be largely absorbed by the fundamentally flexible fibre optic cables.

The free spaces along the geometric pivot axis according to the invention thus optimise the fibre optic cable arrangement with regard to the movements transmitted to the cables.

Preferably, guides for the cables in the area around the geometric pivot axis are also provided in the context of the present invention, i.e. similar to those in the prior art document last discussed. However, such guides are not absolutely necessary as far as an arrangement at least very close to the pivot axis is ensured. In any case, the guides should ensure the possibility of at least one fibre optic cable passing through the geometric pivot axis, wherein a guide wall can be provided for example on both sides of the geometric pivot axis (on both sides in a direction perpendicular thereto).

The pivotability of the splice modules, as already in the prior art, preferably concerns the movement between a closed position and an open position. In the closed position, an adjacent element (adjacent in the sense of a direction parallel to the geometric pivot axis) ensures that the respective splice point receiver is covered on at least one side, preferably of course the side allowing access to the splice point receivers. This adjacent element can be a neighbouring splice module, which in turn can be largely closed and plate-shaped and thus designed to cover. It may also be the cover at the end of a stack, such as a housing part of a housing protecting the splice module stack. The open position, in turn, is a position in which said access to the splice point receiver is permitted, at least if a splice module adjacent to the corresponding side is not also arranged in the open position.

There are two preferred variants of the realisation of the already explained free spaces along the geometric pivot axis. The first variant, which is not part of the claimed invention, in a sense provides that the pivot axis body does not pass straight through along the geometric pivot axis, but in a sense keeps a distance from the geometric pivot axis at the free spaces around it. In other words, the pivot axis body quasi deflects at the free spaces of the pivot axis and thus keeps the free spaces free. This can again be done in two ways, on the one hand through openings through the pivot axis body corresponding to the free spaces, whereby the pivot axis body can then simultaneously form part of or the corresponding cable guide. The other possibility is free spaces that are not completely enclosed by the pivot axis body but are open, in which the pivot axis body is preferably only guided laterally around the free space.

Both possibilities of this first variant are advantageous and, above all, have the advantage already mentioned in relation to the state of the art of a continuous (not necessarily one-piece) pivot axis body, if desired, or in any case a design that is supported over the entire length (in the direction of the pivot axis) and thus stable.

The second variant according to the claimed invention, concerns an interrupted design of the pivot axis body instead. Accordingly, this is divided into a plurality of pivot axis pins, each of which is only responsible for the pivot joint connection between two adjacent splice modules and is separated from each other by the corresponding free spaces. This variant has the advantage, as in the prior art, of being slim in terms of directions perpendicular to the geometric pivot axis. It is shown in more detail in the embodiment example.

Of course, mixed cases can also occur, where part of the open spaces are designed in one way and another part in the other.

According to the invention, the said pivot pins each connect a retaining plate of the respective splice modules to one another. Pivot pins on the outside of the splice module stack can accordingly connect such a retaining plate to the cover or a housing part. The retaining plates, in turn, can contribute to stabilising the splice module stack during the pivoting movements by sliding along each other at least in the event of a weight- or load-induced deflection and thus securing or even guiding the moving splice module in the pivoting movement. The embodiment example shows this in more detail.

In this sense, a relatively large radial extension (radial in the sense of perpendicular to the geometric pivot axis) of the retaining plates is preferred. In particular, the retaining plates can favourably account for at least 10 % of the total extension of the respective splice module in the same direction in at least one such radial direction. Particularly preferably, this also applies to the lower limits of 15 % or 20 %. Furthermore, these statements preferably apply to a further radial direction which is perpendicular to the first mentioned one. However, the same lower limits or extensions do not have to be present in both cases.

In addition, a not too small radial extension of the retaining plates starting from the geometric pivot axis in all directions is preferred, so that the geometric pivot axis is not too close to the edge. For example, a sensible lower limit can be 15 %, or better even 16 %, 17 % or even 18 % in relation to the respective opposite direction. Thus, if the retaining plates have a certain radial extension starting from the geometric pivot axis in one direction, such a minimum extension should correspondingly exist in the opposite direction. In this way, excessive shear forces on the pivot axis pins can be avoided and these can be stressed above all in the tensile direction.

For the sake of clarity, the invention has so far been explained with reference to at least one fibre optic cable, although it is in principle suitable and preferred for splice modules comprising a plurality of such cables. Typically, a series of twelve, twenty-four or more connecting elements may be provided at so-called "patch points" and a corresponding number of cables may be provided in a pivot module. In this case, the majority of the connecting elements are typically arranged in a linear row and the connecting elements progressively move away from the pivot axis in this row. The row is preferably approximately coplanar with the plane of the pivot module and the cable routing through the pivot axis described here.

As already shown in the prior art EP 2 221 650 A1, an essentially rectangular base geometry of the pivot modules with arrangement of the pivot axis near a front corner is preferred.

The angle that can be swept when the pivot module swings out and in is preferably at least 80° and increasingly preferably at least 85° and 90°. Upper limits, however, can be 120°, 115° or 110°. On the one hand, this angle range must be taken into account when routing the cable in the manner described here; on the other hand, large swing-out angles allow good accessibility to the inside of the splice module.

It has already been written about the preferred possibility of a cable guide in the vicinity of the geometric pivot axis. In this context, guide walls are preferred. Preferably, one of these guide walls is designed for inserting fibre optic cables, specifically patch cables, into the guide and is elastically flexible for this purpose. Accordingly, it points to a suitable side (side in the sense of radial direction, i.e. perpendicular to the geometric pivot axis), wherein this can be approximately an outer side with regard to the arrangement of the splice modules. Such a compliant guide wall can be bent, i.e. displaced, when an optical fibre cable or even an operator's finger or a tool is inserted, allow the cable to pass through, and then return substantially to its original position as a result of its elastic properties. In this way, the fibre optic cable(s) can be easily and effectively placed in the guide.

Particularly preferably, the guide wall is made of an elastomer or rubber-like material, at least in its elastically flexible area.

A preferred variant shown in the embodiment provides for such a wall with a slot, e.g. approximately in the middle (in the middle with respect to the direction of the geometric pivot axis). This slit then allows the wall areas divided by the slit to yield elastically. The slit can preferably be wave-shaped, which helps to effectively close the wall again during the elastic return movement.

In general, the slot can remain in the sense of an opening even in the non-deflected state of the more flexible wall, although it will still not let the cables through without elastic deflection if it has a corresponding geometric shape, in particular the wave shape. However, it can also, which is preferred, be closed in the non-deflected state of the wall or wall sections, i.e. merely implement a multipartition of the wall, and only open in the deflected state. The latter is the case in the embodiment example.

According to the invention, a cable guide, for example in the manner described above, can rotate with the respective pivot module and, for example, be realised in a fixed manner relative to the retaining plates, for which reference is made to the embodiment example. This allows a particularly simple and stable design.

As mentioned, the invention relates to a plurality of splice modules which are realised in a serial manner as a stack, namely in a row or stacked in the direction of the pivot axis (i.e. e.g. horizontally or vertically). Furthermore, the splice modules can also be accommodated in such a manner in rows in a distribution cabinet known per se, in particular in the described stack design and in particular with a plurality of stacks therein. Reference can again be made to the prior art already cited.

In the following, the invention is explained in more detail by means of an example of an embodiment.

In detail shows

Figure 1 a perspective view of a simplified splice module according to the invention,

Figure 2 shows	a magnified detail A of Figure 1,
Figure 3 shows	a part of the splice module of Figure 1 close to the pivot axis, separately and enlarged and in a different viewing direction,
Figure 4 shows	the part of Figure 3 stacked several times,
Figure 5 shows	two stacked splice modules of Figure 1 in a relatively pivoted position.

First of all, in order to understand the overall context, reference is made to the two documents already cited, EP 2 221 650 A1 and EP 3 511 753 A1. In particular, Figures 1 and 3 in the former show a relevant distribution cabinet with a plurality of splice module stacks and Figure 2 there shows such a splice module stack with pivot axis A located there at the front right. In the second quotation, the distribution cabinet is shown in Figure 8 and a stack of splice modules is shown in Figure 7, also with pivot axis A on the right front. Figure 6 shows a single pivotable splice module of the stack with pluggable patch points on the front and behind it two vertical stacks of a plurality of splice cassettes, each containing a plurality of splice point receivers.

Figure 1 of the present application largely corresponds to this last described Figure 6, although this time the pivot axis A is at the front left. For the sake of simplicity, the splice module 1 shown is without splice point receivers, i.e. without the relevant splice cassettes, which can, however, be imagined in analogy to Figure 6 in EP 3 511 753 A1. This splice module 1 can be pivoted around the pivot axis A, which is illustrated in Figure 5. In the following, the implementation of the pivot axis A and the components surrounding it will be described in more detail.

Moreover, Figure 1 (and of course also the enlargement in Figure 2) shows a pluggable patch point 2, whereby the Figures already illustrate that in fact instead of the one patch point 2 shown, 24 (namely 4 × 6) of them can be provided next to each other. It can also be seen that a single fibre optic cable 3 leading out of such a pluggable patch point 2 is guided through a row 4 of bending protection elements located in front of the patch points 2 and then continues in front of them to the left in the direction of the pivot axis A. For clarity, however, the fibre optic cable 3 is cut off in the illustration here, although in reality it naturally runs through the cable guide discussed below. Figure 3 also shows a section of the cable 3 with the associated plug-in element at the patch point 2 for illustration purposes.

The geometric pivot axis A runs vertically and passes through holes 5 in metallic plate elements 6 (e.g. made of die-cast zinc), wherein one upper and one lower such plate element 6 are provided for each splice module 1, cf. also Figure 4 with correspondingly eight and Figure 5 with correspondingly four such plate elements 6. The holes 5 in the plate elements 6 are connected, as shown in Figure 4, by separate pivot pins 7, namely two next adjacent plate elements 6 each belonging to different ones of adjacent splice modules 1. The corresponding uppermost and the corresponding lowermost plate element 6 from a stack of splice modules can be connected with corresponding pivot pins, e.g. with housing parts, whereby such a housing comprises and protects such a stack, cf. for example Figure 7 in EP 3 511 753 A1 or Figure 2 in EP 2 221 650 A1.

The pivot axis pins can, for example, be screws with a relatively large head (in particular a flattened head with tool engagement, such as hexagonal engagement) and a locknut, whereby the locknut can, for example, be positively received in a recess of a plate element 6. In this way, the screw can be easily screwed in and the nut does not have to be held. A screw bolt with an external thread is preferably provided on the wide bolt head, which in turn is preferably to be screwed into an internal thread of a bolt attached to the nut. This bolt of the nut can be the actual bearing bolt, i.e. it can produce the bearing function with the plate elements 6. It can also protrude slightly towards the side of the bolt head with such a tolerance that the plate elements are held firmly together on the one hand, but remain rotatable even when the bolt is tightened on the other. On the other hand, the tolerance in the radial dimensions can be much smaller, so that the bearing bolt of the nut sits relatively precisely in the plate elements 6 and thus guides them.

Thus, a multi-part pivot axis body is implemented overall, which replaces the continuous axis pins present in the cited prior art. Accordingly, gaps are created between the axis pins 7, i.e. interruptions of the pivot axis body (which is formed by the ensemble of pivot axis pins 7) interspersed by the geometric pivot axis A. In other words: Between the plate elements 6 of one and the same splice module 1, there is space for the fibre optic cables 3 in the area of the geometric pivot axis A and immediately around it.

Thus, with reference to Figure 1, it can be imagined that a total of up to 24 or even more fibre optic cables 3 pass as a bundle through the area between the two plate elements 6 through which the geometric pivot axis A passes. This area is a guide channel and, with reference to Figures 3, 4 and 5, is bounded approximately to the front and rear by guide walls. An inner wall 8 is a rigid, stable and continuous wall (in particular made of metal) between the two plate elements 6. However, an outer wall 9, which thus lies on the side of the pivot axis A facing away from the splice points, is elastically deformable, namely consists of an elastomer.

Figure 3 shows more clearly that this guide wall 9 consists of an upper and a lower element which are inserted from above and below respectively through slots in the plate elements 6 and meet with an undulating edge approximately in the centre (with regard to the vertical direction). The two edges have a complementary shape and together form an approximately sinusoidal slot-like interruption of the guide wall 9 in the horizontal viewing direction. Accordingly, an optical fibre cable 3 does not have to be threaded lengthwise through the guide channel between the two guide walls 8 and 9, but can be pushed through the elastic elastomer wall 9 with a small amount of force. This applies in both directions, i.e. when inserting an optical fibre cable 3 into the guide channel and vice versa when removing it. The two parts of the guide wall 9 then give way and create a corresponding opening, which is closed again by the elastic reaction after the cable has passed through.

If, after prolonged use or overloading, the return is no longer complete, any remaining distance between the two parts of the wall 9 does no harm, especially because of the undulating shape of the slot between them, as the fibre optic cables are too stiff to fit through such a slot without further ado.

The Figures illustrate that the two panel elements 6 are held together by, for example, four vertically running screw connections 10 and by walls surrounding the axes of these screw connections 10 (in particular with regard to the guide wall 8). The screw connection axes pass through a cavity that is completely closed off from the outside, and the closing walls stabilise the entire construction, in particular the plane parallelism of the two retaining plates 6. One could also use a solid block instead of the walls, but this would mean additional weight. Furthermore, the vertical walls between the two retaining plates 6 in Figure 3 could be integrated with one of the two panel elements and this integrated moulding could be screwed to the other panel element 6 as shown. In any case, the two plate elements 6 are screwed together in a particularly stable manner and are themselves relatively strong.

In this way, instead of the continuous axle bar that no longer exists here, they can absorb the tilting forces on the pivot axis pins that occur in any case when a splice module is pivoted out (Figure 5). Furthermore, the plate elements 6 of adjacent splice modules 1 can slide along each other, for which purpose the screw connections 10 are realised flush with the plate elements 6. So in a way, in addition to the pivot bearings realised by the holes 5 and the pivot axis pins 7, these are also sliding bearings for the pivot movement.

Accordingly, the plate elements 6 have a certain horizontal extension. In this example, this extension in a horizontal transverse direction, i.e. parallel to the row of patch points, is about 21 %, related to the total extension of the splice module 1 according to Figure 1 in this direction, i.e. in particular including the plate elements 6 themselves (and related to the length of the support plate at the row of patch points, i.e. without the plate elements 6 and the mirror-symmetrical element thereto about 28 %). In the depth direction perpendicular to this, these values are 34 % in relation to the entire extension of the splice module 1 of Figure 1 and 49 % if the area in front of the patch points is omitted. Furthermore, it can be seen that the geometric pivot axis A is also clearly distant from the edge of the plate elements 6 to the respective opposite sides, namely in the minimum case about 20 % of the distance to the opposite side (in Figure 3 in relation to the projection of the viewing direction on the plate element 6, i.e. from front to back). Thus, the plate elements 6 provide effective sliding surfaces with regard to the lever lengths that occur.

Incidentally, the Figures show that they offer a favourable and sufficiently long fastening possibility for the rest of the splice module 1 at their rear area (quasi in continuation of the row of patch points). Overall, a stable and reliable overall construction can thus be created despite the modification of the pivot axis body according to the invention, i.e. the interruption into separate pivot axis pins 7, and the thus only small vertical lengths of these individual pins.

PATENTKRAV

1. Splejsemodulstak med en flerhed af lyslederssplejsemoduler (1), der hver drejer om en fælles, geometrisk drejeakse (A) og omfatter tilsvarende splejsepunktsaflejringer i splejsemodulerne (1), hvilke splejsemoduler (1) er stakket langs den geometriske drejeakse (A), hvor en drejeaksekrop, der implementerer drejeaksen (A), har et tilsvarende frirum for hvert af splejsemodulerne (1) langs den geometriske drejeakse (A), således at lyslederkabler (3) fra splejsemodulerne (1) i den geometriske drejeakse (A) kan passere gennem frirummene og den geometriske drejeakse (A),

kendetegnet ved, at die frirummene er udformet således, at drejeaksekroppen er opdelt i flere separate drejeaksestifter (7), og disse er adskilt fra hinanden af frirummene, hvilke drejeaksestifter (7) mellem tilstødende splejsemoduler (1) hver forbinder en holdeplade (6) af de tilsvarende splejsemoduler (1) med hinanden.

2. Splejsemodulstak ifølge krav 1 med tilsvarende føringer (8, 9) til i hvert tilfælde mindst et lyslederkabel (3) fra det tilsvarende splejsemodul, hvilke føringer (8, 9) er udformet således, at lyslederkablerne (3) i hvert tilfælde kan krydse den fælles geometriske drejeakse (A).

3. Splejsemodulstak ifølge et af de foregående krav med en afdækning til mindst et af splejsemodulerne (1), hvor splejsemodulerne (1) kan drejes om drejeaksen (A) mellem en lukket position, hvori splejsemodulerne er dækket mindst til den ene side af et tilstødende splejsemodul (1), såfremt dette ligeledes befinder sig i den lukkede position, eller er dækket af afdækningen i en retning parallelt med den geometriske drejeakse, og en åben position, hvori splejsemodulerne (1) giver adgang til den mindst ene splejsepunktsaflejring, i det mindste når et tilstødende splejsemodul (1) befinder sig i den lukkede position.

4. Splejsemodulstak ifølge krav 1, hvor holdepladerne (6) er udformet på en sådan måde, at de glider langs hinanden under en drejebevægelse af et af de tilsvarende splejsemoduler (1) og dermed sikrer det bevægelige splejsemodul (1).

5. Splejsemodulstak ifølge krav 4, hvor holdepladerne (6) i mindst en retning vinkelret på den geometriske drejeakse (A) udgør mindst 10 % af den samlede udstrækning af det tilsvarende splejsemodul (1) i samme retning.

6. Splejsemodulstak ifølge et af de foregående krav med en flerhed af splejsepunktsaflejringer i hvert splejsemodul (1), hvor splejsepunktsaflejringerne fortrinsvis er i en flerhed af splejsekassetter pr. splejsemodul, hvilke kassetter fortrinsvis er stakkede.

7. Splejsemodulstak ifølge et af de foregående krav med en tilsvarende patch-enhed i hvert splejsemodul (1), hvilke patch-enheder hver har en flerhed af patch-punkter (2), hver med en aftagelig forbindelsesanordning til et tilsvarende lyslederkabel (3).

8. Splejsemodulstak ifølge et af de foregående krav, mindst ifølge krav 2, hvor føringerne (8, 9) hver har en elastisk fleksibel væg (9) på en side, der peger vinkelret væk fra den geometriske drejeakse (A), hvilken væg (9) er udformet på en sådan måde, at et lyslederkabel (3) indsat i føringen (8, 9) forskyder væggen (9) i kraft af dens fleksibilitet for derefter at blive holdt i føringen (8, 9) af den elastisk returnerede væg (9).

9. Splejsemodulstak ifølge krav 8, hvor væggen (9) mindst i et fleksibelt område består af elastomermateriale.

10. Splejsemodulstak ifølge krav 8 eller 9, hvor væggen (9) er spaltet, og to dele af væggen (9), der er adskilt af spalten, er elastisk fleksible.

11. Splejsemodulstak ifølge krav 10, hvor spalten har et snoet forløb.

12. Fordelerskab med en flerhed af splejsemodulstakke ifølge et af de foregående krav, hvis geometriske drejeakser (A) er sammenfaldende, og som er stillet på række eller stakket i denne retning.

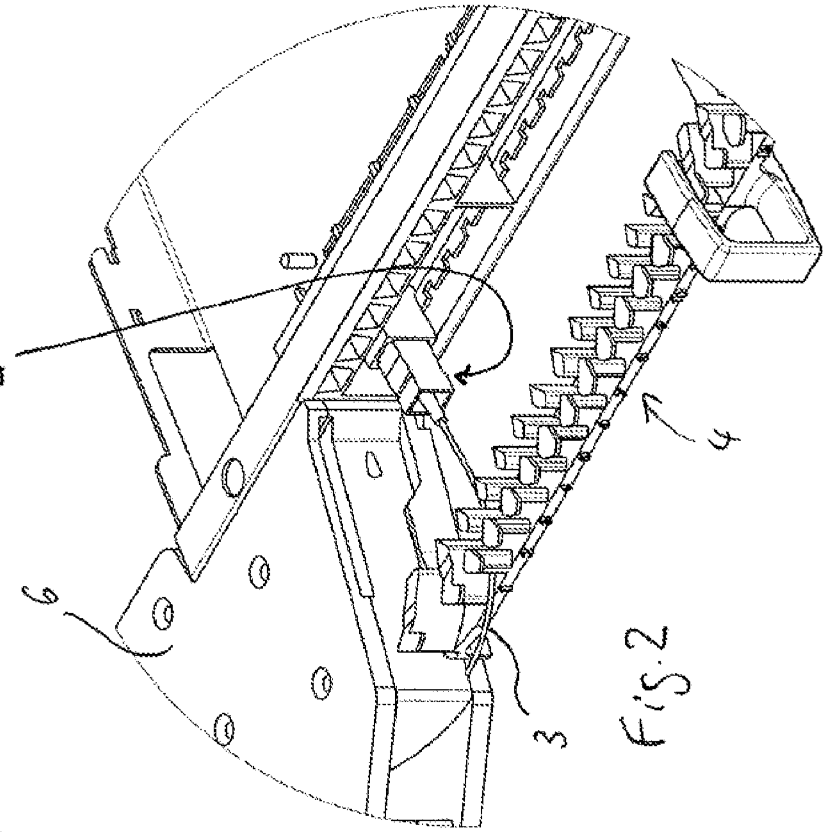

Fig. 2

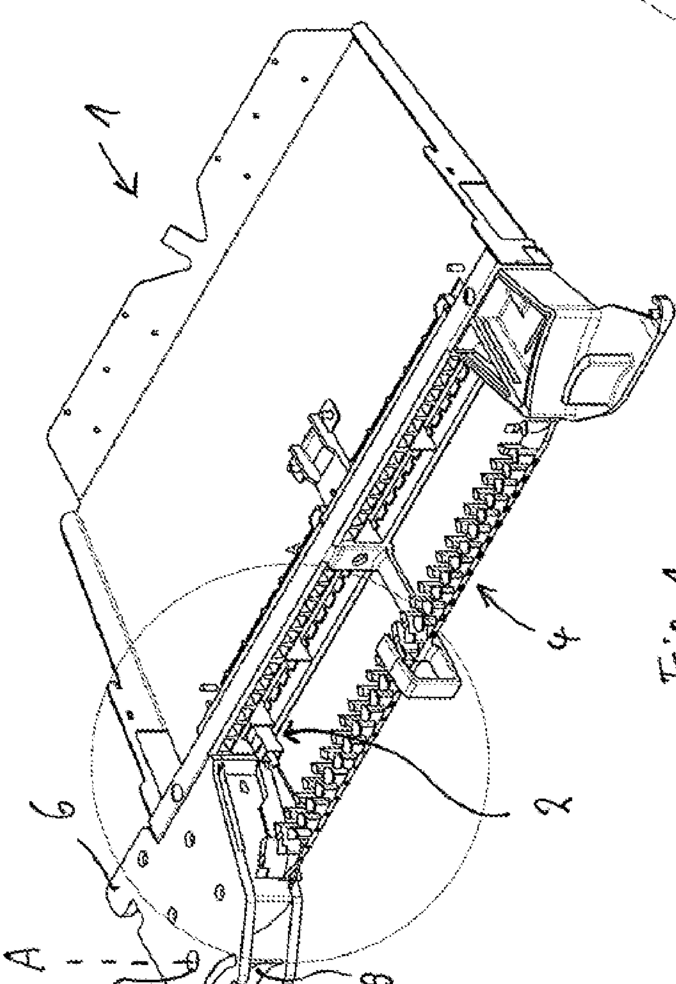

Fig. 1

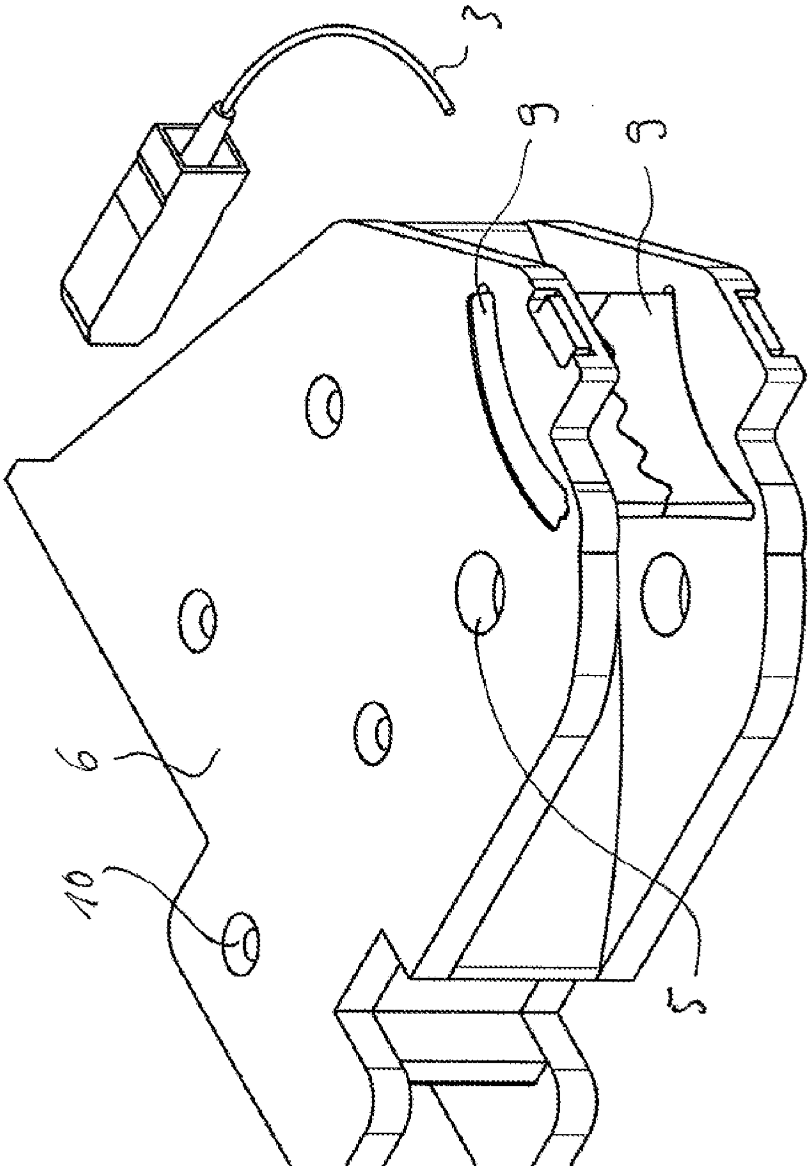

Fig. 3

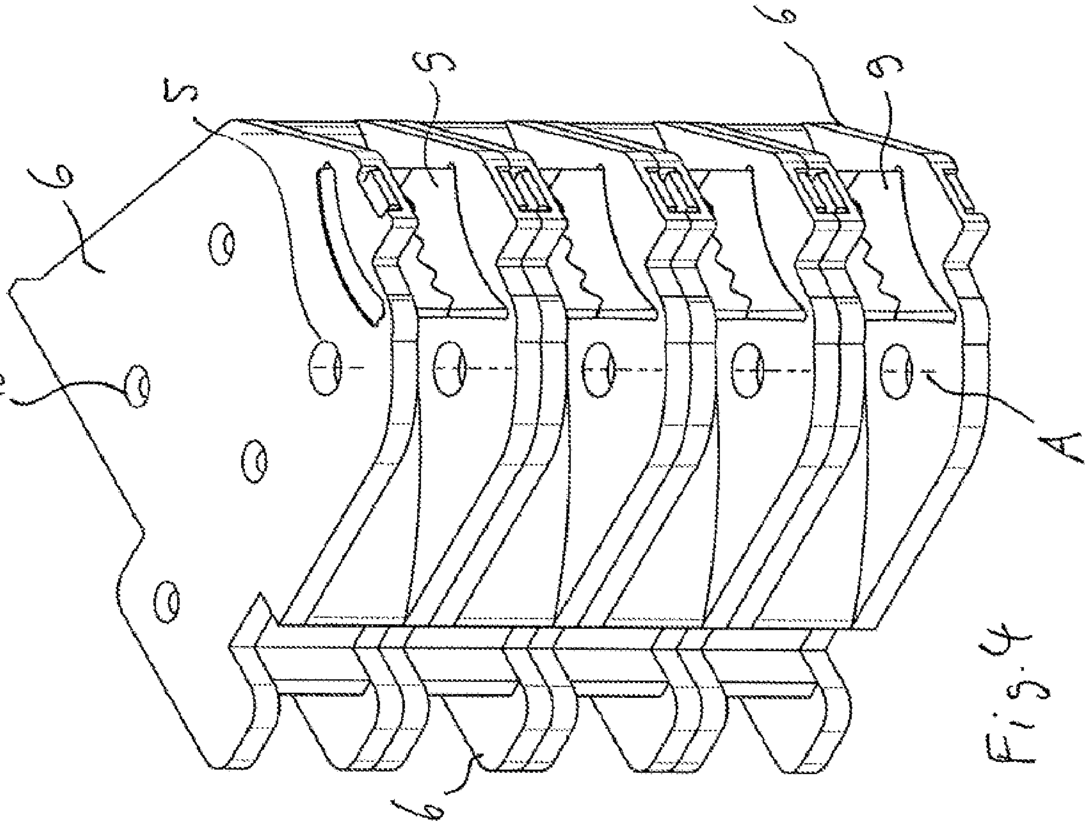

Fig. 4

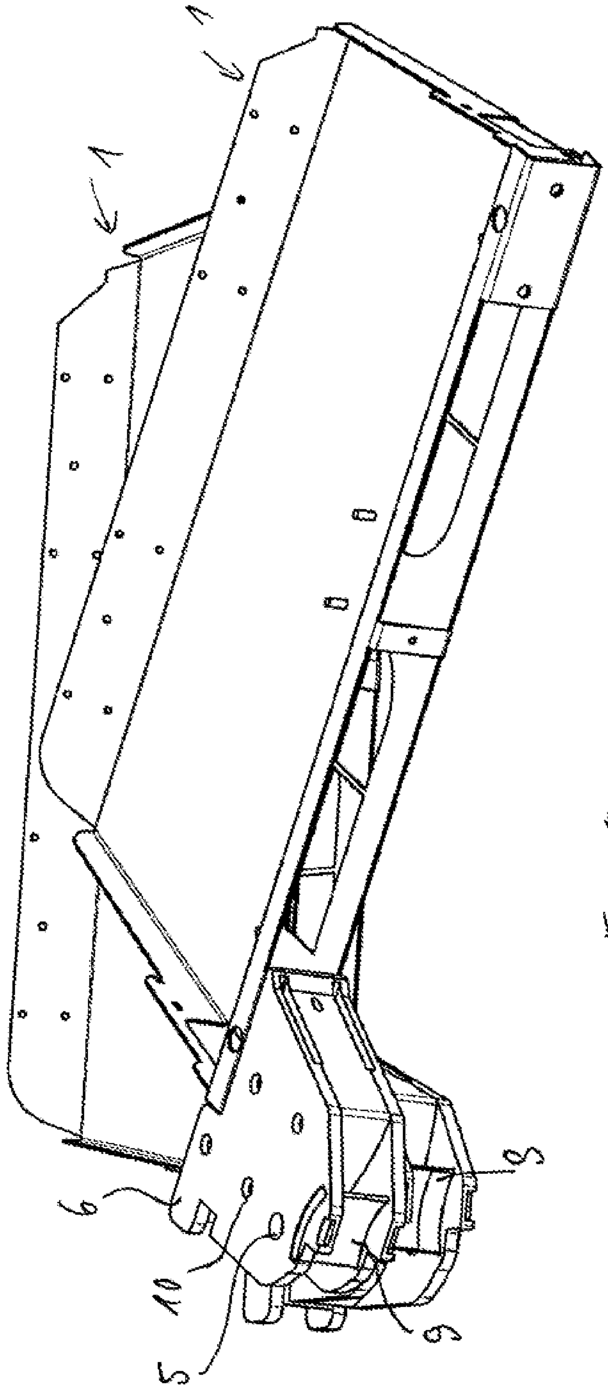

Fig. 5