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

(11) EP 0 933 152 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.08.1999 Bulletin 1999/31

(51) Int. Cl.^{6}: **B22D 11/06**

(21) Application number: **98204472.9**

(22) Date of filing: **29.12.1998**

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

(30) Priority: **15.01.1998 IT MI980056**

(71) Applicant:
**TECHINT COMPAGNIA TECNICA INTERNAZIONALE S.p.A.
20121 Milano (IT)**

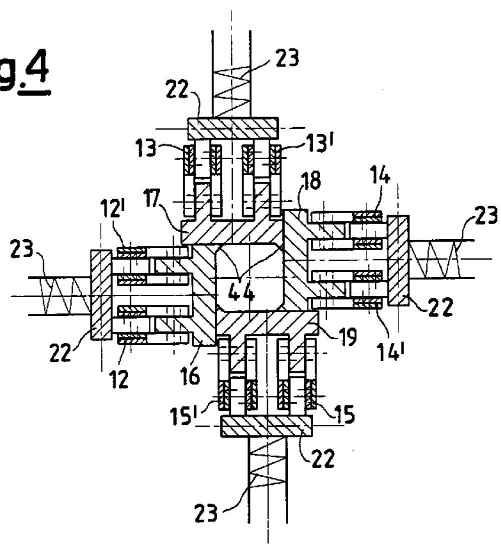
(72) Inventor: **Augusti, Alberto
20095 Cusano Milanino, Milan (IT)**

(74) Representative:
**Martegani, Franco et al
Franco Martegani S.r.l.
Via Carlo Alberto, 41
20052 Monza (Milano) (IT)**

(54) A variable section mobile ingot mold for a continuous casting plant

(57) A variable section mobile ingot mold for a continuous casting plant comprises die molds which can engage along at least one rectilinear portion, and comprises four pulling elements (12, 12', 13, 13', 14, 14' and 15, 15'), that support a plurality of wall die elements (16-19), which are assembled in the shape of a closed ring and are positioned so as to face each other and to be in contact side by side in order to form a variable section continuous cavity that forms a continuous die which moves forward with the cast molten and liquid metal. Said four pulling elements and said respective wall die elements are supported by an upper structure (32) of said ingot mold that allows said four pulling elements and the relevant die elements to get closer to each other along a first axis (X) as well as a linear misalignment along a second axis (Y), perpendicular to the first axis (X), that allows said movement towards each other.

Fig.4



Printed by Xerox (UK) Business Services
2.16.7/3.6

Description

[0001] The present invention is relevant to a variable section mobile ingot mold for a continuous casting plant. In the continuous casting process for the production of billets and ingots it is known that stationary die elements or chill elements, with correct geometric shapes, have been used, steel from the ladle and the tundish is poured into said dies.

[0002] Slight oscillations are present in the direction of the material flow in order to avoid the steel to stick to the walls of the ingot mold.

[0003] In these plants with a fixed ingot mold there are low output speeds. Furthermore, the smallest castable section cannot drop under certain minimum limits so as to guarantee a correct centring of the incoming metal liquid casting without going near the walls of the ingot mold. Apart from these types of stationary plants, mobile ingot mold plants are also used.

[0004] In these mobile plants, the die elements or chill elements slide together at the same speed of the cast material which is in the solidification phase. In such a way any movement between the ingot mold and the material surface is eliminated.

[0005] In this case the forward movement can be realised through a chain that pulls copper blocks with various internal shapes.

[0006] During the pulling and the forward movement of the copper blocks, the material, as it cools, solidifies and shrinks. A solidification with shrinkages is deleterious when it determines a gap between the metal and the ingot mold that notably decreases the thermal exchange.

[0007] Instead, the thermal exchange must always be maximised since, in a minimum amount of time and for a limited section, the solid outer layer of the metal containment has to be formed wherein the core of the section is still at the liquid state.

[0008] In order to overcome said technical problem, plants have been set with ingot molds characterised by die elements or chill elements formed by two halves that have the possibility of moving closer to each other during the forward movement.

[0009] Also this solution has a significant disadvantage since the two halves, by moving closer, determine a different final geometrical configuration.

[0010] The general purpose of the present invention is to solve the technical problems listed above relating to the known art in an extremely simple, economical and particularly functional way, overcoming all the previously cited and disclosed disadvantages.

[0011] Another purpose is to reduce to a minimum the problems related to the thermal exchange between the concerned parts in contact with each other during the continuous casting phase in a continuous casting plant with a mobile ingot mold.

[0012] In view of the above purposes, in accordance with the present invention, a variable section mobile ingot mold for a continuous casting plant has been realised, with its detailed characteristics shown hereinafter in the attached claims.

[0013] The structural and functional characteristics of the present invention and its advantages compared to the known art will be clearer and more evident from the following description, with reference to the attached drawings, that show examples of ingot mold embodiments in accordance with the present invention. In the drawings:

- Figure 1 is a side view of two structures of a variable section mobile ingot mold in accordance with the invention, of a chain type vertical continuous casting plant;
- Figure 2 is a schematic top perspective view of the variable section mobile ingot mold in accordance with the invention, with a head frame element partially exploded;
- Figure 3 is an enlarged cross-section that shows the inner portion of the ingot mold in a working phase,
- Figures 4 and 5 are small scale cross-sections, one corresponding to the upper part and the other corresponding to the lower part of a second embodiment of a ingot mold, in accordance with the invention, in a working phase.

[0014] Figure 1 shows a variable section mobile ingot mold, in accordance with the invention, which is set in vertical type continuous casting plant.

[0015] The molten metal outlet pipe 10 is shown in the figure, for example from a tundish, not shown, wherein said pipe feeds a variable section mobile ingot mold, indicated hereinafter by 11, wherein die elements are provided which can engage with each other at least along a rectilinear portion.

[0016] The ingot mold 11 comprises four pulling elements, properly driven, assembled in a swirl or closed ring shape, each of these pulling elements has, in the example, the chain couples 12, 12', 13, 13', 14, 14' and 15, 15', as shown in figures 3-5.

[0017] The four opposed chain couples rotate in opposite directions and, at any rate, each chain couples 12, 12', 13, 13', 14, 14' and 15, 15' carries a plurality of wall elements or copper sectors 16, 17, 18 and 19 that make up a die or a chill, since they are opposite, adjacent and in contact along the sides to form, for instance, a quadrilateral.

[0018] The wall elements or sectors 16-19 made of copper, or of an equivalent material with a high heat transmission factor, positioned as previously described, i.e. opposite to each other and in contact along the sides, in order to prevent the leakage of the material while still in a liquid state, form a quadrilateral continuous cavity that realises a continuous die which moves forward with the molten metal and the casting liquid poured therein.

[0019] In the general structure of the ingot mold 11 it is noted that chains 12, 12', 13, 13', 14, 14' and 15, 15' wind on the geared wheels 20 and 21 are positioned at the ends of an elongated ring configuration.

[0020] In this way, the chain couples carrying the copper sectors 16-19, set to wind on the respective geared wheels 20 and 21, besides determining the forward movement of the chains and of the copper sectors, locate a rectilinear portion of the ingot mold. In this rectilinear portion the four adjacent and opposite sectors 16-19 are engaged to form a continuous quadrilateral cavity.

[0021] In this area, support plates 22 are provided, said plates are positioned behind the chain couples and serve as a containment frame. These support plates 22 are correctly inclined and are kept in position by elastic elements 23 so as to fit perfectly to the chains that slide while supporting the copper sectors 16-19.

[0022] Then, a pressure is exerted on the already solidified material external skin, said pressure causes an overall section reduction.

[0023] Furthermore, elements suitable to supply cooling water are provided, said element are indicated by 24, the water hits the inclined support plate 22 and the pulling chains 12, 12', 13, 13', 14, 14' and 15, 15' and the copper sectors 16-19. Cooling by water sprayed on a surface of the copper sectors 16-19 is carried out both in the casting phase and along the return section of the chains with the disengaged copper sectors.

[0024] Furthermore, in accordance with the invention, it has to be noted how the chain couples with the corresponding copper sectors are supported on the upper part by structures that can move in two perpendicular directions, allowing the structures to get closer to each other.

[0025] In fact, shafts 25 and 26 of the geared wheels 20 and 21 are provided, said shafts are pivoted, free to rotate, on a couple of elongated plates 27 and positioned on opposite sides of the geared wheels 20 and 21, said shafts connect said geared wheels and keep them at a fixed predetermined distance.

[0026] The upper support shaft 25 of the upper geared wheel 20 extends towards the outside in such a way as to insert itself in the holes 28 of a fork element 29 that encloses the plates 27 and the upper geared wheel 20.

[0027] In this way, there is an oscillation of the chains 12, 12', 13, 13', 14, 14' and 15, 15' and of the corresponding copper sectors 16-19 around said upper shaft 25 with respect to the fork 29.

[0028] This fork element 29 is provided in its central upper portion with an appendix 30 with an attachment hole 31, obtained in a perpendicular direction to that of the previously mentioned upper shaft 25.

[0029] The ingot mold, in accordance to the invention, provides a head frame element 32, with quadrilateral shape and support, to which four similar fork elements are attached and each element supports one of the couples of chains 12, 12', 13, 13', 14, 14' and 15, 15' with their corresponding copper sectors 16-19.

[0030] In particular, the drilled appendix 30 of each fork 29 can be inserted in a 'U-shaped' support 33, directed downward, and provided with holes 34 on the walls of the U-shaped support. A pivot (not shown) is inserted into these holes 31 and 34 of both the appendix 30 and the U-shaped support 33, said pivot allows the oscillation of the single fork elements 29 with respect to the head frame element 32.

[0031] Figure 2 shows this head element 32 exploded and without connecting pivots to the appendixes of the four underlying fork elements 29 that carry the chains and the copper sectors.

[0032] This upper structure of the ingot mold allows the four chain couples and the corresponding copper sectors to realise a movement towards each other according to a first axis X, as well as a linear misalignment along a second axis Y, perpendicular to the first axis X, that allows such a movement.

[0033] Figure 3 shows the cross section of the configuration of a variable section ingot mold for a continuous casting plant wherein the copper sectors 16-19 are shown, and said sectors are engaged, by using pivots 40, to the intermediate supports 41 that are engaged, by using pivots 42, to chains 12, 12', 13, 13', 14, 14' and 15, 15'. The rollers 43, being part of the chain, slide and rotate directly on the corresponding support plate 22, which is placed behind the chain couple, when given the function of containment frame. The elastic elements 23, placed behind the inclined support plates 22, are also shown, said elements allow an adjustment of the chains 12, 12', 13, 13', 14, 14' and 15, 15', maintaining them in a correct working position to exert pressure.

[0034] In this example, the copper sections are perfectly flat. Figures 4 and 5 show a different embodiment of the copper sectors and their actions in two different sections of the ingot mold.

[0035] In this case, the copper sectors 16-19 present, at one of their ends, a wedge-shaped protrusion 44 that, engaging with equivalent shaped sectors, determines a blunt edge section configuration, of the pseudo octagonal type or an octagon with unequal sides.

[0036] Figure 4 is obtained at the upper portion of the ingot mold, where the metal is still in a liquid state and has still a significant overall dimension in the casting cavity.

[0037] Figure 5 is obtained at the lower portion of the ingot mold, in accordance with the invention, wherein the metal has at last a good solidified skin.

[0038] Both positions are similar to the one schematised in figure 1 and they show that the section of the metal in figure 5 is smaller than the section previously shown in figure 4, because of the presence of the particular type of couple chains support with the corresponding copper sectors. In fact, providing the upper support structures that can move in two perpendicular directions, allows the movement towards each other of the opposite and of the adjacent sectors.

[0039] Further, in this case, the blunt edge configuration section, of the pseudo octagonal type, significantly reduces the problems related to the sharp edges, as previously shown in the example with flat copper sectors. This is how a continuous variable section cavity is realised, which is defined inside the four opposite, adjacent and joined sectors, into which the metal is cast directly from the tundish.

[0040] The constant reduction of the cross-section of the metal that moves forward between the copper sectors during the solidification phase determines some sort of rolling of the skin with the core still being in a liquid state. In fact, the skin is subjected to the action of the copper sectors that move closer to each other to decrease the quadrilateral section, by moving in relation to the skin with a limited mutual sliding between the contact surfaces. Therefore, the section of the metal coming out from the ingot mold has smaller dimensions than the dimensions of the entrance section.

[0041] In the rectilinear portion of the ingot mold, the presence of the rollers, placed so as to interact on the support plate surfaces, positioned behind the chain couples and serving as a containment frame, realise a further rear guide, in collaboration with the other elastic elements which adjust the thrust.

[0042] It is natural and evident that there can be different dispositions and shapes of the sectors and of the chains, as well as of the related elements, without thereby departing from the principles of novelty of the inventive idea.

[0043] This is how the purpose mentioned at the beginning of the description is attained.

[0044] Naturally, the embodiments can be different from those shown, as a non limiting example, in the drawings, the same goes for the engagement elements suitable to generate the interaction between the various elements. The invention is protected by the boundaries defined in the attached claims.

Claims

1. A mobile ingot mold for a continuous casting plant, said ingot mold comprises die molds which can engage along at least one rectilinear portion, characterised by comprising four pulling elements (12, 12', 13, 13', 14, 14' and 15, 15'), which support a plurality of wall die elements (16-19), which are assembled in the shape of a closed ring and are positioned so as to face each other and to be in contact side by side in order to form a variable section continuous cavity that forms a continuous die which moves forward with the cast molten and liquid metal, wherein said four pulling elements and said respective wall die elements are supported by an upper structure (32) of said ingot mold that allows said four pulling elements and the relevant die elements to get closer to each other along a first axis (X) as well as a linear misalignment along a second axis (Y), perpendicular to the first axis (X), that allows said movement towards each other.

2. A mobile ingot mold as claimed in claim 1, characterised in that each of said four pulling elements comprises a couple of chains (12, 12', 13, 13', 14, 14' and 15' 15'), wherein opposite chains rotate in opposite directions, each couple of chains carries said plurality of die elements (16-19) that form a continuous quadrilateral cavity, and said two chain couples (12, 12', 13, 13', 14, 14' and 15' 15') are set to wind on the geared wheels (20, 21), wherebetween said rectilinear portion is formed.

3. A mobile ingot mold as claimed in claim 2, characterised in that said die elements (16-19), carried by said chain couples to form said continuous quadrilateral cavity in said rectilinear portion, are provided with rear support plates (22) and elements suitable to supply cooling water (24), elastic thrust elements are engaged (23) to said support plates (22), for reducing the section.

4. A mobile ingot mold as claimed in claim 3, characterised in that said support plates (22) can be inclined together with said upper structure (32) of said ingot mold.

5. A mobile ingot mold as claimed in claim 1, characterised in that said die elements are formed by copper sectors (16-19).

6. A mobile ingot mold as claimed in claim 1, characterised in that said die elements are made of a material with a high heat transmission factor (16-19).

7. A mobile ingot mold as claimed in claim 1, characterised in that said die elements (16-19) are flat.

8. A mobile ingot mold as claimed in claim 1, characterised in that said die elements (16-19) are flat and are provided at one of their ends with a wedge-shaped protrusion 44, in such a way that, by engaging with equivalent die elements, said protrusions form a section having blunt edges with an octagonal shape.

9. A mobile ingot mold as claimed in claim 1, characterised in that said upper structure (32) of said ingot mold comprises a head frame whereto four support fork elements (29) are attached through the pivot arrangement (25, 27, 28) of each pulling element, said fork element carries a drilled appendix (30, 31) pivoted (33, 34) to said upper structure (32).

Fig.1

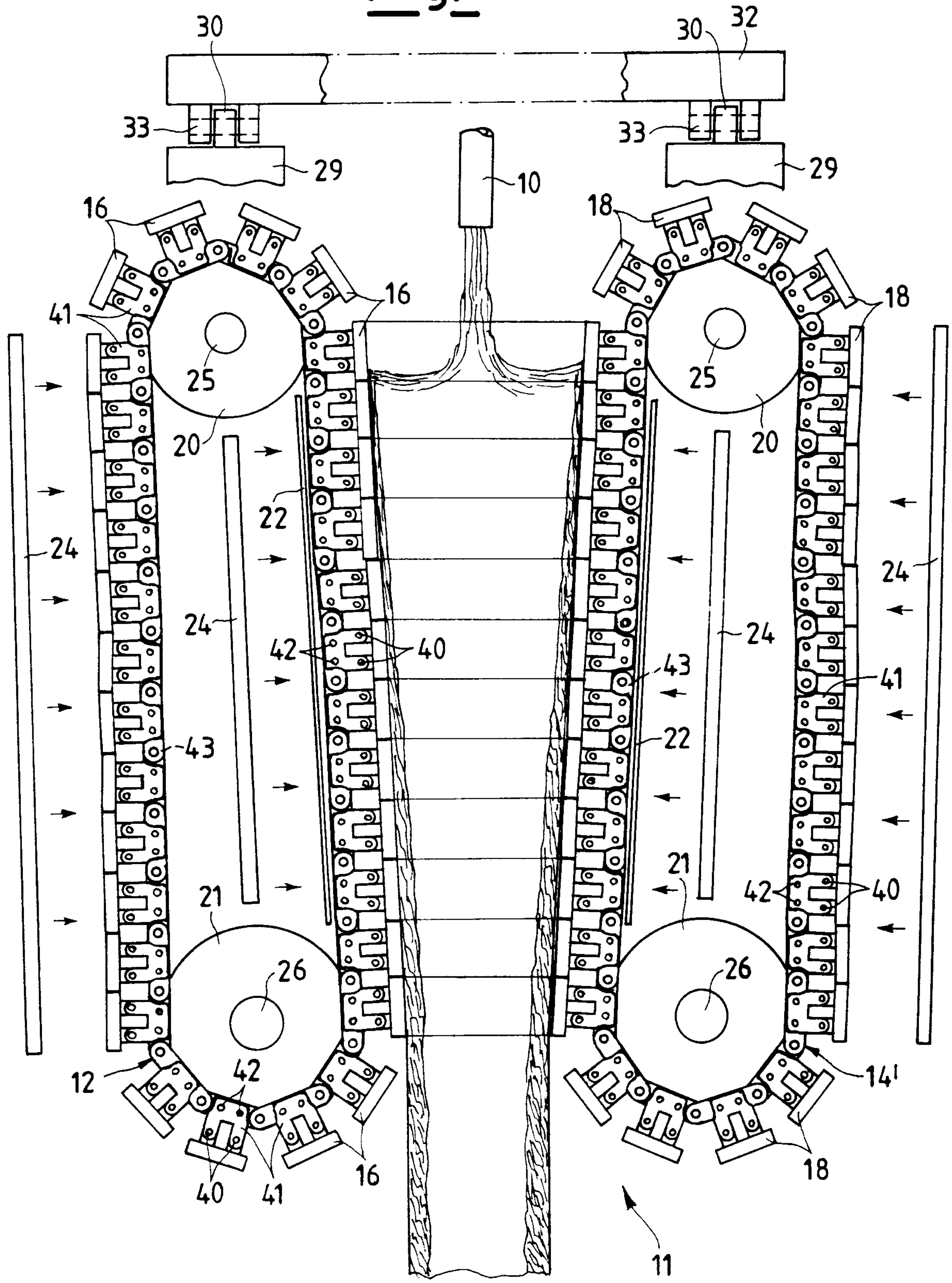

30
30
32
33
33
29
29
10
16
16
18
18
41
25
25
20
20
22
22
24
24
24
24
42
40
43
43
41
21
21
26
26
42
40
12
14'
42
40
41
16
18
11

Fig.2

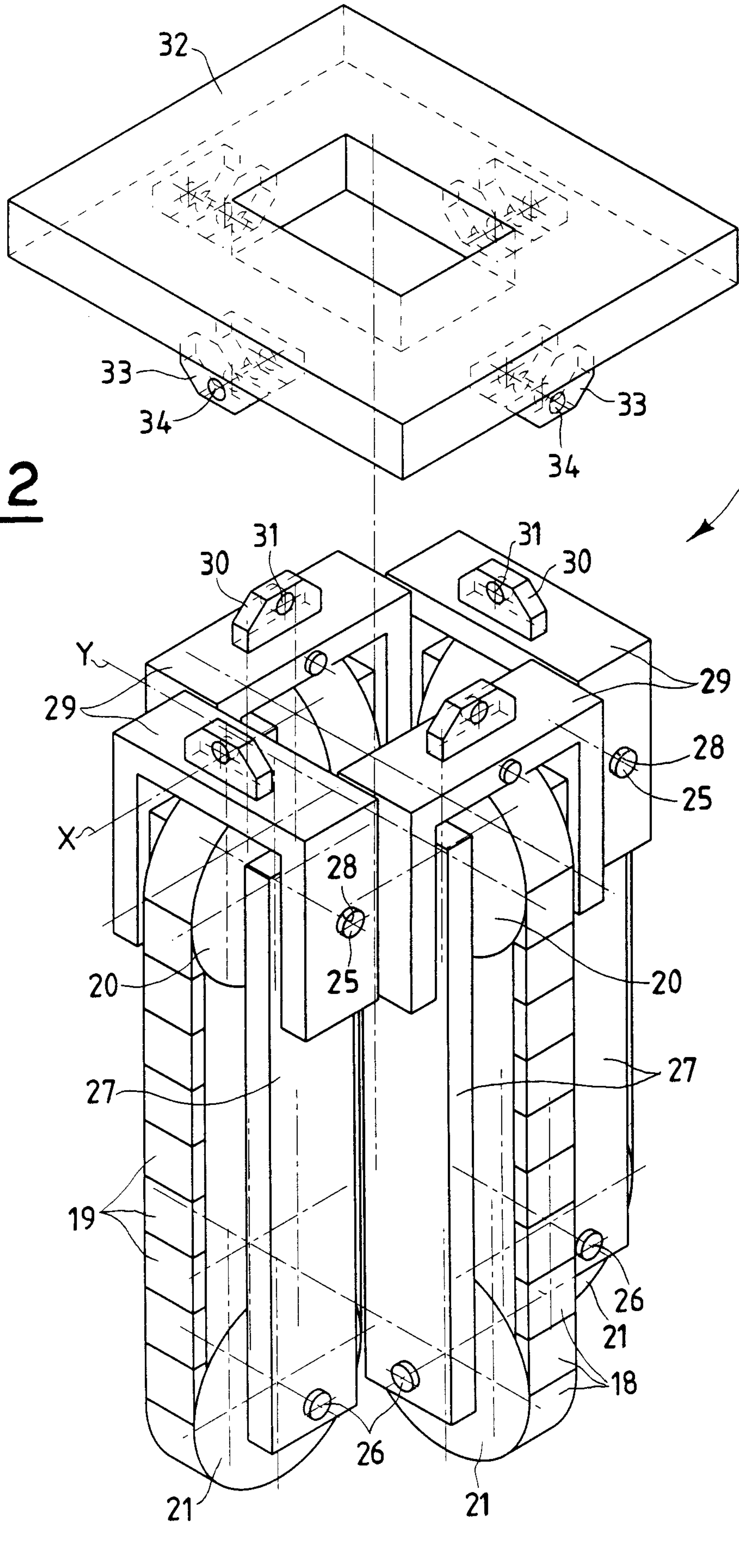

32
33
34
33
34
11
31
30
31
30
Y
29
29
28
25
X
28
25
20
20
27
27
19
26
21
18
26
21
21

Fig.3

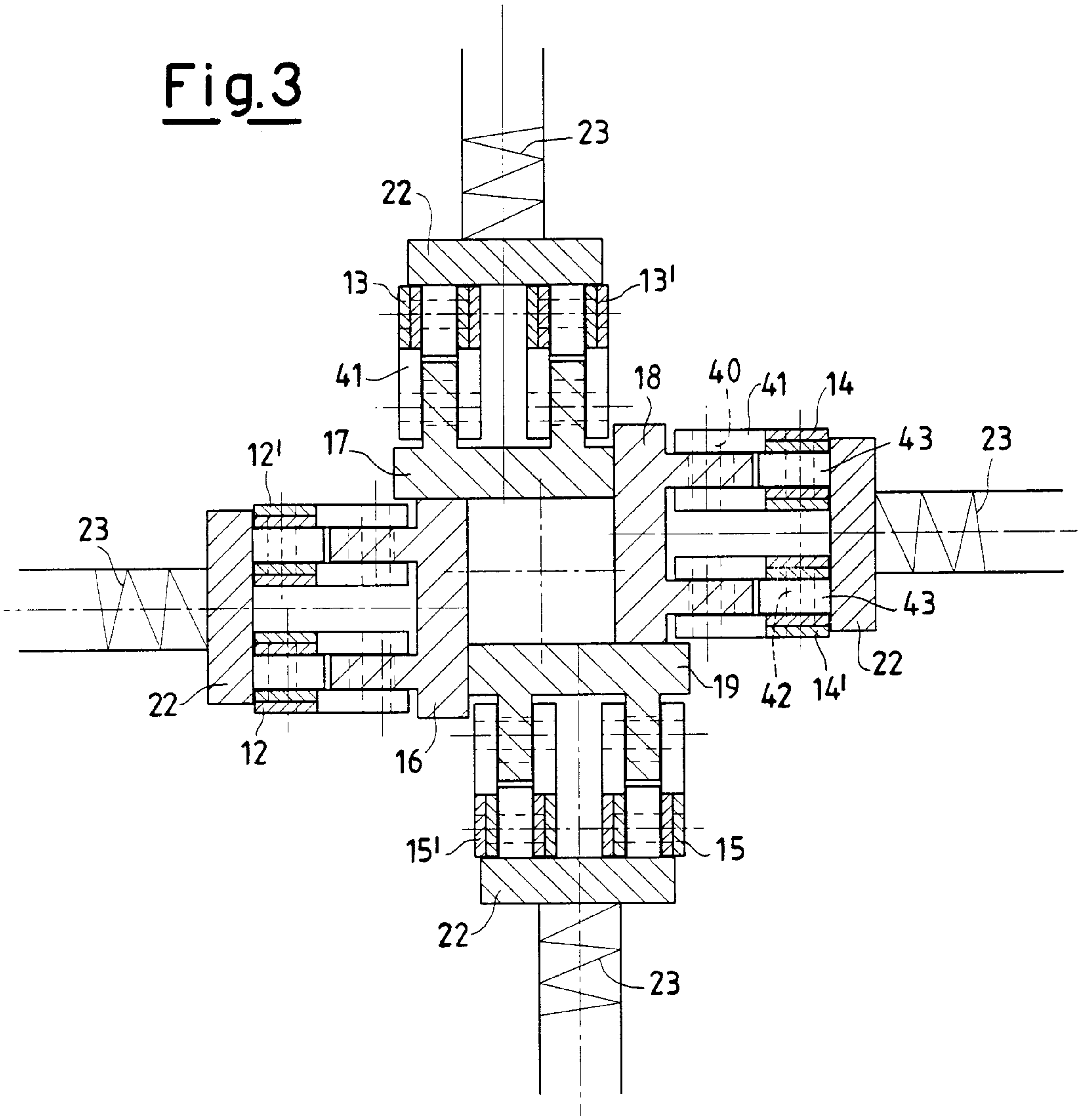

23
22
13
13'
41
18
40
41
14
17
12'
43
23
23
43
22
19
42
14'
22
12
16
15'
15
22
23

Fig.4

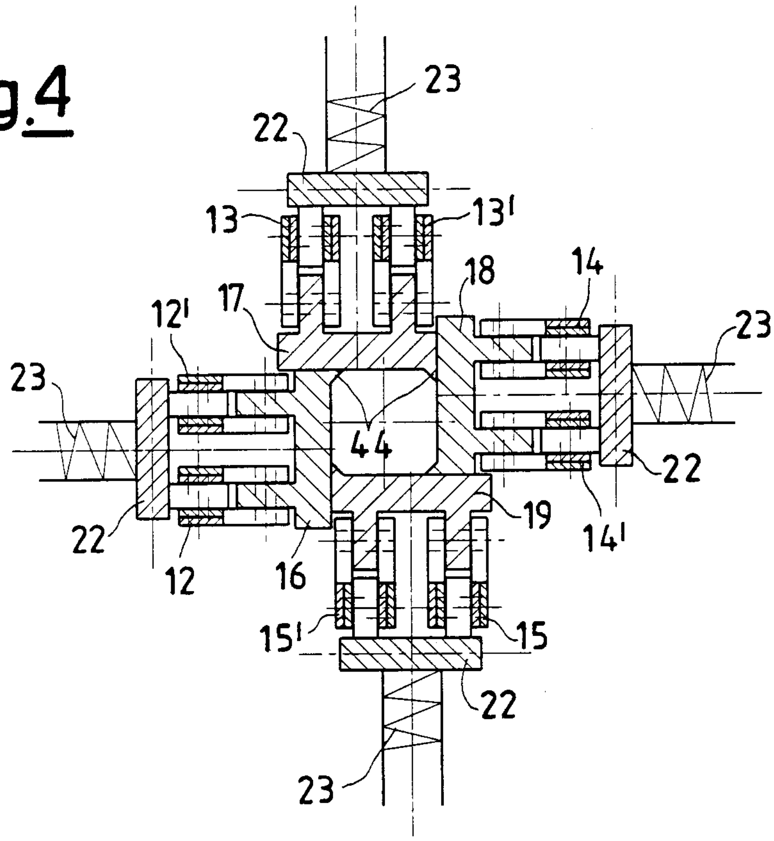
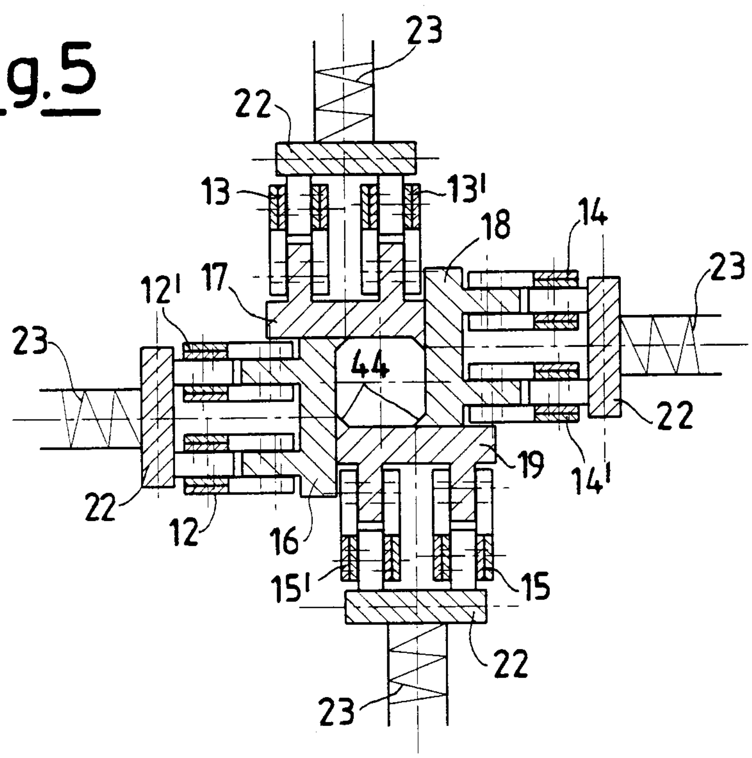

23
22
13
13'
18
14
17
12'
23
23
44
22
19
22
14'
12
16
15'
15
22
23

Fig.5


23
22
13
13'
18
14
12'
17
23
23
44
22
19
14'
22
12
16
15'
15
22
23

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 20 4472

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.6)
A	DE 39 11 283 A (BOLLIG GEORG DR., KREFELD, DE) 11 October 1990 * column 2, line 7 - line 14 * * column 2, line 40 - column 3, line 21 * * column 3, line 58 - column 4, line 14 * * claim 6 * ---	1-3,5-8	B22D11/06
A	PATENT ABSTRACTS OF JAPAN vol. 013, no. 300 (M-848), 11 July 1989 & JP 01 091942 A (NIPPON STEEL CORP;OTHERS: 01), 11 April 1989 * abstract * ---	1,2,7,8	
A	PATENT ABSTRACTS OF JAPAN vol. 013, no. 376 (M-862), 21 August 1989 & JP 01 130855 A (ISHIKAWAJIMA HARIMA HEAVY IND CO LTD;OTHERS: 01), 23 May 1989 * abstract * -----	3	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B22D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 April 1999	Peis, S

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 ON EUROPEAN PATENT APPLICATION NO. EP 98 20 4472

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08-04-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 3911283 A	11-10-1990	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82