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(54) **Size adjustable tunnel form carriage**

(57) A form carriage (1) which is placed inside a tunnel (2) with a longitudinal axis (3) of the form carriage parallel to an axis of the tunnel (2), and which has at least two structural members (14, 15) deformable in

controlled, adjustable manner in respective directions perpendicular to the longitudinal axis (3) of the form carriage (1) and forming with each other an angle of other than zero, so as to selectively adjust the dimensions of the form carriage (1) in each of the two directions.

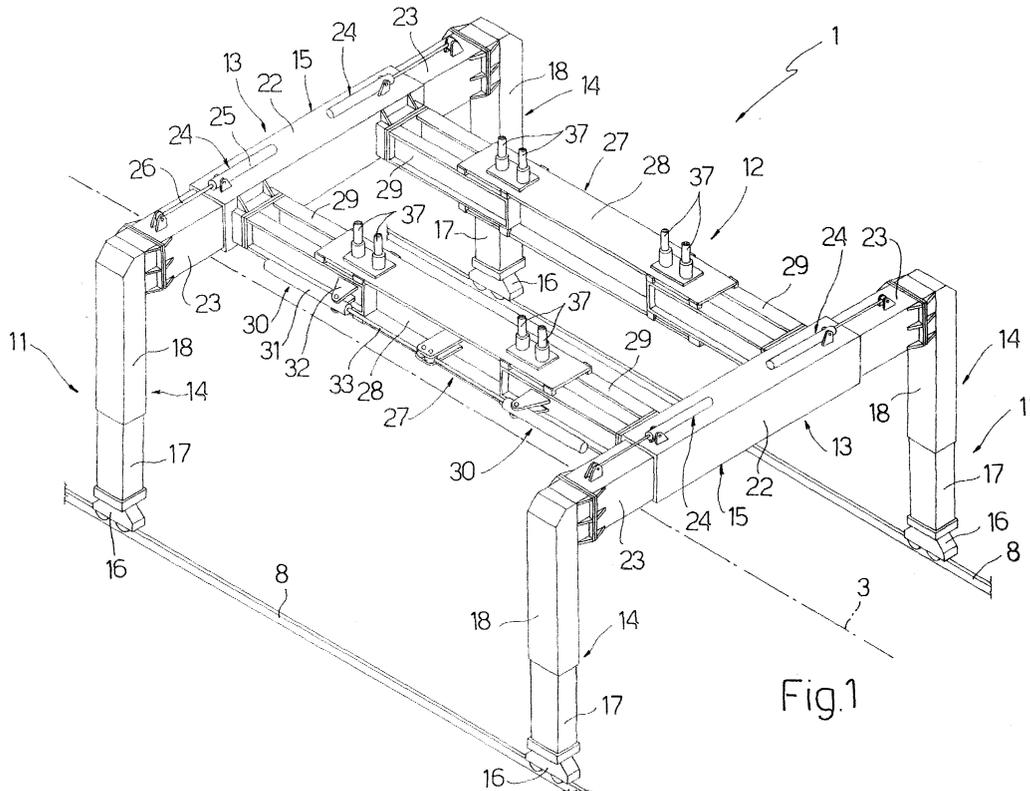


Fig.1

## Description

**[0001]** The present invention relates to a tunnel form carriage.

**[0002]** More specifically, the present invention relates to a form carriage which is placed inside a tunnel with its longitudinal axis parallel to an axis of the tunnel, and which supports a form defining, with the inner surface of a portion of the tunnel, a chamber in which to cast a concrete liner.

**[0003]** Form carriages of the above type are normally mounted on rails running along an inner reference surface, normally a temporary road surface, of a tunnel for lining, and are moved along the rails to line successive portions of the inner surface of the tunnel.

**[0004]** Form carriages, which in themselves are relatively complex, high-cost rigs, are normally designed according to the shape and size of the tunnel section for lining, and are seldom used more than once, on account of being only marginally more expensive to build than to adapt to tunnel sections of different shapes and sizes. As a result, they are normally only used once and then scrapped.

**[0005]** It is an object of the present invention to provide a form carriage designed to eliminate the aforementioned drawback.

**[0006]** More specifically, it is an object of the present invention to provide a reusable form carriage, which can be adapted quickly and cheaply to a wide range of tunnels of different section shapes and sizes.

**[0007]** According to the present invention, there is provided a tunnel form carriage; the form carriage being placed inside a tunnel with a longitudinal axis of the form carriage parallel to an axis of the tunnel, and being characterized by comprising at least a first and a second structural member deformable in controlled, adjustable manner in a first and second direction respectively, to adjust the dimensions of the form carriage in the respective said directions; and supporting and actuating means for supporting a tunnel form; said first and said second direction being substantially crosswise to said longitudinal axis and forming with each other an angle of other than zero.

**[0008]** The form carriage defined above preferably also comprises at least one third structural member deformable in controlled, adjustable manner in a third direction substantially parallel to said longitudinal axis, so as to adjust the dimensions of the form carriage in said third direction.

**[0009]** A non-limiting embodiment of the invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic view in perspective of a preferred embodiment of the form carriage according to the present invention;

Figure 2 shows a larger-scale, partly sectioned front view of the Figure 1 form carriage;

Figure 3 shows a larger-scale, partly sectioned side view of the Figure 1 form carriage.

**[0010]** Number 1 in the accompanying drawings indicates as a whole a form carriage which is placed inside a tunnel 2, with its longitudinal axis 3 parallel to an axis (not shown) of tunnel 2, and which supports and moves along tunnel 2 a form 4 defining, in use, with an inner surface 5 of a portion of tunnel 2, a chamber 6 in which to cast a concrete liner 7.

**[0011]** In the example shown, form carriage 1 is mounted on two rails 8, each of which extends parallel to the longitudinal axis (not shown) of tunnel 2 along the top of a respective base 9 formed on a temporary road surface 10 of tunnel 2, so that form carriage 1 can be moved along tunnel 2 to form successive portions of liner 7.

**[0012]** As shown clearly in Figure 1, form carriage 1 comprises two longitudinal-end supporting structures 11, and an intermediate supporting structure 12 connecting structures 11.

**[0013]** Each structure 11 comprises a gantry 13 in turn comprising two uprights 14, the top ends of which are connected by a cross member 15 crosswise to axis 3, and two wheel assemblies 16, each interposed between the bottom end of a respective upright 14 and a respective rail 8.

**[0014]** In the example shown, each wheel assembly 16 comprises flanged wheels engaging relative rail 8, whereas, in variations not shown, rails 8 are eliminated and the flanged wheels are replaced with preferably rubber-tired wheels or with a track device.

**[0015]** As shown clearly in Figure 2, each upright 14 comprises an axially deformable structural member defined by a tubular bottom rod 17 and a tubular top rod 18, which are coaxial and connected telescopically to each other. More specifically, top rod 18 has a larger section than bottom rod 17, a top portion of which slides inside a bottom portion of top rod 18 to enable top rod 18 to be moved axially, with respect to bottom rod 17 and by a hydraulic cylinder 19, between a fully collapsed position shown on the right in Figure 2, and a fully extracted position shown on the left in Figure 2. Each hydraulic cylinder 19 is coaxial with relative rods 17 and 18, and comprises a body 20 inserted inside relative bottom rod 17, and a piston or output rod 21 extending inside relative top rod 18 and integral with top rod 18 at the free end.

**[0016]** As shown clearly in Figure 2, each cross member 15 comprises an axially deformable structural member defined by a tubular intermediate rod 22 and two tubular lateral rods 23, which are coaxial and connected telescopically to one another to move axially, with respect to one another, between a fully collapsed configuration and a fully extracted configuration. More specifically, intermediate rod 22 has a larger section than lateral rods 23, one end of each of which is integral with the top end of relative top rod 18 of relative upright 14,

while the other end slides inside a respective end portion of intermediate rod 22 to move axially, with respect to intermediate rod 22 and by means of a respective hydraulic cylinder 24, between a fully collapsed position shown on the right in Figure 2, and a fully extracted position shown on the left in Figure 2. Each hydraulic cylinder 24 is positioned parallel to and over relative rods 22 and 23, and comprises a body 25 hinged to rod 22 at a fork 26; and a piston or output rod hinged at the free end to relative lateral rod 23.

[0017] As shown in Figure 1, intermediate supporting structure 12 comprises two parallel cross members 27—one of which is optional - extending parallel to longitudinal axis 3 of form carriage 1 to connect cross members 15.

[0018] As shown clearly in Figure 3, each cross member 27 comprises an axially deformable structural member defined by a tubular intermediate rod 28 and two tubular lateral rods 29, which are coaxial and connected telescopically to one another to move axially, with respect to one another, between a fully collapsed configuration and a fully extracted configuration. More specifically, intermediate rod 28 has a larger section than lateral rods 29, one end of each of which is integral with intermediate rod 22 of relative cross member 15 of relative gantry 13, while the other end slides inside a respective end portion of intermediate rod 28 to move axially, with respect to intermediate rod 28 and by means of a respective hydraulic cylinder 30, between a fully collapsed position shown on the right in Figure 3, and a fully extracted position shown on the left in Figure 3. Each hydraulic cylinder 30 is positioned parallel to and alongside relative cross member 27, and comprises a body 31 hinged to relative lateral rod 29 by a fork 32; and a piston or output rod 33 hinged at the free end to relative intermediate rod 28.

[0019] As shown clearly in Figure 2, form 4 in the example shown is a braced articulated form defined by two half-forms 34 positioned symmetrically with respect to axis 3 and each defined by three longitudinal portions 35, each hinged to each adjacent portion 35 by a hinge 36 parallel to axis 3. Of the three longitudinal portions 35, the top longitudinal portion 35, indicated 35a, is supported by each intermediate rod 28 of each cross member 27 with the interposition of two jacks 37 substantially parallel to uprights 14; the bottom longitudinal portion 35, indicated 35b, is anchored at the bottom end to relative base 9 by an anchoring device 38; bottom longitudinal portion 35b and the intermediate longitudinal portion 35, indicated 35c, are position controlled with respect to form carriage 1 by respective jacks 39 interposed between bottom and intermediate longitudinal portions 35b, 35c and each intermediate rod 28; and the relative angular position of top and intermediate longitudinal portions 35a, 35c is regulated by a hydraulic jack 40 interposed between brackets fitted to top and intermediate longitudinal portions 35a, 35c.

[0020] The size-adjustable structural members de-

finied by uprights 14 and cross members 15 provide for adapting form carriage 1 to tunnel 2 sections of different shapes and sizes, while length-adjustable cross members 27 simply provide for adjusting the length of the portion of tunnel 2 lined for each stop of form carriage 1 along rails 8, and may be replaced with rigid cross members. Unlike form carriage 1, form 4 is obviously specially designed for a given tunnel and is normally only used once.

[0021] In a variation not shown, each longitudinal-end supporting structure 11 is substantially T-shaped with a single central upright similar to uprights 14, and a cross member similar to cross member 15.

[0022] In a further variation not shown, the two cross members 27 are replaced with a single length-adjustable or rigid central cross member.

### Claims

1. A tunnel form carriage; the form carriage (1) being placed inside a tunnel (2) with a longitudinal axis (3) of the form carriage parallel to an axis of the tunnel (2), and being **characterized by** comprising at least a first and a second structural member (14, 15) deformable in controlled, adjustable manner in a first and second direction respectively, to adjust the dimensions of the form carriage (1) in the respective said directions; and supporting and actuating means (37, 39) for supporting a tunnel form (4); said first and said second direction being substantially crosswise to said longitudinal axis (3) and forming with each other an angle of other than zero.
2. A form carriage as claimed in Claim 1 and also comprising at least one third structural member (27) deformable in controlled, adjustable manner in a third direction substantially parallel to said longitudinal axis (3), so as to adjust the dimensions of the form carriage (1) in said third direction.
3. A form carriage as claimed in Claim 2, wherein said supporting and actuating means (37, 39) are carried by said third structural member (27).
4. A form carriage as claimed in Claim 2 or 3, wherein each said structural member (14; 15; 27) comprises at least two portions (17, 18; 22, 23; 28, 29) movable with respect to each other to adjust the dimensions of the structural member (14; 15; 27) in the relative said direction.
5. A form carriage as claimed in Claim 4, wherein said two portions (17, 18; 22, 23; 28, 29) are connected to each other telescopically to move with respect to each other in the relative said direction.
6. A form carriage as claimed in one of the foregoing

- Claims, and comprising at least two longitudinal-end first supporting structures (11), each comprising at least one said first and at least one said second structural member (14, 15).
7. A form carriage as claimed in Claim 6, wherein at least one of said first supporting structures (11) comprises a gantry (13) in turn comprising two uprights (14); at least part of each said upright (14) being defined by a said first structural member (14). 5
8. A form carriage as claimed in Claim 7, wherein each said upright (14) comprises a bottom rod (17) and a top rod (18) coaxial with and connected telescopically to each other to move axially with respect to each other between a fully collapsed position and a fully extracted position. 10
9. A form carriage as claimed in Claim 8, wherein first actuating means (19) for axial displacement are interposed between said bottom rod (17) and said top rod (18) to impart relative axial motion to and to selectively lock the bottom rod (17) and the top rod (18) in any relative axial position between said fully extracted position and said fully collapsed position. 15
10. A form carriage as claimed in Claim 9, wherein said bottom rod (17) and said top rod (18) are tubular; and said first actuating means (19) are housed inside the bottom rod (17) and top rod (18). 20
11. A form carriage as claimed in Claim 9 or 10, wherein said first actuating means (19) are hydraulic. 25
12. A form carriage as claimed in one of Claims 9 to 11, wherein said first actuating means (19) comprise a hydraulic cylinder (19) coaxial with said bottom rod (17) and said top rod (18) and in turn comprising a body (20) integral with said bottom rod (17), and a piston (21) integral with said top rod (18). 30
13. A form carriage as claimed in one of Claims 2 to 12, and comprising an intermediate second supporting structure (12) connecting said two first supporting structures (11) to each other; said second supporting structure (12) comprising at least one said third structural member (27). 35
14. A form carriage as claimed in Claim 13, wherein each said first supporting structure (11) comprises a first cross member (15), and said second supporting structure (12) comprises at least one second cross member (27) perpendicular to the first cross member (15); at least part of said first cross member (15) being defined by a said second structural member (15), and at least part of said second cross member (27) being defined by a said third structural member (27). 40
15. A form carriage as claimed in Claim 14, wherein each said cross member (15; 27) comprises an intermediate rod (22; 28) and two lateral rods (23; 29) coaxial with and connected telescopically to one another to move axially with respect to one another between a fully collapsed configuration and a fully extracted configuration. 45
16. A form carriage as claimed in Claim 15, wherein said intermediate rod (22; 28) is tubular; each of said lateral rods (23; 29) being mounted partly inside said intermediate rod (22; 28); and the intermediate rod (22) of said first cross member (15) being connected integrally to a lateral rod (29) of said second cross member (27). 50
17. A form carriage as claimed in Claim 15 or 16, wherein said supporting and actuating means (37, 39) are carried by the intermediate rod (28) of said second cross member (27). 55

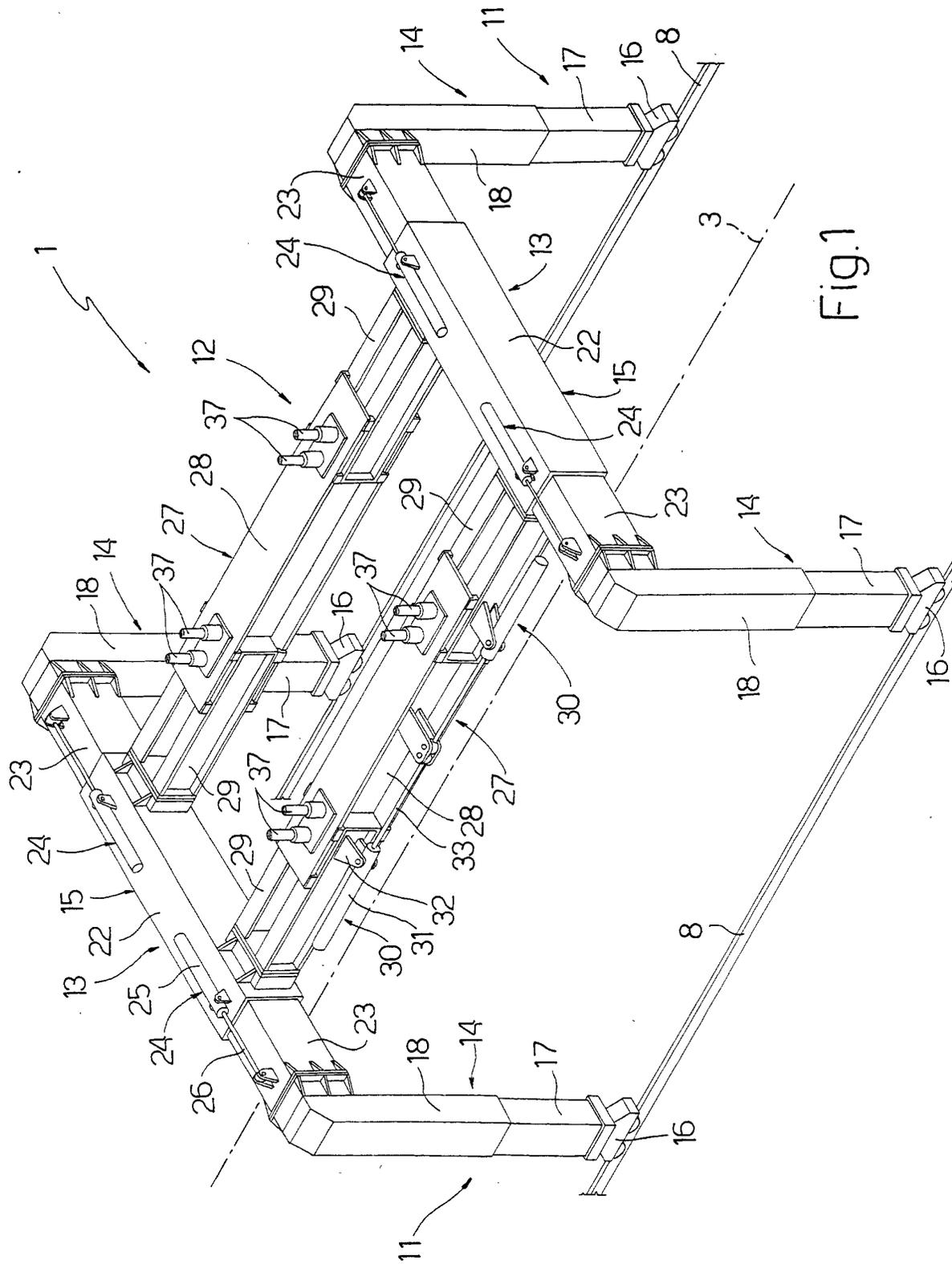
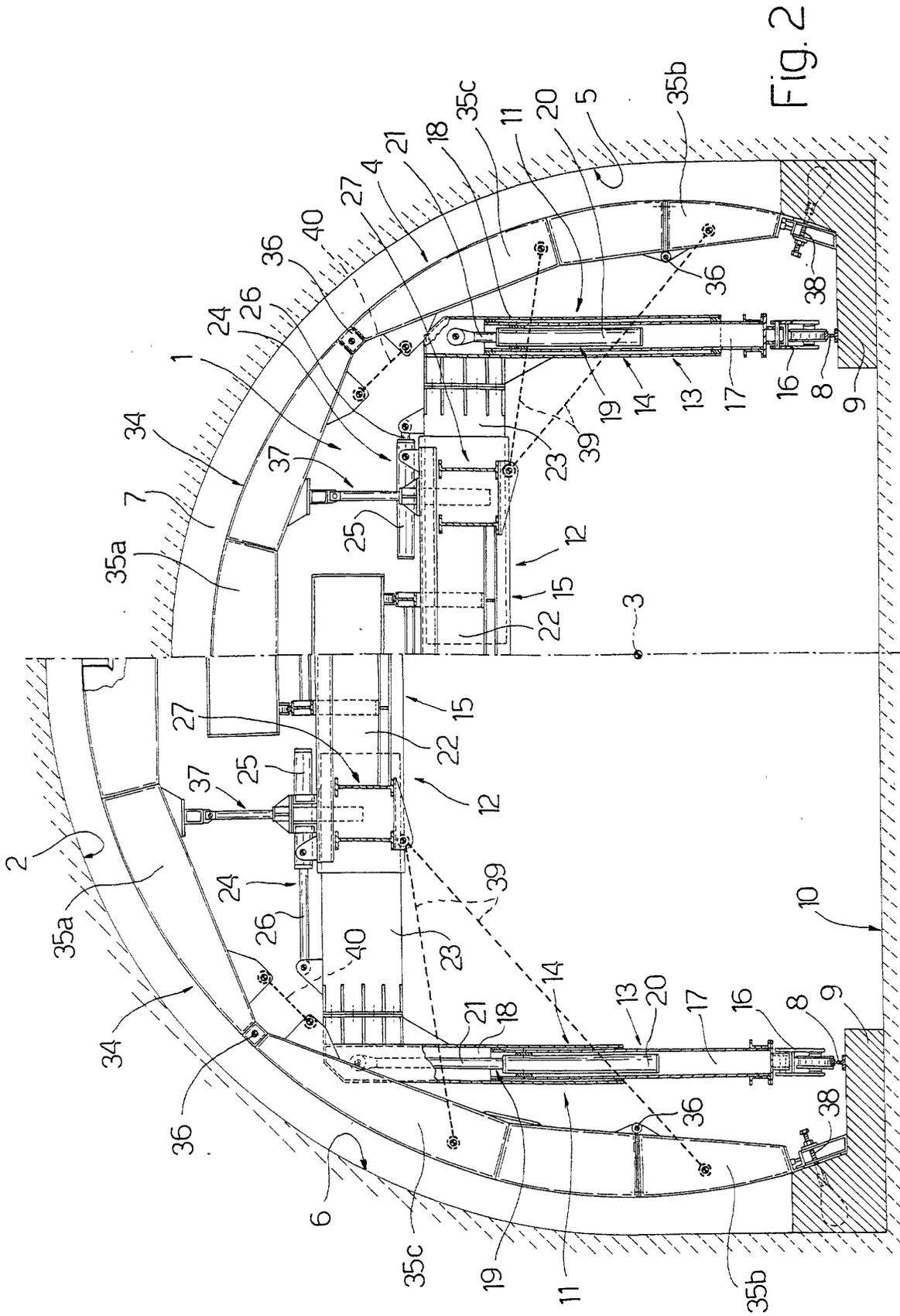
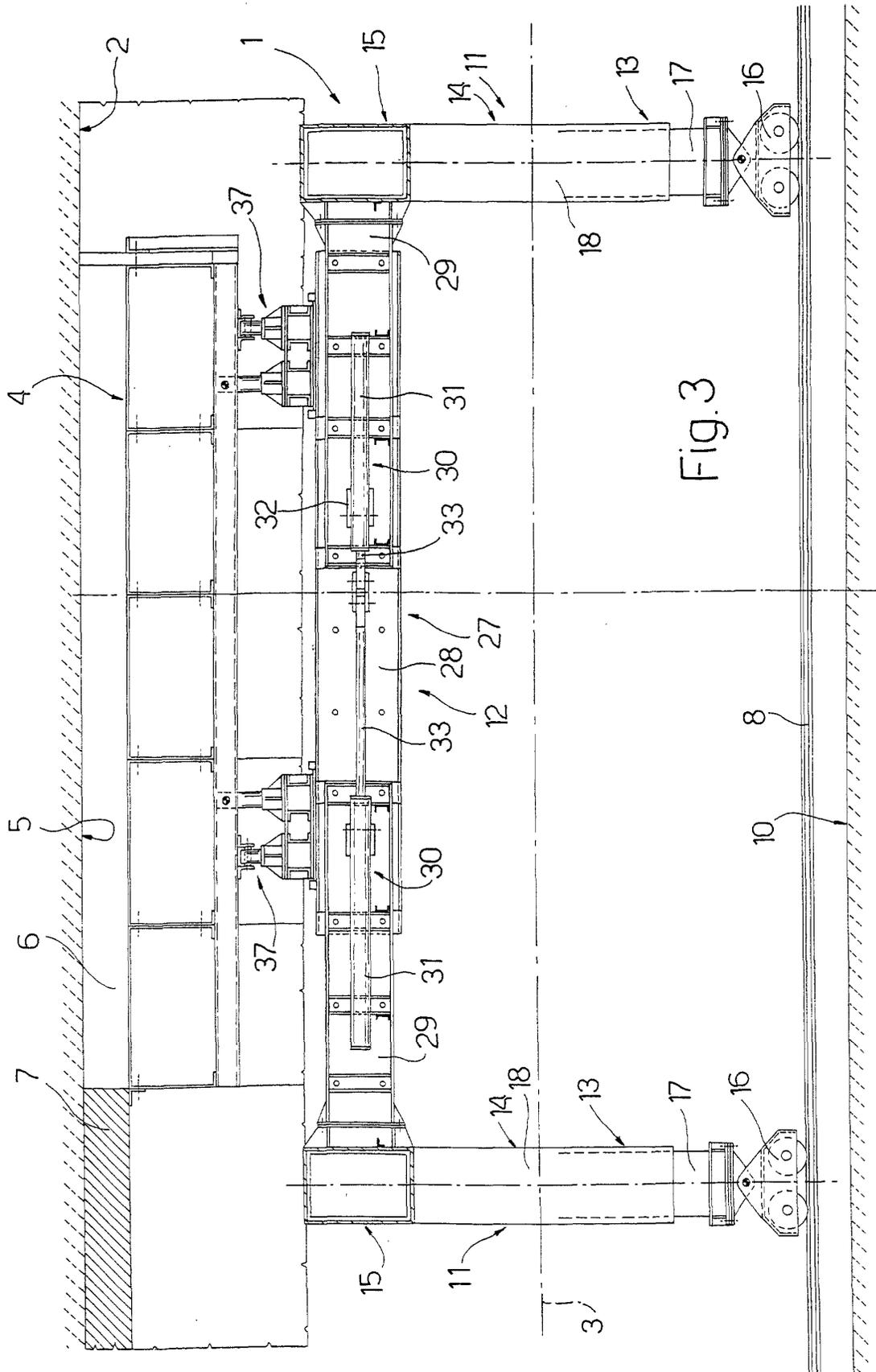


Fig.1







European Patent  
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EUROPEAN SEARCH REPORT

Application Number  
EP 01 10 7292

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.CI.7)
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The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>13 July 2001</b>	Examiner <b>Fonseca Fernandez, H</b>
CATEGORY OF CITED DOCUMENTS		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	
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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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