(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 520 781 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.04.2005 Bulletin 2005/14

(51) Int Cl.7: **B63H 9/06**, B63B 15/00

(21) Application number: **04077693.2**

(22) Date of filing: **30.09.2004**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR LT LV MK

(30) Priority: **02.10.2003 IT MI20031888**

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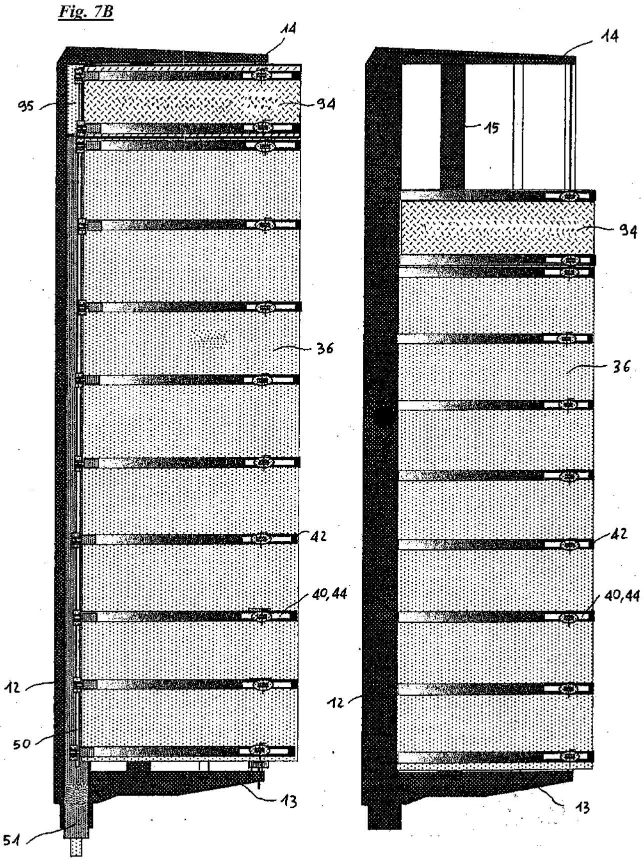
(54) Variable profile wing sail system for sailboats

(57) The invention is about a variable profile wing sail system to be used on sailboats or windsurfs, whose profile is variable by rotating the mast (12), made enbloc with the two booms, to which the bars (42) of the two sail cloths (36) are coupled by pivoting on vertically movable sliding shoes (48, 48'), in order to allow that the sail is hoisted, lowered and reefed using traditional halyards. Advantageously, the variable profile wing sail system (10) comprises an upper anti-inclination topsail (94), having a similar variable profile and being independently movable with respect to the main sail.

Fig. 7B



Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention is about a variable profile wing sail system to be used on sailboats or windsurfs.

[0002] In past years, it was noted that the sailboats efficiency can be considerably increased (of about 30%) by using spankers, or rectangular or differently shaped sails of wing type, i.e. rigid, similar to airplane's wings. However, the advantages in power and lift of the airplane's wings come together with the disadvantage that these known sails remain steady on the boat. In fact, it is not possible either to modify their profile, or to quickly lower them except by completely dismounting the mast and the sail, and it is not possible to shorten (to reef) the sail in few minutes in case of strong wind, that is possible instead with the traditional spankers.

[0003] On the other hand, on a sailboat the rigging is dedicated to generate an aerodynamic force. As a function of the "relative wind speed vector" and "course" variables, its geometry is modified with the purpose to minimize its propulsive component (projection of the aerodynamic force on the course), particularly in bowline sailing. On the polar curve, the condition of highest propulsive force corresponds to the point of highest difference between lift and drag. Following such principle, and according to the aerodynamic data available in literature, it is possible to univocally connect a sail profiles geometry with the highest propulsive force condition.

[0004] Therefore, a variable profile wing sail system has been disclosed (Italian patent N. 1298274 of the same applicant), having booms pivoted on the rotating mast and with a high range of wing profile variations, in which said sail system is actuated by means of halyards and it comprises an upper anti-inclination topsail, independently controllable with respect to the sail and having itself a variable profile.

[0005] It is thus an object of the present invention to provide for a variable profile wing sail system which comprises a bearing mast made enbloc with the two booms, in order to obtain a more practical and economic sail system, without requiring further dies for separately manufacturing the mast and the booms.

[0006] This problem is brilliantly solved with a variable profile wing sail system according to claim 1. Further advantageous characteristics of said sail system are described in the dependent claims.

[0007] Characteristics, objects and advantages of the present invention will be better highlighted in the following description and in the annexed figures of drawings, showing embodiments given in not limiting way. Obviously, the same reference numbers in the different figures show the same or equivalent components.

Figure 1 shows an example of a sail system according to the invention, with an anti-inclination topsail;
Figures 2A and 2B show an embodiment of the wing sail with boom for a sail system according to the invention, in side view and in three distinct sections;
Figure 3 is a front and top view of the stiffening bars of the cloth of a sail system according to the invention;
Figure 4 is a top sectional view of the mast with a pair of bars and their respective sliding block, in two configurations of the wing profile;
Figures 5A, 5B, 5C and 5D show details of the coupling of the cloth to the mast by means of sliding shoes;
Figures 6A, 6B, 6C, 6D and 6E show different views of a sliding block for coupling the sail bars at the trailing profile of the sail; and
Figures 7A and 7B show some assembly and use sequences of the sail system according to the invention.

[0008] With combined reference to the figures of the annexed drawings, the wing sail system 10 of the present invention is carried out with a single bearing structure 11, comprising a wing profiled mast 12, two booms or fixed arms, a lower one 13 and an upper one 14, for tensioning the sails, and at least a vertical central reinforcement 15, of substantially elliptic or circular section. Said single bearing structure 11 is made of glass, carbon or aluminium fibre, and it partially rotates to follow the sail profile and to control the opening of the sail according to the course. The lower 13 and upper 14 booms comprise, at the opposite free ends with respect to the mast 12, a milling 24 which houses a pulley 26 for the passage of the sail control halyard 74, and holes 28 for the passage of tension stays 78, as better described hereinafter. The upper boom 14 further comprises, at the mast 12, a pulley for a second sail control halyard 92, or mast halyard.

[0009] Two symmetrical cloths 36 (of which only one is visible) have a series of horizontal pockets 38, spaced for instance of 50-70 cm, with oblong slots 40 at the trailing profile when mounted overhanging on the mast 12. The pockets 38 house bars 42 similarly provided with oblong slots 44. The bars 42 are tapered starting from the end of the slot 44, and they are made of a material having proper flexibility, for reasons which will be clarified hereinafter.

[0010] Figure 4 is a schematic sectional view of the mast 12, taken at one of the bars 42 of the cloths 36. The mast 12 has a substantial conical section whose base, or rear portion, has a substantially semicircular notch in which a cylindrical shaft 51, shown in section in Figure 2B, slides and partially rotates inside the mast 12, and it is connected thereto by means of sliding bushes. Two sliding shoes 48, 48', joined to the bars 42, are housed at two opposite ends of said cylindrical shaft 51, in two respective guides of substantially circular shape. Said bars 42, inserted in the respective cloths 36, are coupled at the oblong slots 40, 44, shown in Figure 3, by means of sliding blocks 52 which will be better described hereinafter. As one can see by comparing the two drawings present in Figure 4, the mutual rotation of the mast 12 and the cylindrical shaft 51, by engagement with the surface of the bars 42, causes an elastic deformation therein which is structurally reflected, modifying the aerodynamic profile of the whole sail system 10. The coupling between the blocks 52 and the slots 40, 44 is such, as it is better highlighted hereinafter, to allow the mutual sliding of the pressure side and the back side of the wing sail cloths 36. As a consequence, the elastic deformation imposed to the bars 42 by the particular cusp shape of the mast 12 is reflected up to the trailing edge of the wing sail. The lability of the bars 42 can undergo an aerodynamic load windward, generating an aero-elastic geometry of the pressure side of the cloths. Alternatively, said lability can be eliminated, for example by connecting with tie rods the pairs of bars 42 on the windward and leeward sides. Obviously, depending on the section of the cylindrical shaft 51 and the stiffness and tapering of the bars 42, it is possible to obtain a family of sail aerodynamic profiles, each of them being subsequently identified with the sole angular parameter given by the cylindrical shaft 51 rotation. Therefore, during the sailing, the rigging adjustment takes place by simply correlating this parameter with the intensity of the relative wind vector and the aerodynamic incidence determined by the course and the sheet angle.

[0011] Figures 5A, 5B, 5C and 5D show in detail an embodiment of sliding shoes 48, 48' which allows the sliding fastening of the cloths 36 in the guides 50 of the cylindrical shaft 51. A plate 54, having a perforated overhang 56 to receive a threaded pin 58, is fixed to the cloth 36 at the bars 42, by sizing, screws, rivets or the like. The pin 58 comprises, at the opposite end, a ring 60 able to be inserted between two similar rings 62, centrally protruding from a plate 64, 64' of the sliding shoe 48, 48'. The ring 60 of the pin 58 is fastened therein in pivoted mode by means of a nut 66. The sliding shoe 48, 48' is housed in the circular guide 50 of the cylindrical shaft 51 with its plate portion 64, 64' only, and therefore it can vertically slide along said cylindrical shaft 51, dragging the group of bars 42 and the cloth 36 with itself. The sliding shoe 48' is modified with respect to the sliding shoe 48, because its plate 64' is prolonged at the bottom, housing a screw or snap lock 68. This sliding shoe 48' which comprises the lock 68 is provided for the cloths 36 positions corresponding to the base of the sail system 10 and to the reef hinges 46, to support the sail at the bottom when it is completely hoisted or when reefed of one or more bands, as one can see in Figure 7B.

[0012] Figures 6A, 6B, 6C, 6D and 6E show an embodiment of the sliding block 52 for coupling the bars 42 and the cloths 36 at the trailing profile of the wing sail system 10. The sliding block 52 is provided with a central body 70 tapered in the trailing profile direction. A vertical hole 72 for the passage of the sail control halyard 74 and two vertical holes 76 for the passage of the tension forestays 78 of said blocks 52 are obtained along the central body 70 longitudinal axis. Two elongated projections 80, at least one of them having a central transversal hole 82 to fix the halyard 74 to the block 52 by means of a screw 84, horizontally protrude on both sides of the central body 70 of the blocks 52. When assembled, the projections 80 are received in the slots 40, 44 of the bars 42 and the cloths 36, said slots 40, 44 are of considerably greater length with respect to the projections 80. A pair of plates 86, having a slot complementary to the projections 80, houses the respective projections 80 with the interposition of the bars 42 and the cloths 36, said pair of plates 86 being blocked with respective locks 88, for example made of steel, properly shaped and disposed in vertical holes 90 in the projections 82 of the sliding block 52 central body 70. As it will be obvious from the preceding description, the blocks 52 design is such to allow the horizontal and independent sliding of the two cloths 36, and thus to allow the wing sail system 10 to assume a profile configuration which is substantially dependent from the cylindrical shaft 51 rotation only.

[0013] With the aid of the Figures 7A and 7B, the assembly and the operation of the wing sail system 10 will be now described, with reference to the sail control, that is how it can be hoisted, lowered and reefed in an easy and quick way. As visible in Figure 7A, the stays 78 are made to pass in the holes 28 of the upper boom 14 and subsequently the central bodies of the sliding blocks 52 are introduced in said stays 78, obviously respecting the tapering orientation, and finally the stays 78 are made to pass in the holes 28 of the lower boom 13, being tensioned and thus fixed to said lower boom 13. Then, the halyard 74 is made to pass around the pulley 26 in the milling 24 of the upper boom 14. The halyard 74 is subsequently made to pass in the central hole 72 of the blocks 52, and the blocks 52 are then fixed to the halyard 74, at proper distances, by means of the proper screw 84 (Figure 6D). At the same time, the two mast halyard 92 are made to pass in the pulley 34 of the upper boom 14 plate 30 boring 32 and they are fixed in proper rings sewed on the top of the cloths 36. Then, the sliding shoes 48, 48' are inserted in the guides 50 of the cylindrical shaft 51 and at the same time the bars 42 of the cloths 36 are inserted, so that their slots 40, 44 house the projections 80 of the blocks 52 central bodies, further inserting the plates 86 in the projections 80 of the blocks 52 and blocking them therein through the locks 88. This is visible in Figure 7B.

[0014] At last, an anti-inclination topsail 94, placed above the sail system 10, is shown in Figure 7B. The anti-inclination topsail 94 is manufactured in a similar way with respect to the previously described main sail, and thus it is not described in detail hereby. In fact, although the halyards are not present, the details of the sliding blocks 52 and the sliding shoes 48, 48' could be included in the topsail 94 too, to allow its hoisting and lowering. The anti-inclination topsail 94 is fixed to a proper rotating shaft 95, connected to the cylindrical shaft 51 at the bottom and to the upper boom 14 at the top, said rotating shaft 95 being able to partially rotate inside the wing bearing mast 12 in the same way with respect to the cylindrical shaft 51. This type of arrangement allows an independent movement of the anti-inclination topsail 94 with respect to the main sail of the sail system 10 so that, by pivoting the rotating shaft 95 in the opposite direction with respect to the cylindrical shaft 51, an inverse profile able to put straight the boat is achieved, with evident sailing advantages for those skilled in the art.

[0015] It is evident that numerous alterations, adjustments, integrations, variations and modifications could be resorted to the previously described embodiments, given as an illustrative example only, without falling outside the scope of protection of the invention, as it is also defined in the appended claims.

Claims

1. A variable profile wing sail system (10), comprising a wing profiled mast (12), two booms, a lower one (13) and an upper one (14), for tensioning the sails, at least a vertical central reinforcement (15), two sail cloths surfaces (36), overhanging on said mast (12) and provided with flexible bars (42) able to assume a wing profile conditioned by the rotation of said mast (12), **characterized in that** said mast (12), said two booms (13) and (14) and said vertical central reinforcement (15) are provided in a single bearing structure (11).

2. The variable profile wing sail system (10) according to claim 1, **characterized in that** said mast (12) has a substantially conical section whose base, or rear portion, has a substantially semicircular notch in which a cylindrical shaft (51) slides and partially rotates within said mast (12), and it is connected thereto by means of sliding bushes.

3. The variable profile wing sail system (10) according to claim 1, **characterized in that** said bars (42) of the two sail cloths surfaces (36) are coupled at the trailing profile by means of sliding blocks (52), in which the two bars (42) of the same pair horizontally slide in an independent way, thus following the elastic deformation imposed to the bars (42) by the rotation of said cylindrical shaft (51).

4. The variable profile wing sail system (10) according to claims 1 and 3, **characterized in that** said sliding blocks (52) comprise projections (80) able to be partially housed in horizontal slots (40, 44) of the cloths (36) and the bars (42) respectively.

5. The variable profile wing sail system (10) according to the preceding claims, **characterized in that** said bars (42) are pivoted on sliding shoes (48, 48') sliding in guides (50) of said cylindrical shaft (51).

6. The variable profile wing sail system (10) according to the preceding claims, **characterized in that** the cloths (36) have more panels joined by removable connecting means to reef the sail of one or more bands.

7. The variable profile wing sail system (10) according to claim 6, **characterized by** comprising locks (68) in the sliding shoes (48') disposed at the removable connecting means (46) of the cloths (36) reef bands.

8. The variable profile wing sail system (10) according to claims 1 and 2, **characterized by** comprising an anti-inclination topsail (94), fixed to a proper rotating shaft (95) connected to said cylindrical shaft (51) at the bottom and to the upper boom (14) at the top.

9. The variable profile wing sail system (10) according to claim 8, **characterized in that** said anti-inclination topsail (94) has a variable wing profile similar to that of the main sail.

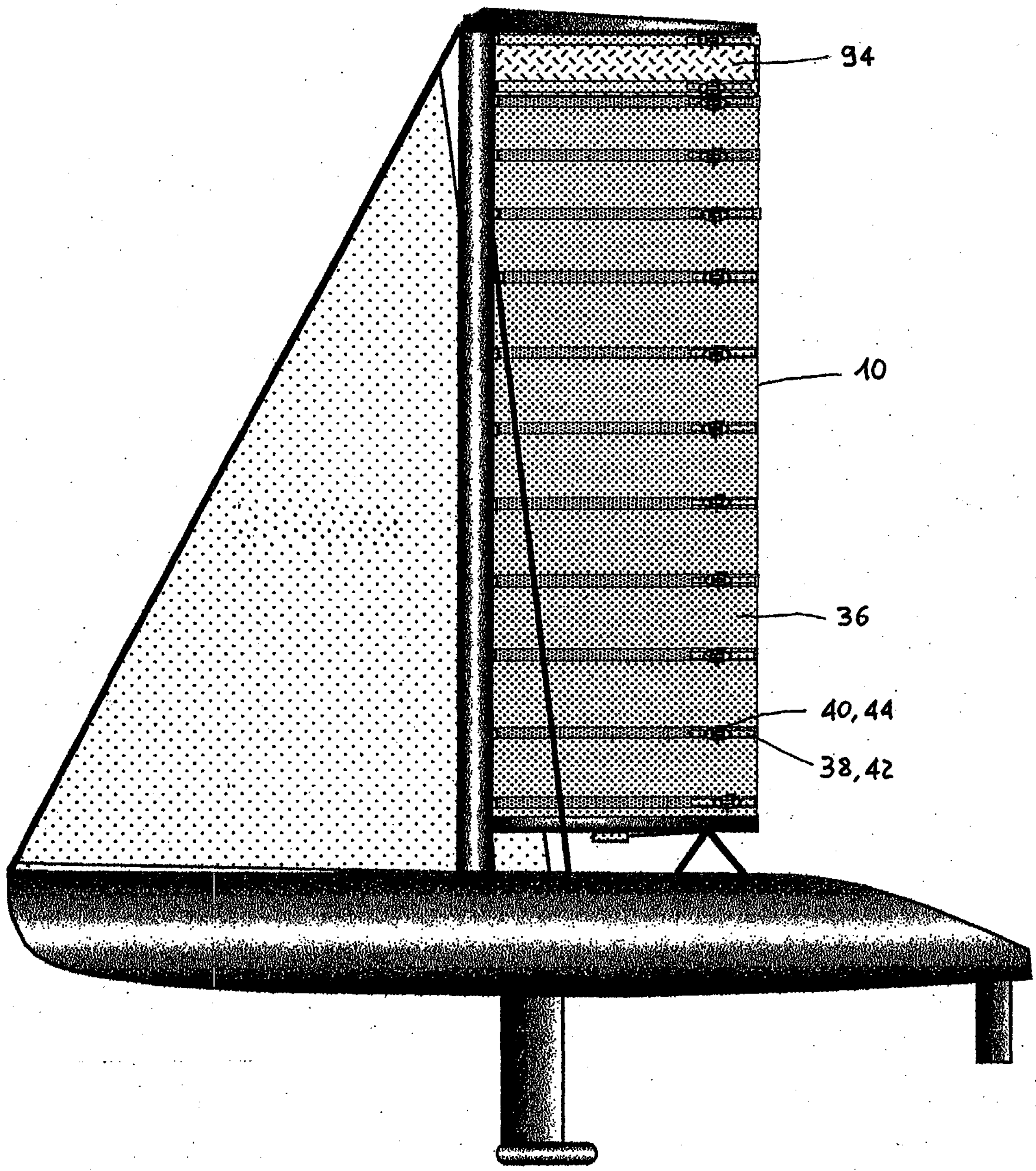


Fig. 1

Fig. 2A

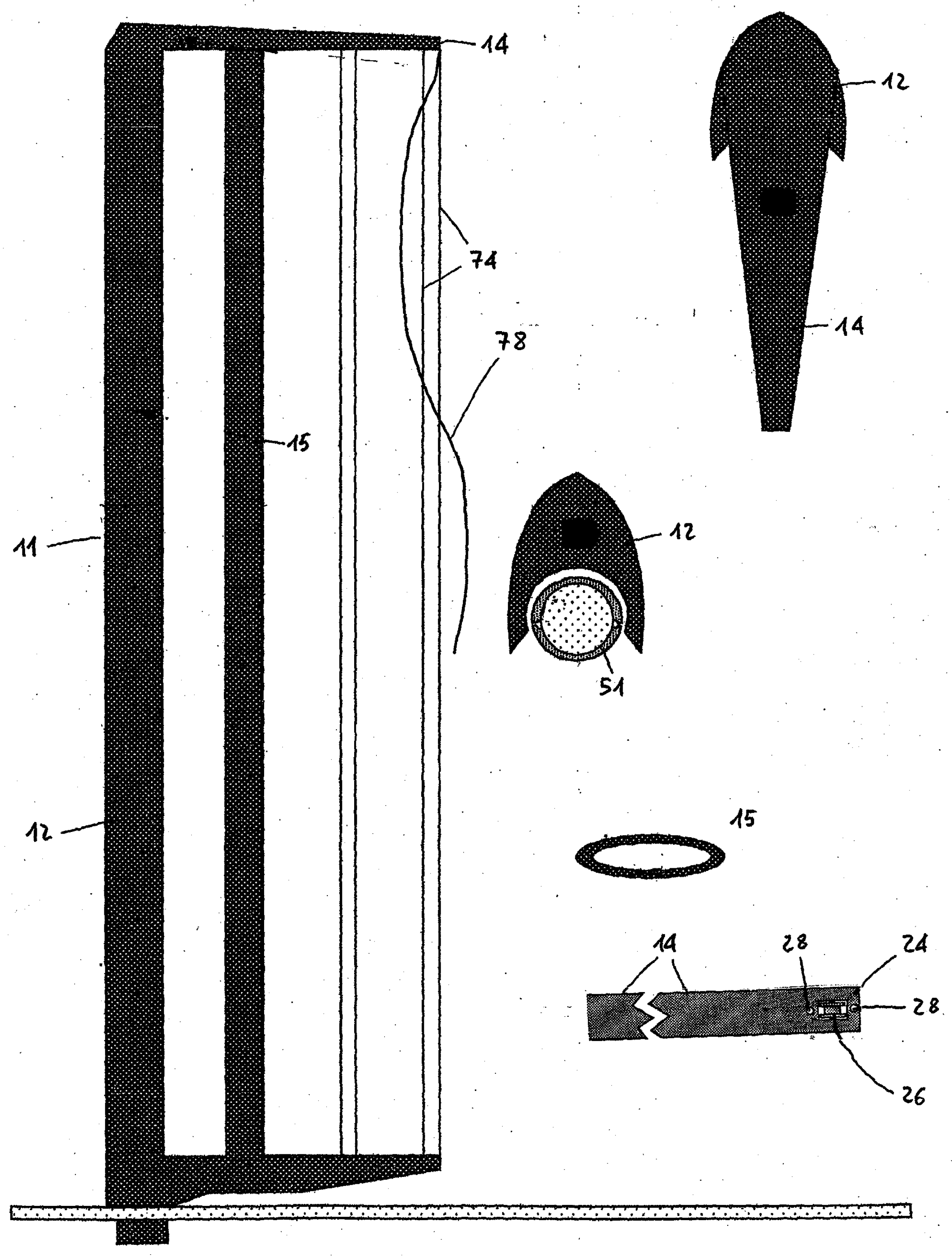
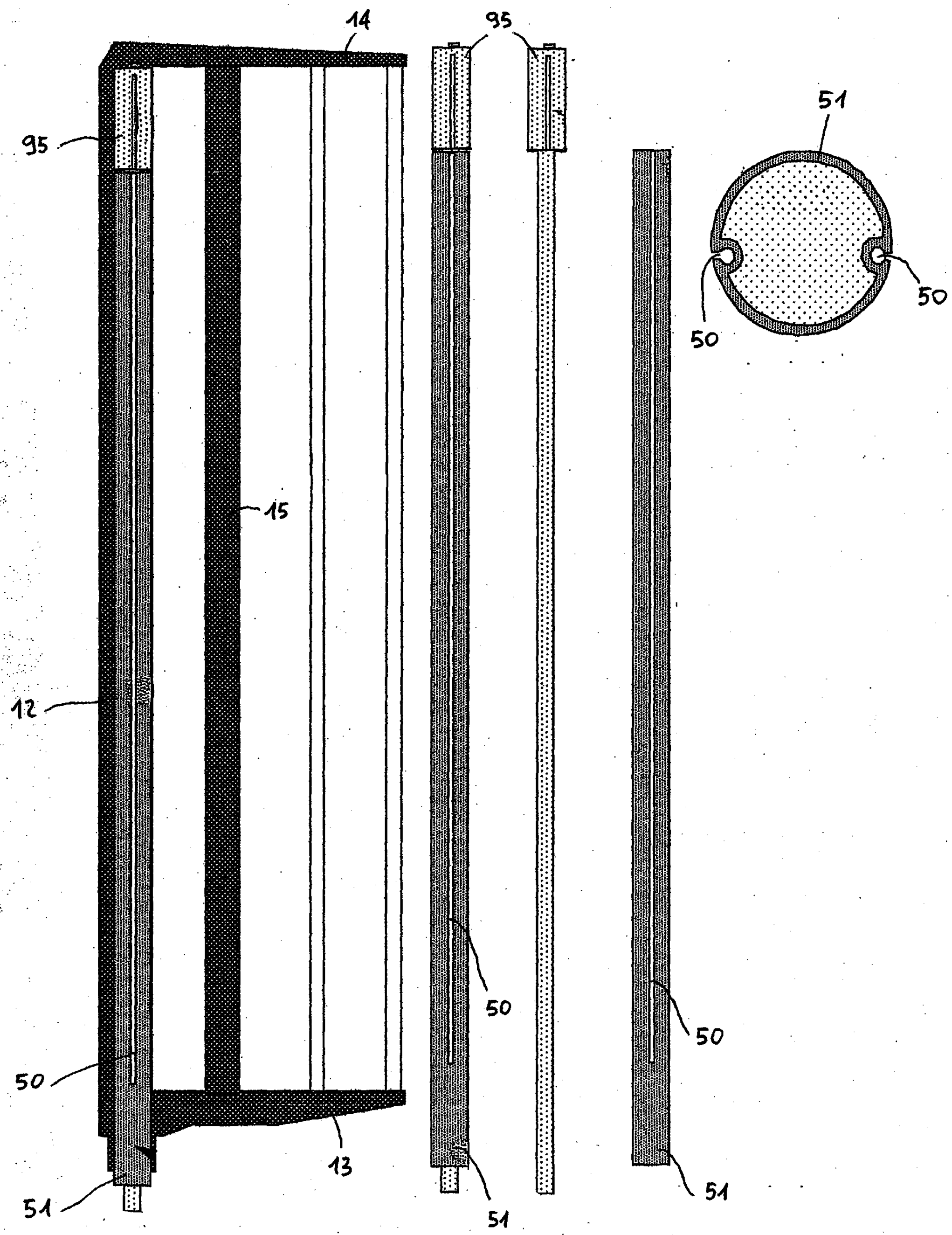


Fig. 2B



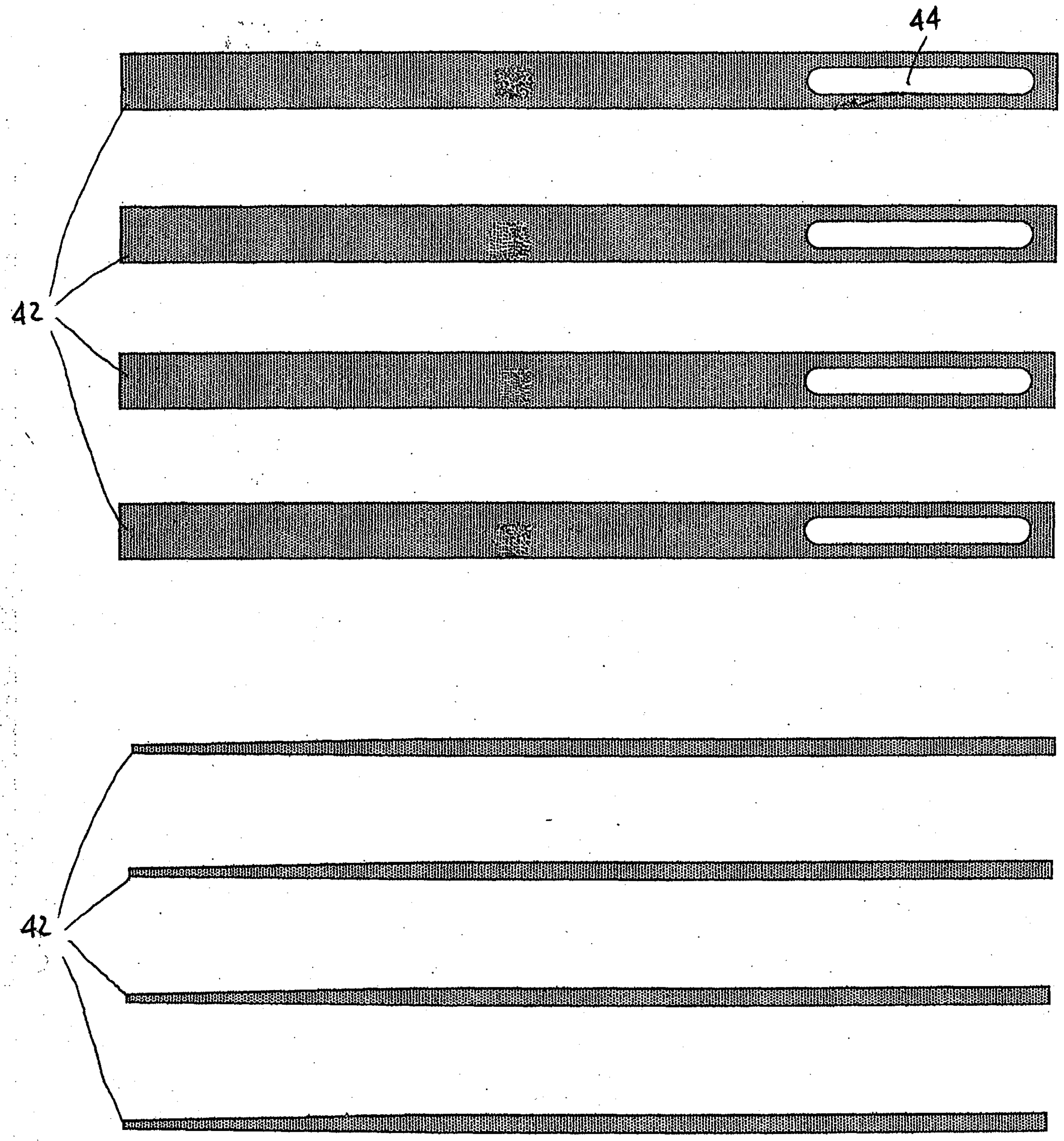
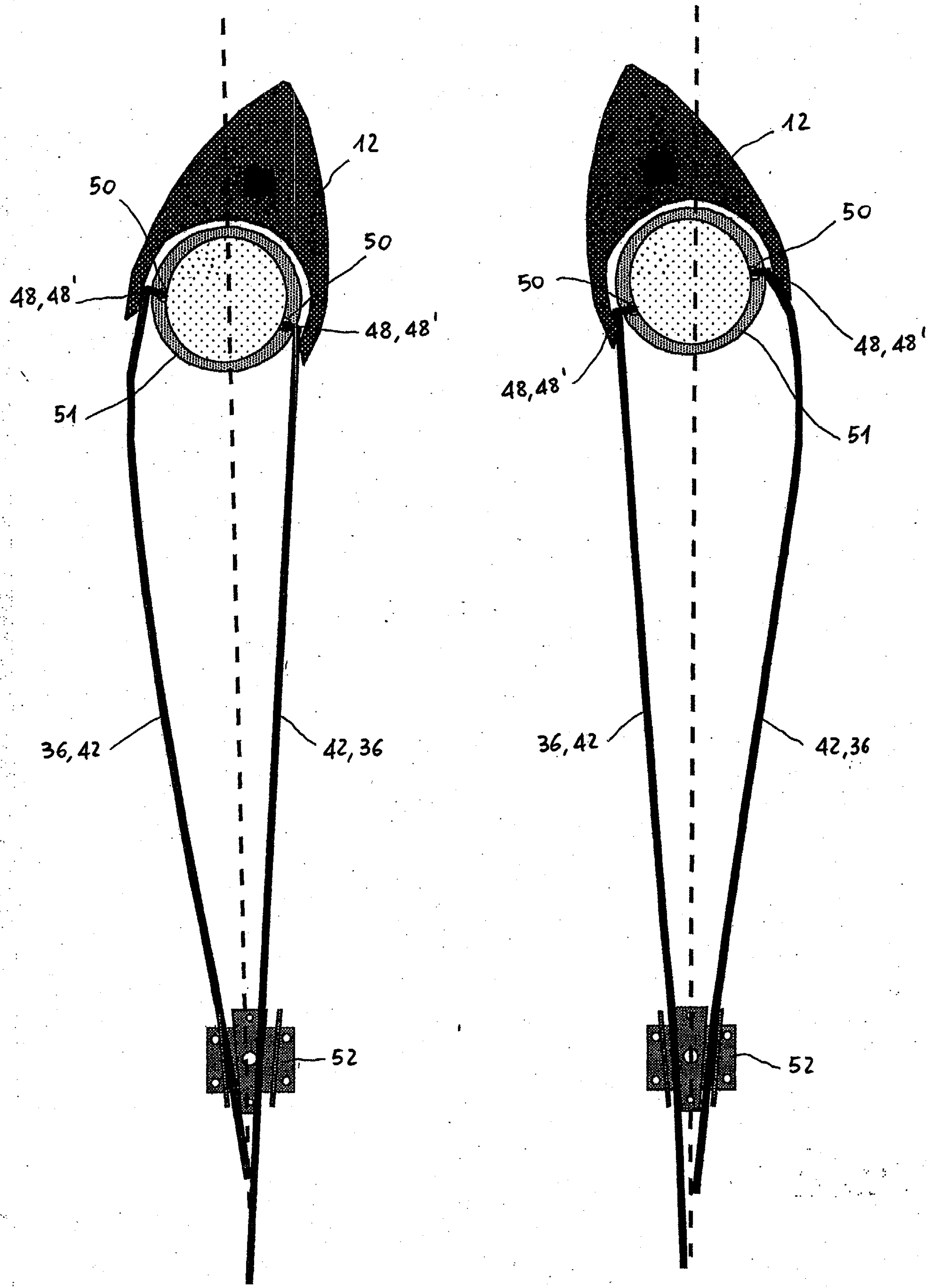


Fig. 3

Fig. 4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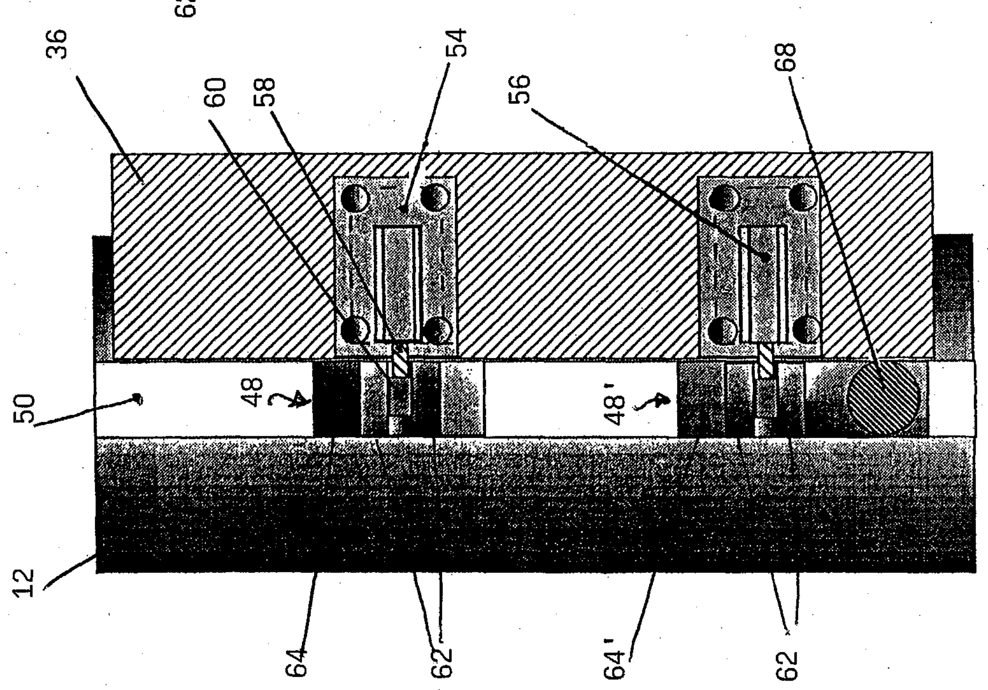

Fig. 5A

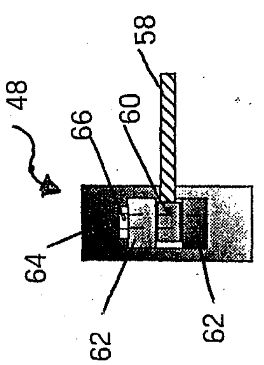

Fig. 5B

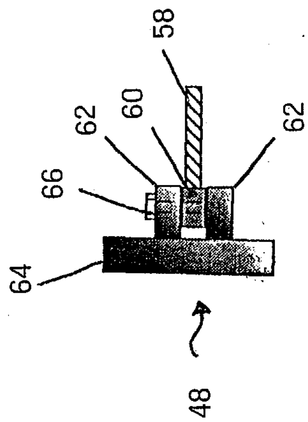

Fig. 5C

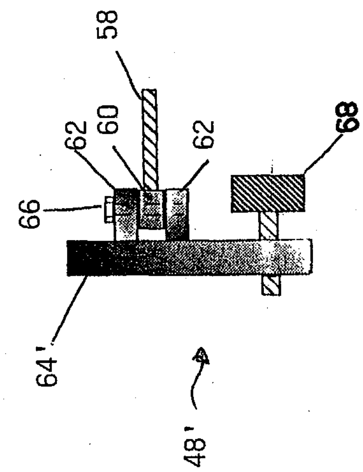

Fig. 5D

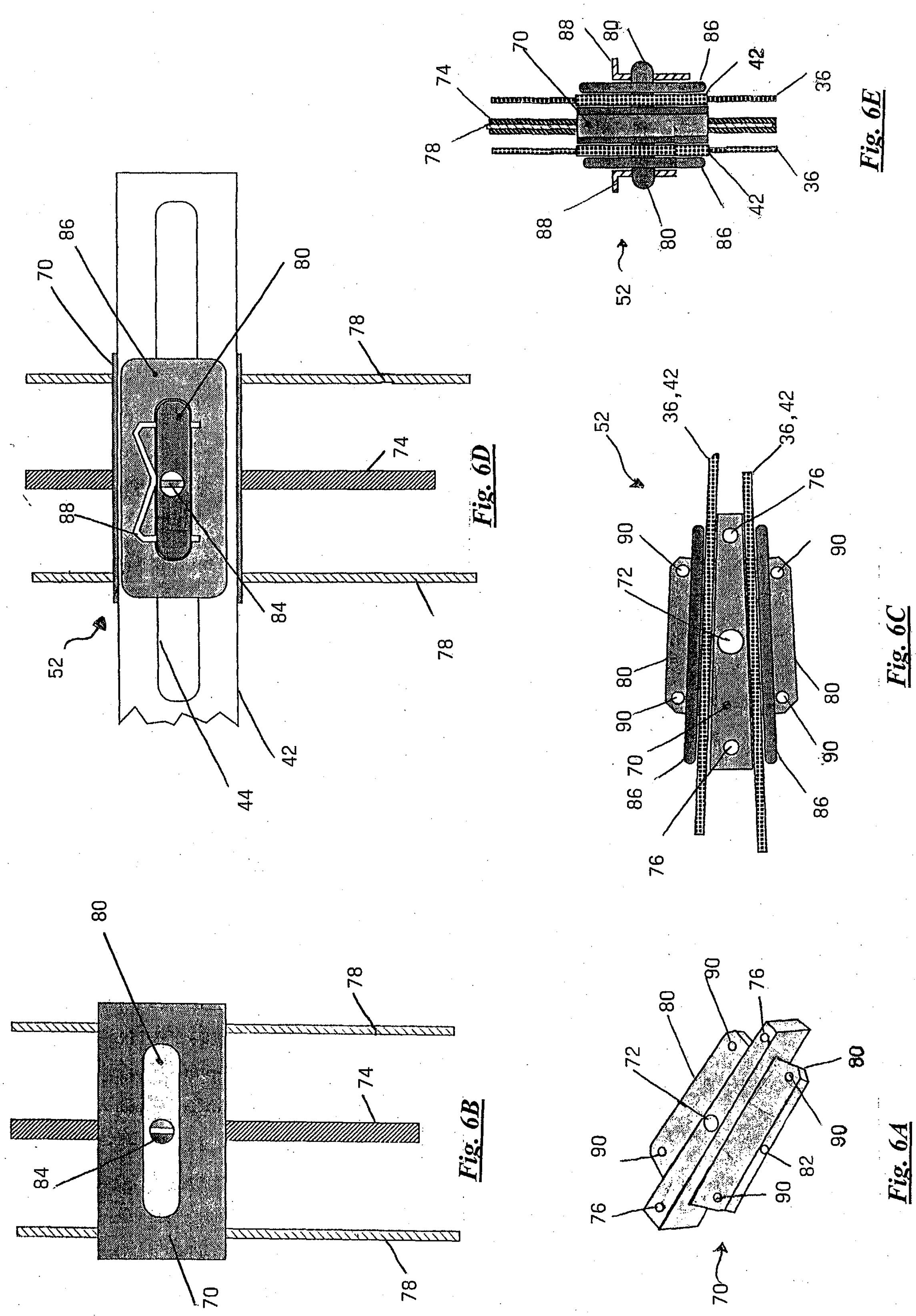

Fig. 6A

Fig. 6B

Fig. 6C

Fig. 6D

Fig. 6E

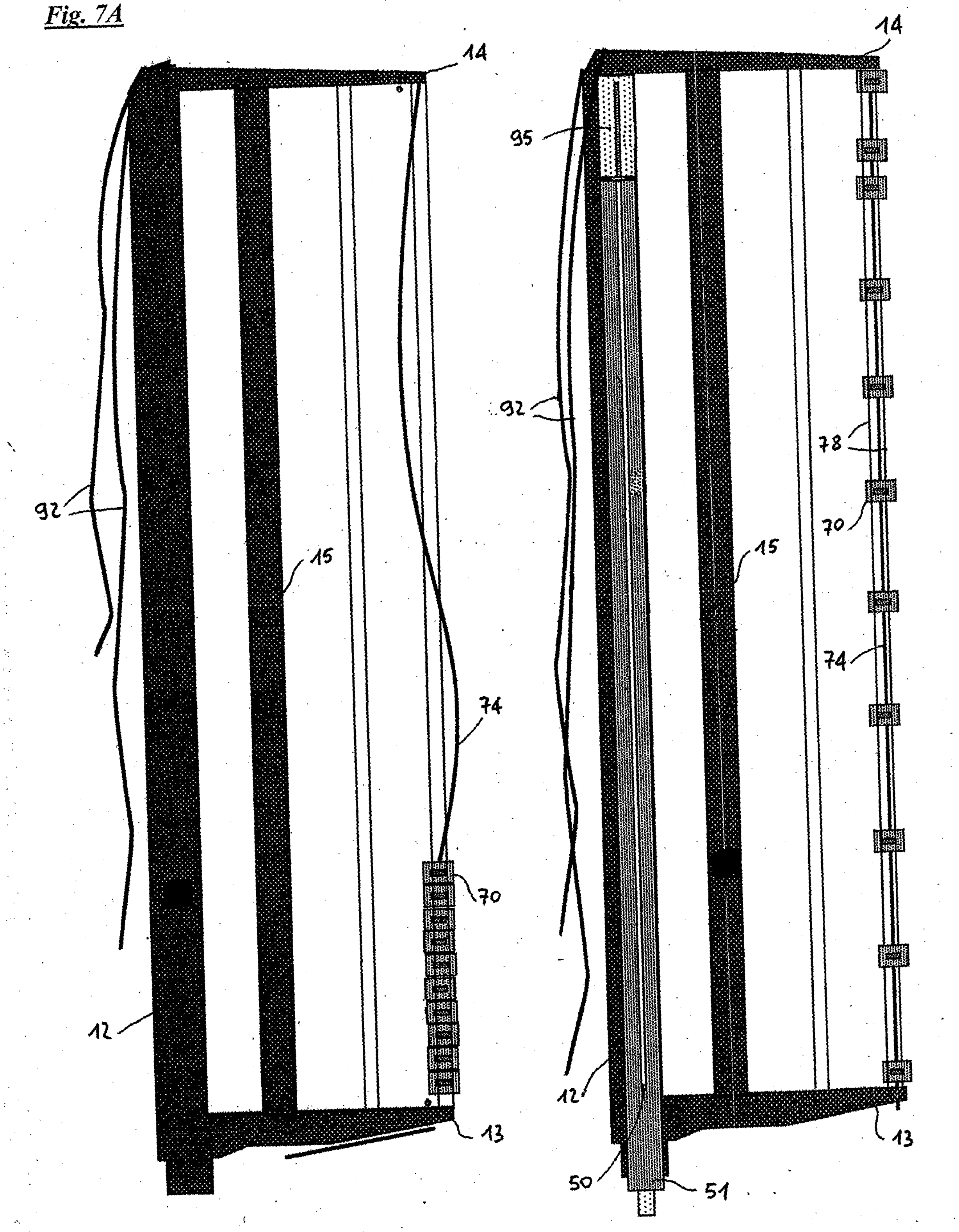
Fig. 7A
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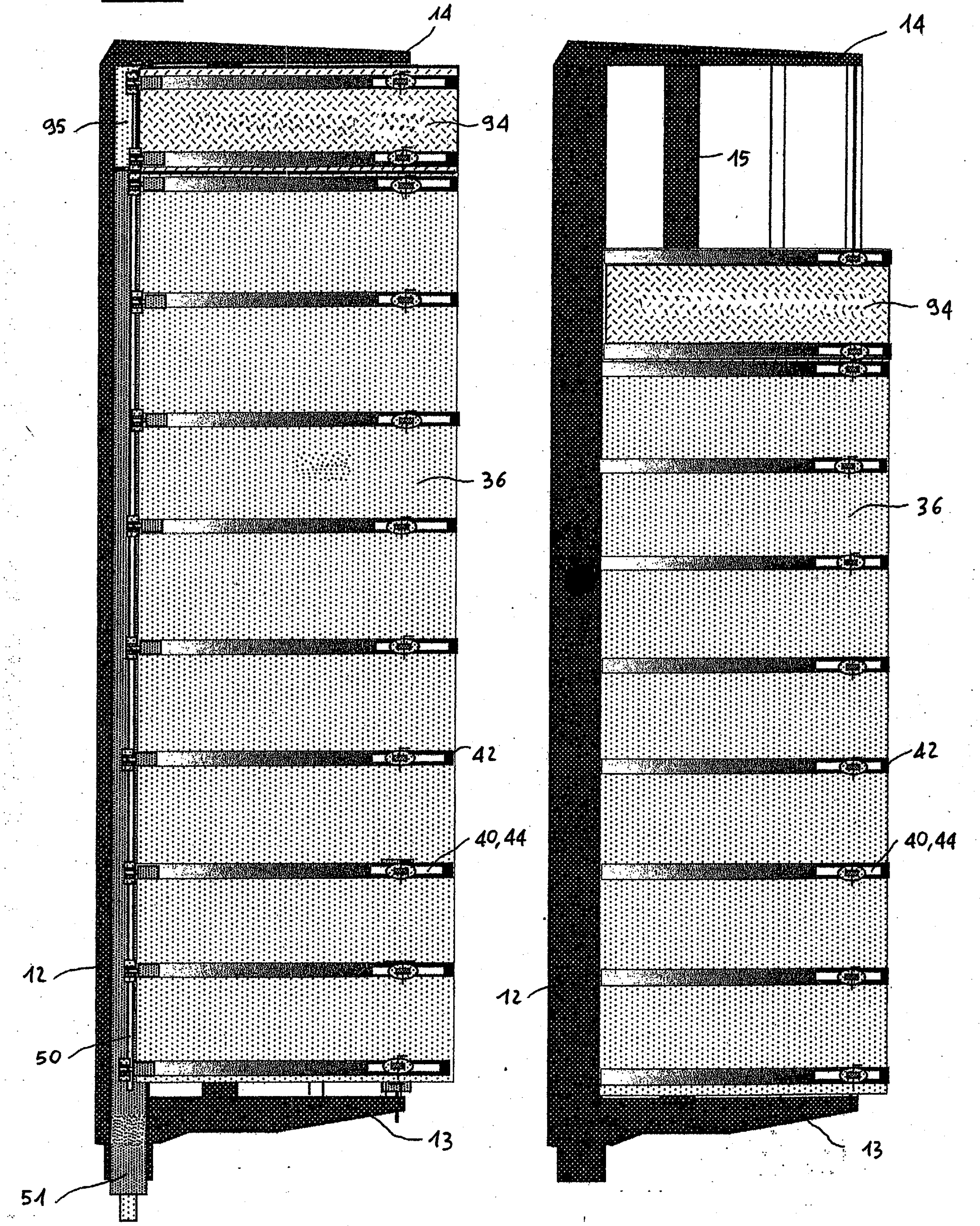
Fig. 7B



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EUROPEAN SEARCH REPORT

Application Number
EP 04 07 7693

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	US 4 703 707 A (ANDERSON THOMAS R) 3 November 1987 (1987-11-03) * the whole document *	1 6	B63H9/06 B63B15/00
Y	US 4 388 888 A (GUSHURST JR FRED W) 21 June 1983 (1983-06-21) * column 5, line 58 - line 65; figures 1-8 *	6	
A	US 4 437 426 A (LATHAM RONALD D) 20 March 1984 (1984-03-20) * the whole document *	2	
A	DE 43 06 255 A (HATLAPA ROLF) 20 October 1994 (1994-10-20) * figures 1-7 *	6	
A	US 3 580 203 A (MARTIN BENJAMIN P) 25 May 1971 (1971-05-25) * figures 1-3 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B63H B63B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	11 January 2005	DE SENA HERNANDORENA

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