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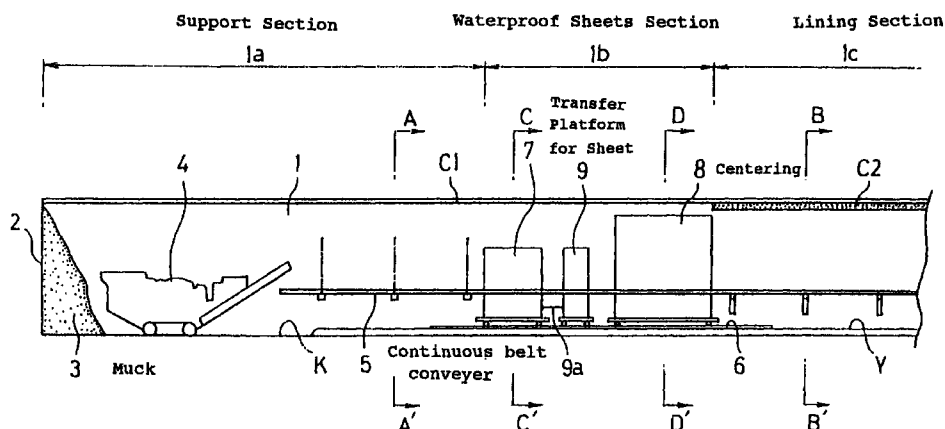
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(54) **TUNNELING DEVICE**

(57) A tunneling plant to perform an excavation, a mucking and a lining from a face side, which plant comprises a transfer platform for sheets (7), a centering (8) and a continuous belt conveyor (5) to convey muck. The continuous belt conveyor has two sections, a tunnel supporting section (a support section (1a) and a lining section (1c)) where the conveyor is supported from a tunnel side in front of a transfer platform for sheets part and in the rear of a centering part, and a tunnel non-supporting section (waterproof sheet section (1b))

where the conveyor is not supported from the tunnel side, whereby the continuous belt conveyor passes through the transfer platform for sheets and the centering part. When a continuous belt conveyor is used to convey muck, the lining can be performed at the same time as the excavation (mucking). This leads to a rapid construction, remarkable improvement of safety and a clean working environment in the tunnel.

FIG. 1



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## Description

### FIELD OF THE INVENTION

[0001] This invention relates to a tunneling plant to perform a sequence of tunneling works such as an excavation, a mucking and a lining in a tunnel from a face side to an entrance of a tunnel, particularly to a type of a tunnel plant using a continuous belt conveyor in conveying muck, which plant can perform the lining work at the same time as the excavation (mucking) work.

### BACKGROUND OF THE INVENTION

[0002] In a mucking work during an excavation of a tunnel, a continuous belt conveyor whose belt is expandable has hitherto been used. The muck is conveyed by means of the continuous belt conveyor which is arranged throughout the tunnel to be constructed. The amount of large vehicles which go through the tunnel inside is considerably reduced since there is no need to use dump trucks to convey the muck. This makes it possible to remarkably enhance safety in tunnel and, at the same time, to attain a clean working environment in the tunnel

[0003] However, the conventional continuous belt conveyor is disadvantageous in that, when it is used, for example, in a two-lane tunnel, a lining work cannot be performed at the same time as an excavation (mucking) work since the conventional continuous belt conveyor is supported from the tunnel side (from a bottom or a side of the tunnel) for the purpose of maintaining a passing way for construction vehicles.

[0004] With a type of continuous belt conveyor supported from a tunnel bottom, the continuous belt conveyor and a support which supports the continuous belt conveyor prevent the work at the working area where blocking with wooden forms and the like of a space between a lower end of a steel rib form of a centering and a formation level, and location of the steel rib form by the expansion and contraction of a centering jack are performed (hereinafter, referred to as "the lower part working area"). Accordingly the lining work cannot be performed unless the continuous belt conveyor is removed after the excavation (mucking) work.

[0005] With a type of continuous belt conveyor supported from a side of a tunnel, the continuous belt conveyor and brackets which support the continuous belt conveyor also prevent the work at the working area where attachment of waterproof sheets over the tunnel wall at a transfer platform for sheets attachment, location of the steel rib form by expansion and contraction of the centering jack, and concrete compaction with a vibrator by looking through an inspection window are performed (hereinafter, referred to as "the middle part working area"). Accordingly the lining work cannot be performed unless the continuous belt conveyor is

removed after the excavation (mucking) work.

[0006] The continuous belt conveyor is not arranged at the upper part of a transfer platform for sheets attachment or a centering so as to support it, which is extremely dangerous.

[0007] An object of the present invention is, therefore, to provide a tunneling plant which can perform the lining work at the same time as the excavation (mucking) work when the continuous belt conveyor is used to convey the muck during the excavation work, which condition leads to a rapid construction of the tunnel. Another object of the present invention is to provide a tunneling plant which can remarkably improve safety in the tunnel, and by which a clean working environment can be attained in the tunnel being constructed.

### THE DISCLOSURE OF THE INVENTION

[0008] To achieve the above objects, the present invention provides a tunneling plant which comprises a transfer platform for sheets, a centering and a continuous belt conveyor to convey the muck, characterized in that, the continuous belt conveyor has two sections, a tunnel supporting section in which the continuous belt conveyor is supported from a tunnel side in front of the transfer platform for sheets part and in the rear of the centering part, and a section other than the tunnel supporting section, serving as a tunnel non-supporting section in which the continuous belt conveyor is not supported from the tunnel side, whereby the continuous belt conveyor passes through the transfer platform for sheets part and the centering part.

[0009] In the present invention, when the continuous belt conveyor is used to convey the muck during the excavation of the tunnel, the continuous belt conveyor is supported from the tunnel side in front of the transfer platform for sheets and in the rear of the centering. At the scaffold and the centering, the continuous belt conveyor passes through them without being supported, thereby the scaffold and the centering can move freely according to their work. Consequently the lining work is performed at the same time as the excavation (mucking) work, which condition leads to a rapid construction of the tunnel. Furthermore, such condition leads to remarkable improvement of safety and a clean working environment in the tunnel being constructed. This is particularly efficient when the continuous belt conveyor is applied to a long tunnel which has been considered that it is difficult to attain a clean working environment thereof.

[0010] In this field, the continuous belt conveyor in the tunnel non-supporting section is considered that it can be arranged at any range of the tunnel cross section if the transfer platform for sheets and the centering can move freely according to their work. However, in order to perform the work at the scaffold and at the centering easily and smoothly, and to maintain vehicular traffic in the tunnel, it is preferable that the continuous belt con-

veyor is arranged within the range between the lower part working area and the middle part working area.

**[0011]** In particular, in order to support the continuous belt conveyor in the tunnel non-supporting section more stably, it is more preferable that the continuous belt conveyor is supported with brackets projecting from at least one of the transfer platform for sheets and the centering without preventing their movement.

**[0012]** In this case, in order to make the transfer platform for sheets and the centering move more smoothly, preferably the continuous belt conveyor is supported with the brackets via rollers.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### [0013]

FIG. 1 is a schematic side view showing a tunneling plant according to a first and a second embodiment of the present invention.

FIG. 2 is a sectional view A-A' of Fig.1 showing a tunneling plant according to a first and a second embodiment of the present invention.

FIG. 3 is a sectional view B-B' of Fig.1 showing a tunneling plant according to a first and a second embodiment of the present invention.

FIG. 4 is a sectional view C-C' of Fig.1 showing a tunneling plant according to a first embodiment of the present invention.

FIG. 5 is a sectional view D-D' of Fig.1 showing a tunneling plant according to a first embodiment of the present invention.

FIG. 6 is a sectional view C-C' of Fig.1 showing a tunneling plant according to a second embodiment of the present invention.

FIG. 7 is a sectional view D-D' of Fig.1 showing a tunneling plant according to a second embodiment of the present invention.

#### DESCRIPTION OF THE BEST EMBODIMENTS

**[0014]** Embodiments of the present invention will now be described by referring to the attached drawings.

##### The first embodiment of the present invention

**[0015]** Now, Fig.1 is a schematic side view showing a tunneling plant according to the first embodiment. Here, the tunneling plant of the present invention is applicable to various types of tunnel. The tunnel according to this first embodiment is excavated by means of blasting and NATM.

**[0016]** As shown in Fig.1, the reference numeral 1 indicates a tunnel composed of a section 1a, 1b and 1c from a face 2 side. Section 1a is a section where both setting out necessary timbering and placement of spray concrete C1 are completed and both attachment of waterproof sheets and placement of lining concrete C2

are not completed (hereinafter, referred to as "the support section"). In the section 1b, attachment of waterproof sheets are completed and placement of the lining concrete C2 is not completed (hereinafter, referred to as "the waterproof sheets section"). Both attachment of waterproof sheets and placement of the lining concrete C2 are completed in the section 1c (hereinafter, referred to as "the lining section"). The reference numeral 2 indicates a face at the forefront of the tunnel, at which face the muck as a reference numeral 3 is generated by blasting. The reference numeral 4 indicates a traveling crusher, which is a self-propelling crawler and crushes the muck 3 into equal sized fragments. The reference numeral 5 indicates a continuous belt conveyor, which consecutively conveys to the tunnel entrance the muck 3 crushed with the traveling crusher 4.

**[0017]** The reference number 6, 7 and 8 indicates rails, a transfer platform for sheets and a centering respectively. The rails 6 are laid on a working floor Y in the tunnel 1 along the direction of the excavation. The transfer platform for sheets 7 serves as a scaffold for attaching waterproof sheets over the tunnel wall to prevent the water leakage after the completion of the tunneling works, which scaffold can move back and forth on the rails 6. The centering 8 comprises a steel rib form 8a for the lining concrete C2 which forms a finished surface of the tunnel 1, a centering jack 8b and a main body 8c, which centering is movable back and forth on the rails 6.

**[0018]** The reference numeral 9 indicates a movable support gantry to support the continuous belt conveyor 5, which gantry can move back and forth on the rails 6. This movable support gantry 9 and the transfer platform for sheets 7 is connected by a tow wire 9 having a given length.

**[0019]** In this first embodiment, the tunneling plant which comprises a traveling crusher 4, a continuous belt conveyor 5, a transfer platform for sheets 7, a centering 8, and a movable support gantry 9. The continuous belt conveyor 5 has two sections, a tunnel supporting section (composed of support section 1a and a lining section 1c) in which the continuous belt conveyor 5 is supported from a tunnel side in front of the transfer platform part and in the rear of the centering part, and a section other than the tunnel supporting section, serving as a tunnel non-supporting section (composed of waterproof sheets section 1b) in which the continuous belt conveyor 5 is not supported from the tunnel side, whereby the continuous belt conveyor passes through the transfer platform for sheets part and the centering part.

**[0020]** Here, in the tunnel supporting section, the continuous belt conveyor 5 at the support section 1a is, as shown in Fig.2 showing a sectional view A-A' of Fig.1, supported with chains or H-steels 11 in order that the belt conveyor can be located at a prescribed position (at L in length from the tunnel center line and at H in Height from the formation level K). The chains or H-steels 11

are fixed at a suitable space to the spray concrete C1 from which the chains or H-steels 11 are hanging. On the other hand, the continuous belt conveyor 5 at the lining section 1c is, as shown in Fig.3 showing sectional view B-B' of Fig.1, supported at the above prescribed position with brackets 12 which are fixed to the lining concrete C2 of the tunnel 1 side at a suitable space.

**[0021]** The continuous belt conveyor 5 at the transfer platform for sheets part is, as shown in Fig.4 showing a sectional view C-C' of Fig.1, suspended away from the spray concrete C1 without being supported from the scaffold since being located in the tunnel non-supporting section. On the other hand, the continuous belt conveyor 5 at the centering part is also located in the same section as the scaffold, and is suspended away from the lining concrete C2 without being supported from the centering 8 as shown in Fig.5 showing a sectional view D-D' of Fig.1.

**[0022]** Further, in this first embodiment, the continuous belt conveyor 5 at the transfer platform for sheets part and the centering part, i.e. in the tunnel non-supporting section is located at the same position in length and height as the continuous belt conveyor 5 in the tunnel supporting section, i.e. at the aforementioned length and height. At the same time, the continuous belt conveyor 5 in the tunnel non-supporting section is located within the range between the lower part working area (b) and the middle part working area(c) other than a center area (a) (hereinafter, referred to as "the vehicle passing area") in tunnel cross section so as not to prevent the vehicles from passing.

**[0023]** In this connection, as shown in Fig.2 to 5, a lightweight reinforced frame 13 which has a long cross section is used as a frame of the continuous belt conveyor 5 in the first embodiment, and this frame is strong enough to bear a long span.

**[0024]** However, there is a possibility that the reinforced frame 13 may be weighed down at the middle part of the span, thereby the stability of the continuous belt conveyor may not be maintained. In the first embodiment, the movable support gantry 9 therefore supports the middle part of the continuous belt conveyor 5 in the tunnel non-supporting section. And the movable support gantry 9 supports the continuous belt conveyor 5 in the way to underpin the continuous belt conveyor 5 via rollers (not shown in Figures) to maintain its free movement.

**[0025]** Now, referring to Fig.1 to 5, a tunneling plant according to the first embodiment of the present invention will now be described.

#### (1) Working at the transfer platform for sheets

**[0026]** While the muck 3 is being conveyed by means of the continuous belt conveyor 5, at the transfer platform for sheets a series of waterproof sheets attachment works are performed, such as a nailing of the waterproof sheets to the spray concrete C1 and a dep-

osition of the edges of the waterproof sheets.

**[0027]** During this work, the continuous belt conveyor 5 at the transfer platform for sheets part is suspended away from the surface of the spray concrete C1, thereby not preventing the waterproof sheets attachment works. At the same time, the continuous belt conveyor 5 is located above the height of workers, thereby the works can be performed easily and smoothly.

**[0028]** Further, the continuous belt conveyor 5 at the transfer platform for sheets 7 is located within the range other than the vehicle passing area (a), thereby not preventing a vehicular traffic for conveying such materials as timbering, rock bolts and powder. Accordingly various tunneling works at the face 2 can progress smoothly.

#### (2) Working at the centering

**[0029]** The works at the centering 8, while the muck is being conveyed by means of the continuous belt conveyor 5, is described below.

**[0030]** First, the works at the outside of the centering 8 are performed, such as a cleaning of the top surface of the steel rib form 8a and an application of stripping agent to the surface. Then, at the lower part working area (b), the steel rib form 8a is located by the expansion and contraction of the centering jack 8b, and a space between the lower end of the steel rib form 8a and the formation level K is blocked. Finally, at the middle part working area (c), concrete is compacted with a vibrator by looking through an inspection window M after bulkheads are arranged.

**[0031]** During this work, the continuous belt conveyor 5 at the centering part is suspended away from the centering 8, which makes a prescribed clearance between the continuous belt conveyor 5 and the centering 8. The continuous belt conveyor 5 therefore does not prevent the aforementioned works at the centering 8. The continuous belt conveyor 5, furthermore, is applicable to the specific works of a centering which is mainly required at the lower part working area (b) and the middle part working area (C).

**[0032]** In addition, the continuous belt conveyor 5 at the transfer platform for sheets part allows the vehicular traffic since it is located within the range other than the vehicle passing area (a). Consequently various tunneling works at the face 2 can progress smoothly.

#### (3) Replacement of the supports for the continuous belt conveyor

**[0033]** When there is a need to move the transfer platform for sheets 7 (the movable support gantry 9) and the centering 8 to the face 2 side, the following replacement of the supports for the continuous belt conveyor 5 is performed.

**[0034]** First, the chains or the H-steels 11 closing to the front of the transfer platform for sheets 7 are

removed to enable the transfer platform for sheets 7 to move freely. Then, the transfer platform for sheets 7 self-propels from the section where the waterproof sheets are already attached, to the section where the surface of the spray concrete C1 is exposed. This movement of the transfer platform for sheets 7 tows the movable support gantry 9 via a tow wire 9a.

[0035] At this time, the continuous belt conveyor 5 at the transfer platform for sheets 7 is not obstructed by the movement of the transfer platform for sheets 7 since it is suspended away from the transfer platform for sheets 7. Consequently the muck 3 can be conveyed continuously and also the transfer platform for sheets 7 can move freely. Further, the continuous belt conveyor 5 does not prevent the vehicular traffic in the tunnel 1 since it is located within the range other than the vehicle passing area (a).

[0036] The continuous belt conveyor 5 at the transfer platform for sheets part is supported via rollers, so that the movable support gantry 9 is towed smoothly.

[0037] On the other hand, the centering 8 moves from the section where the lining concrete C2 is already placed, to the section adjacent to the face 2 side to which section the lining concrete is to be placed. The centering 8 self-propels according to the cycle of the concrete placement and the curing differently from the movable support gantry 9 which is towed by the transfer platform for sheets 7.

[0038] At this time, the continuous belt conveyor 5 at the centering part allows the free movement of the centering 8 since it is suspended away from the centering 8. Further, the continuous belt conveyor 5 does not prevent the vehicular traffic in the tunnel 1 since it is located within the range other than the vehicle passing area (a).

[0039] After this centering 8 moves, new brackets 12 are set out to the surface of the lining concrete C2 at the entrance side of the tunnel so as to support the continuous belt conveyor 5. This work completes the replacement of the supports.

[0040] According to the tunneling plant related to this first embodiment of the present invention, the continuous belt conveyor 5 having a reinforced frame 13 is supported from the tunnel side in front of the transfer platform for sheets 7 and in the rear of the centering 8. At the transfer platform for sheets 7 and the centering 8 the continuous belt conveyor 5 passes through them without being supported. At the middle part thereof it is supported with the movable support gantry 9 via rollers. Consequently, the transfer platform for sheets 7 and the centering 8 can move freely, thereby the lining work is performed at the same time as the excavation (mucking) work.

#### The second embodiment of the present invention

[0041] Fig.1 is a schematic side view showing a tunneling plant according to the first embodiment.

[0042] The tunneling plant according to this second embodiment is, as shown in Fig.6 and Fig.7 showing sectional view C-C' and the D-D' of Fig.1 respectively, much the same as the first embodiment. However, the second embodiment is different from the first embodiment in that the continuous belt conveyor 5 in the non-supporting section is supported with the brackets 21 projecting from the transfer platform for sheets 7 and the centering 8 in the transverse direction to the tunnel.

[0043] To be specific, the continuous belt conveyor 5 at the transfer platform for sheets part is supported on a roller 22 which is supported with the brackets 21 projecting from the transfer platform for sheets 7 in the transverse direction to the tunnel. The continuous belt conveyor 5 at the centering part is supported on the roller 22 which is supported with the brackets 21 projecting from the centering 8 in the transverse direction to the tunnel.

[0044] According to the tunneling related to this second embodiment, the reinforced frame 13 of the continuous belt conveyor 5 in the tunnel non-supporting section is supported on the roller 22 which is supported with the brackets 21 projecting from the transfer platform for sheets 7 and the centering 8. Consequently the continuous belt conveyor can be supported more stably and the cross section length of the reinforced frame 13 can be minimized compared with the first embodiment. In addition, the transfer platform for sheets 7 and the centering 8 can move continuously and smoothly. The continuous belt conveyor 5 has no difficulty in being supported with at least one of the transfer platform for sheets 7 and the centering 8.

#### INDUSTRIAL APPLICABILITY

[0045] According to the tunneling plant of this present invention described above, the tunneling plant comprises a transfer platform for sheets, a centering, and a continuous belt conveyor to convey muck. The continuous belt conveyor has two sections, a tunnel supporting section in which the continuous belt conveyor is supported from a tunnel side in front of the transfer platform for sheets part and in the rear of the centering part, and a section other than the tunnel supporting section, serving as a tunnel non-supporting section in which the continuous belt conveyor is not supported from the tunnel side, whereby the continuous belt conveyor passes through the transfer platform for sheets part and the centering part. Consequently, the lining work can be performed at the same time as the excavation (mucking) work when the continuous belt conveyor 5 is used to convey the muck during the excavation work. This leads to a rapid construction of the tunnel. Furthermore, such condition leads to remarkable improvement of safety and a clean working environment in the tunnel being constructed.

[0046] In this case, if the continuous belt conveyor in the tunnel non-supporting section is located within the

range between a lower part working area and a middle part working area other than vehicle passing area, the works at the transfer platform for sheets part and the centering part can be performed easily and smoothly. The vehicular traffic in the tunnel can be also maintained. 5

**[0047]** Further, if the continuous belt conveyor in the tunnel non-supporting section is supported with brackets projecting from at least one of the transfer platform for sheets and the centering without preventing their continuous movement, more stable support can be attained. 10

**[0048]** In this case, if the continuous belt conveyor is supported with the brackets via rollers, the transfer platform for sheets and the centering can move more smoothly. 15

## Claims

1. A tunneling plant which comprises 20
  - a transfer platform for sheets,
  - a centering, and
  - a continuous belt conveyor to convey muck, characterized in that, said continuous belt conveyor has two sections, a tunnel supporting section in which the continuous belt conveyor is supported from a tunnel side in front of the transfer platform for sheets part and in the rear of the centering part, and a section other than 25
    - the tunnel supporting section, serving as a tunnel non-supporting section in which the continuous belt conveyor is not supported from the tunnel side, whereby said continuous belt conveyor passes through said transfer platform for sheets part and said centering part. 30 35
2. The tunneling plant as claimed in claim 1, wherein said continuous belt conveyor in the tunnel non-supporting section is located between a lower part working area and a middle part working area other than vehicle passing area. 40
3. The tunneling plant as claimed in claim 1, wherein said continuous belt conveyor in the tunnel non-supporting section is supported with brackets projecting from at least one of said transfer platform for sheets and said centering without preventing their continuous movement. 45 50
4. The tunneling plant as claimed in claim 2, wherein said continuous belt conveyor in the tunnel non-supporting section is supported with brackets projecting from at least one of said transfer platform for sheets and said centering without preventing their continuous movement. 55
5. The tunneling plant as claimed in claim 3 or 4,

wherein said continuous belt conveyor is supported with said brackets via rollers.

FIG. 1

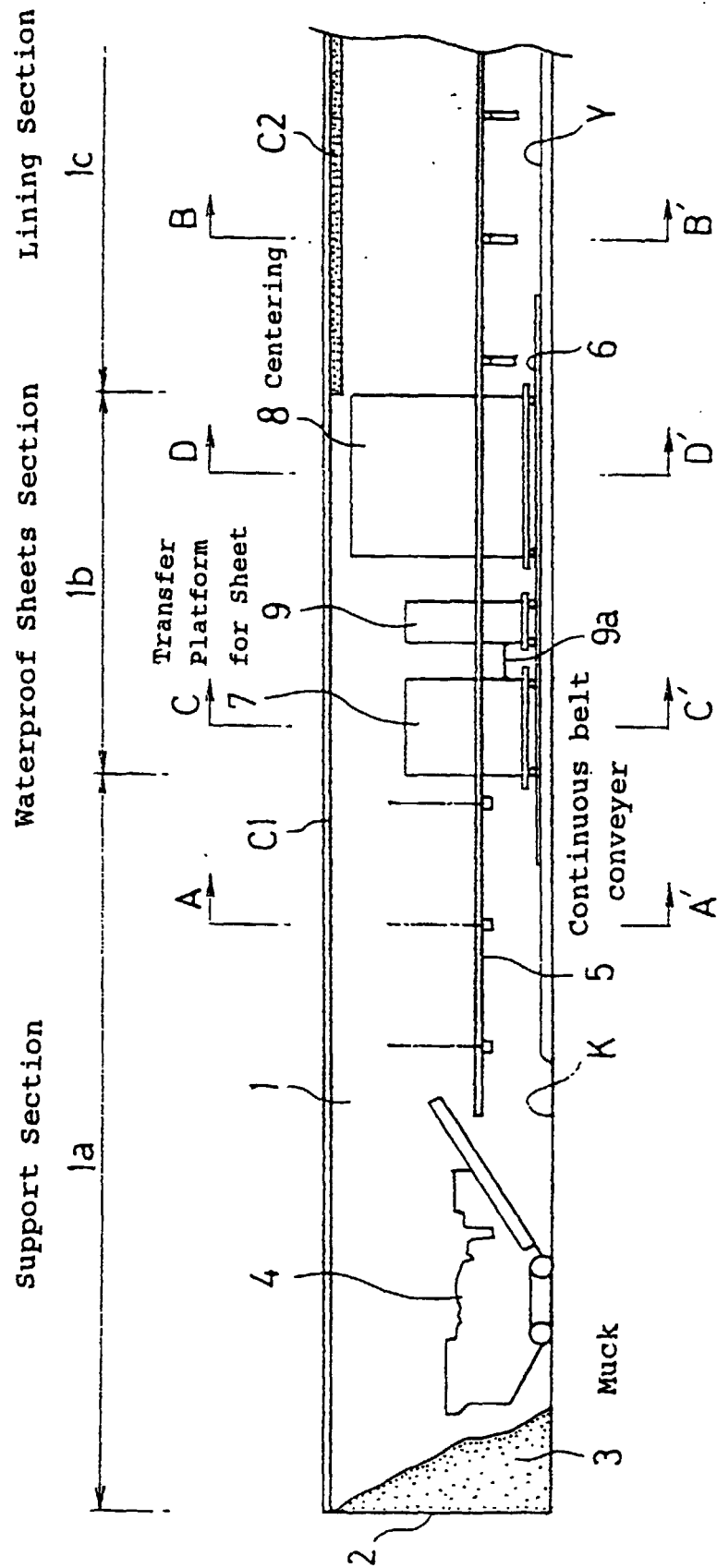


FIG. 2

Sectional View A-A'

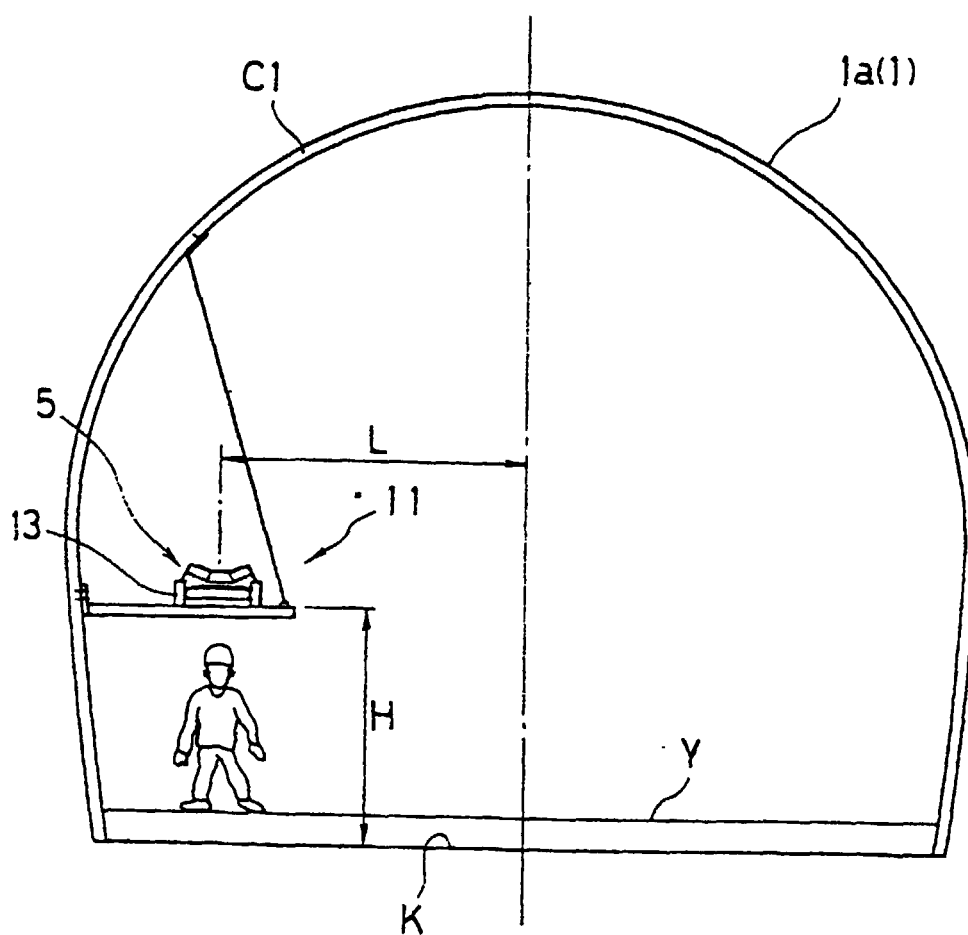




FIG. 3

Sectional View B-B'

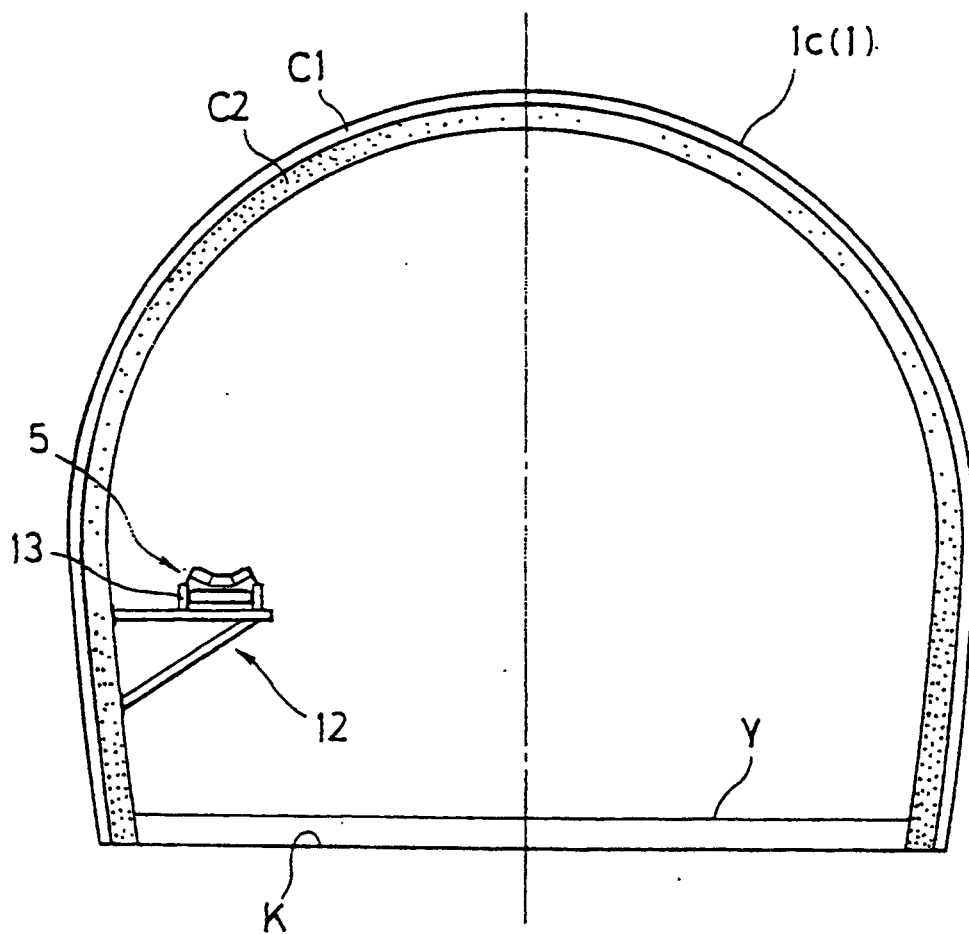


FIG. 4.

### Sectional View C-C'

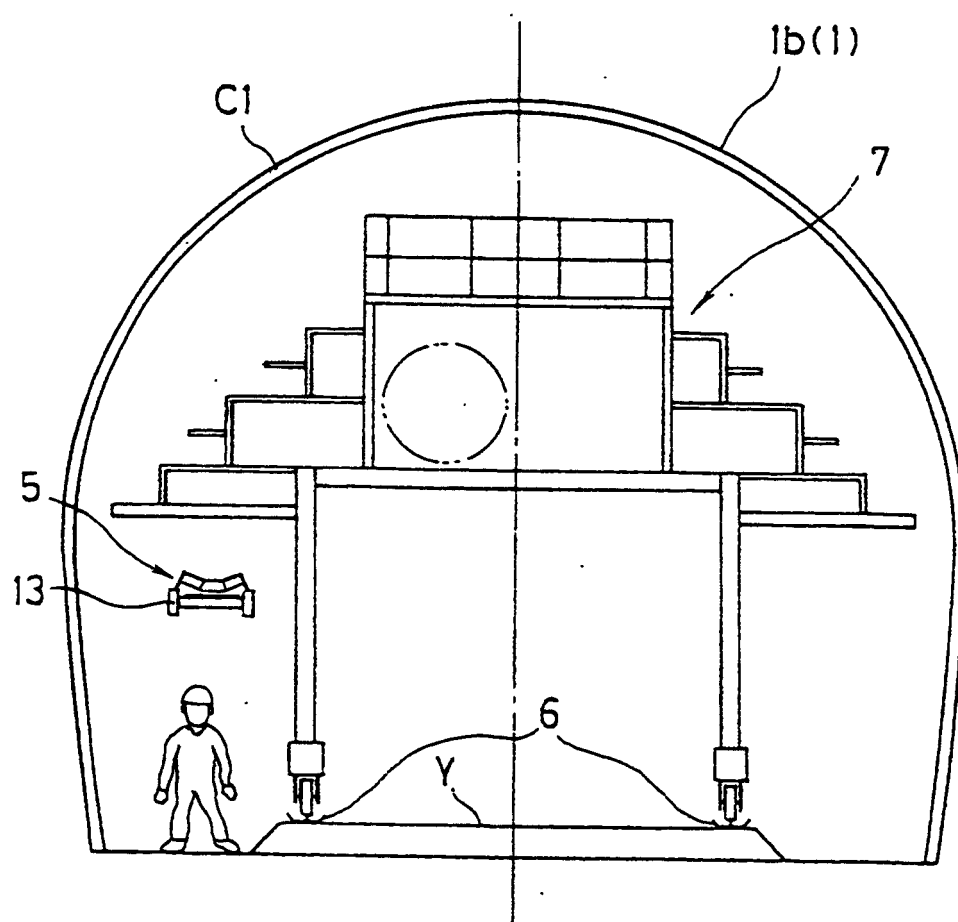


FIG. 5

Sectional View D-D'

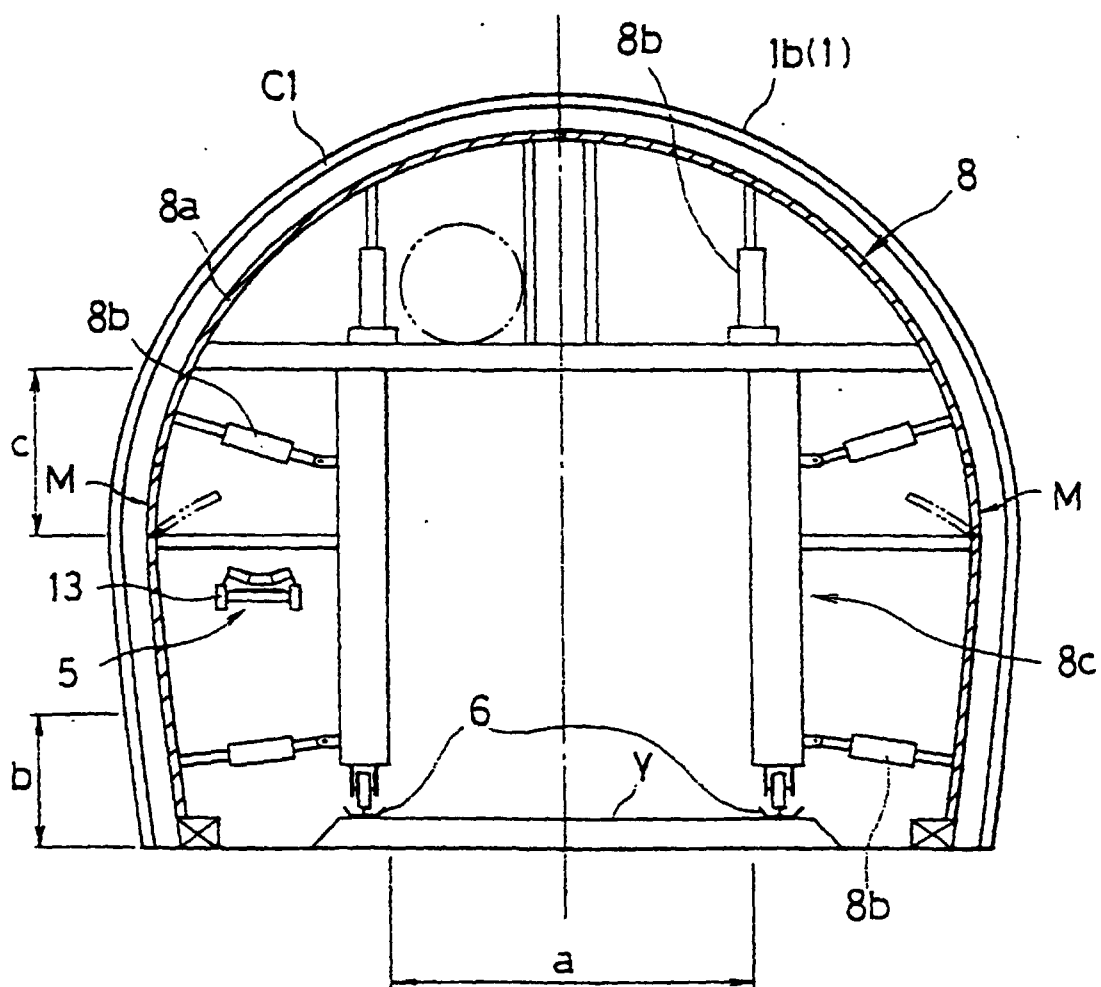


FIG. 6

Sectional View C-C'

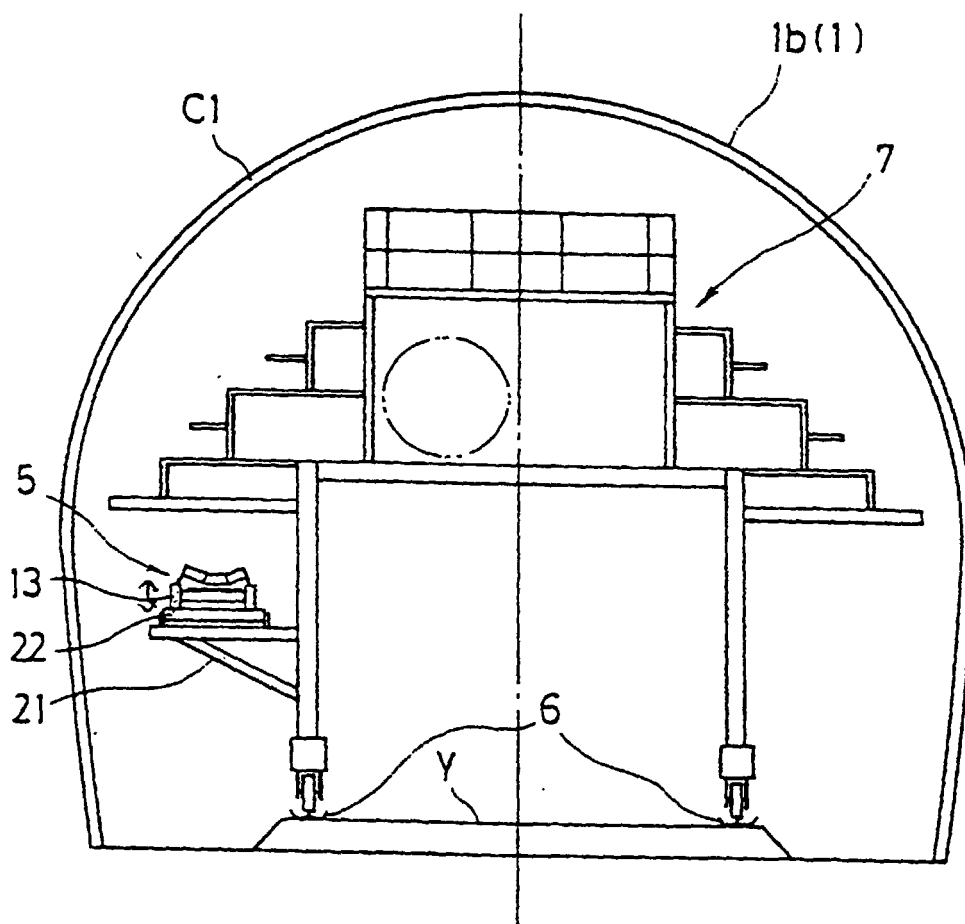
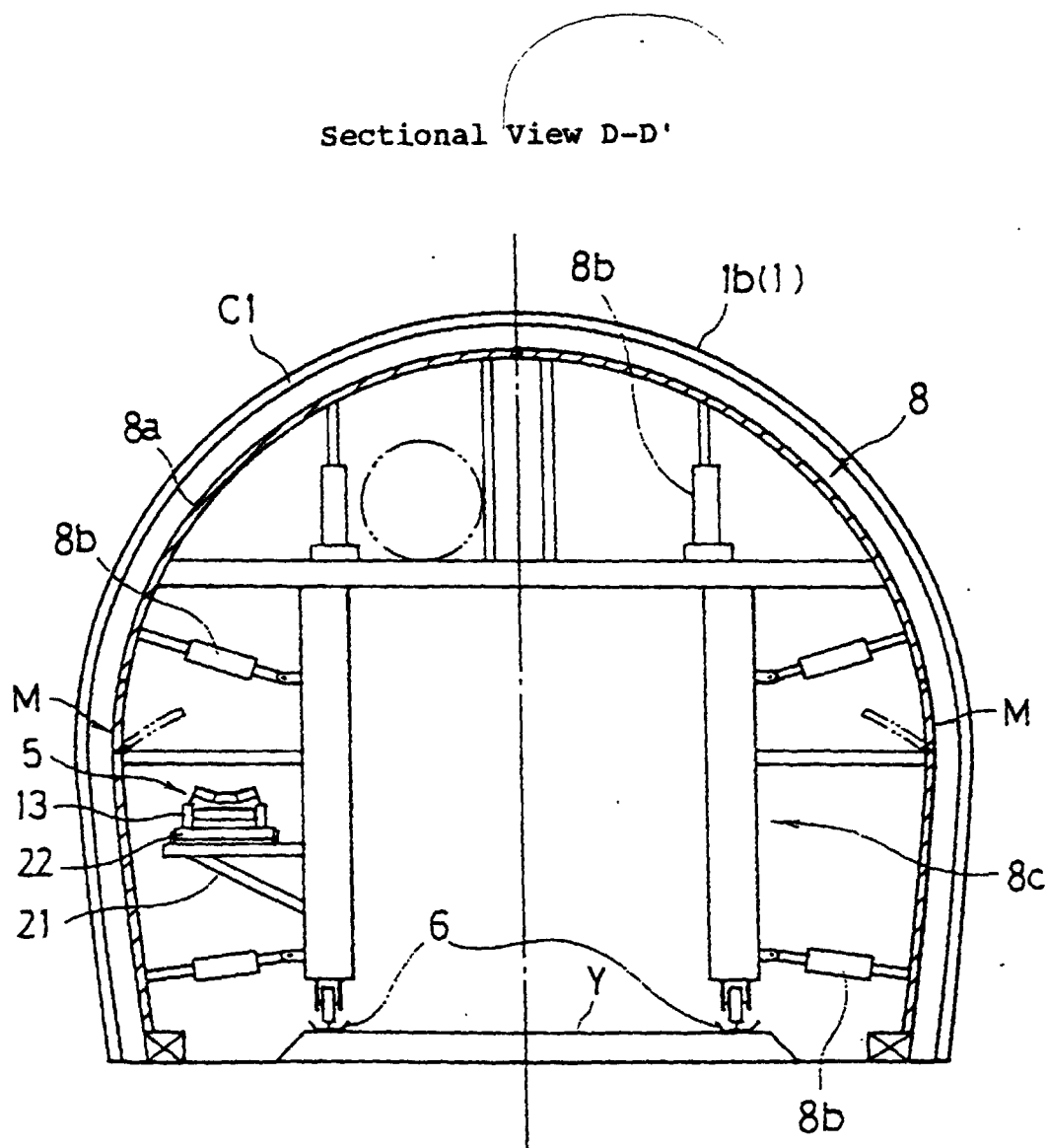


FIG. 7

Sectional View D-D'



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP99/01647

| <b>A. CLASSIFICATION OF SUBJECT MATTER</b><br>Int.Cl <sup>6</sup> E21D9/12, 11/10, 11/38<br><br>According to International Patent Classification (IPC) or to both national classification and IPC   |  |  |
|---|--|--|
| <b>B. FIELDS SEARCHED</b><br><br>Minimum documentation searched (classification system followed by classification symbols)<br>Int.Cl <sup>6</sup> E21D9/12, 11/10, 11/38<br><br>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched<br>Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-1999<br>Kokai Jitsuyo Shinan Koho 1971-1999 Jitsuyo Shinan Toroku Koho 1996-1999<br><br>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)   |  |  |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>   |  |  |
| Category*   | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No.  |
| A   | JP, 9-273393, A (Furukawa Co., Ltd.),<br>21 October, 1997 (21. 10. 97)             | 1-5  |
| A   | JP, 8-165881, A (Obayashi Corp.),<br>25 June, 1996 (25. 06. 96)                    | 1-5  |
| A   | JP, 5-280274, A (Okumura Corp.),<br>26 October, 1993 (26. 10. 93)                  | 1-5  |
| A   | JP, 55-85194, U (Shimizu Construction Co., Ltd.),<br>12 June, 1980 (12. 06. 80)    | 1-5  |
| <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.   |  |  |
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| Date of the actual completion of the international search<br>29 June, 1999 (29. 06. 99)   |  | Date of mailing of the international search report<br>13 July, 1999 (13. 07. 99) |
| Name and mailing address of the ISA/<br>Japanese Patent Office<br><br>Facsimile No.   |  | Authorized officer<br><br>Telephone No.  |

Form PCT/ISA/210 (second sheet) (July 1992)