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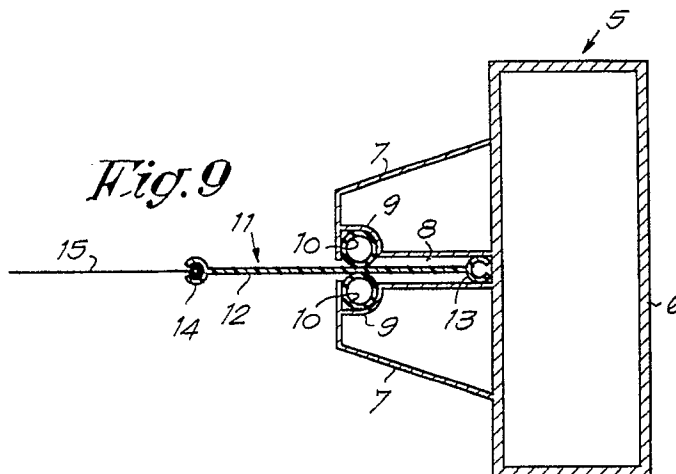
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Retention wall and procedure for making a liquid-tight wall in the ground.

Procedure for making a liquid-tight wall (1) in the ground (2), according to which procedure a trench (3) is made in the ground, the trench (3) is filled with cement (4), at least a length (15) of sealing foil and at least an auxiliary construction (5) for holding one side of the length (15) in the trench (3) are let down vertically, and the auxiliary construction (5) is later removed again from the trench (3) characterized in that first a trench (3) is dug in order to make a wall part, called panel (22) and filled with cement (4), two auxiliary constructions (5) are installed in this first

trench (3) one at each extremity of the trench (3) with a slot (8) provided with a seal (10) over their height and on their sides facing each other and a length (15) of sealing foil is lowered between these auxiliary constructions (5) and a joining construction (11) lowered onto both edges thereof so that the length (15) is connected by its edges to the auxiliary construction (5), in each auxiliary construction (5) a joining part (14) of the joining construction (11) is present and the slots (8) in the sides of the auxiliary constructions (5) are sealed.



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PROCEDURE FOR MAKING A LIQUID-TIGHT WALL IN THE GROUND AND WALL THUS MADE

The invention relates to a procedure for making a liquid-tight wall in the ground, according to which procedure a trench is made in the ground, the trench is filled with cement, at least a length of sealing foil and at least an auxiliary construction for holding one side of the length in the trench are let down vertically and the auxiliary construction is later removed again from the trench.

Procedures for making a liquid-tight wall are known whereby a sheet piling section is placed in a trench filled with bentonite cement prior to hardening or stiffening. These procedures are very difficult to apply with great depths. A large crane must be utilized for installing the sheet piling sections and often a vibrator must be utilized in order to overcome the friction of the overlapping edges of the sections. The utilization of this known procedure is therefore very expensive.

That is why procedures were devised of the type referred to here whereby use is made of lengths of sealing foil in place of piling sections.

A procedure of this type is known from EP-A-0 292 765. According to the procedure described in this patent application lengths of a plastic foil are placed one next to the other in a trench filled with bentonite. The vertically overlapping edges of these lengths are held in an auxiliary construction which is pumped out after placing the lengths. In the pumped out hollow auxiliary construction a welding apparatus is then introduced and with this the overlapping edges are welded to each other. Through the necessity of pumping out the auxiliary construction and welding the edges to each other this known procedure is relatively laborious.

The purpose of the invention is to remedy these disadvantages and to provide a procedure for making a liquid-tight wall in the ground which is very simple and can also be easily utilized for great depths of the wall.

For this purpose a first trench of a wall part, called panel is dug and this is filled with cement, two auxiliary constructions are installed in this first trench, one at each extremity of the trench, with a slot provided with a seal over their height and on their sides facing each other and a length of sealing foil is lowered between these auxiliary constructions and a joining construction down on both edges thereof so that the length is connected by its edges to the auxiliary construction, in each auxiliary construction a joining part of the joining construction is present and the slots in the sides of the auxiliary constructions are sealed, a second trench for a second panel is dug at a distance which is almost equal to the width of the length of sealing foil and this trench is filled with cement, two auxil-

ary constructions are installed therein in the manner described above with a length of sealing foil between them which is connected to these auxiliary constructions by auxiliary constructions of which a joining part extends into the auxiliary constructions, subsequently an intermediate trench, which is filled with cement, is dug between the two trenches and thus between two auxiliary constructions, after sufficient hardening or stiffening of hardenable or stiffenable cement in the first and the second trench the two auxiliary constructions are removed from these trenches and finally in the thereby enlarged intermediate trench, filled with cement, for a third panel a third length of sealing foil is installed joining edges on its edges which work together with the joining parts of the lengths in the first and second trench after which, in as far as necessary, the wall is made further by forming a following panel each time at a distance of a panel at the extremity of the trench, in the manner described above for a first or second panel, and subsequently forming an intermediate panel between the two panels in the same manner as the third panel.

In a preferably applied embodiment of the invention the joining construction of the lengths in a first and a second trench is a separate joining element in relation to the length, which joining element is installed with a joining part in an auxiliary construction and has a joining edge on its opposite edge which works together with a joining edge on an edge of the length.

It is desirable to install the joining element together with the corresponding auxiliary construction in the trench.

The joining edge of a length of sealing foil can be formed by a folded over edge which forms a sleeve and a relatively stiff tube which is installed in this sleeve.

Suitably a rollable foil is utilized which is unwound from a drum in the trench, which foil is provided with weights.

The invention also relates to a wall manufactured according to one of the preceding embodiments.

In order to show better the characteristics according to the present invention, some preferred embodiments of a procedure for making a liquid-tight wall in the ground and of a wall thus made according to the invention are described hereafter, as examples without any restrictive character, with reference to the enclosed drawings, in which:

Figures 1 through 8 are schematically maintained horizontal cross-sectional representation of a wall during successive steps of its manufacture according to the procedure of the invention;

figure 9 represents a part from the cross-section from figure 2 drawn on larger scale;
 figure 10 represents a part of the cross-section from figure 3, also drawn on larger scale;
 figure 11 represents a part of the cross-section from figure 8, also drawn on larger scale;
 figure 12 is a detail from figure 10 drawn on still larger scale, and represented during a phase of the manufacture;
 figure 13 represents the detail from figure 12 but in a later phase;
 figure 14 represents a vertical cross-section of a trench after the installation of the auxiliary constructions but prior to the installation of a sealing foil;
 figure 15 represents a vertical cross-section of a trench analogue to that from figure 14 but relating to a following phase of the procedure, namely during the installation of a sealing foil;
 figure 16 represents a longitudinal vertical cross-section of a trench during the application of the procedure namely during the installation of a sealing foil in a trench.

In the various figures the same reference numbers relate to the same elements.

For making a watertight wall 1 in the ground 2 the following will be effected according to the invention.

A first trench 3 with a length of 3 to 8 meters and a width of 0.3 to 1.2 meters is dug with a trencher or trench excavator. During or immediately after the digging the trench 3 is filled with bentonite 4 or a mixture of bentonite and cement. The condition as represented in figure 1 is obtained.

At both extremities of the trench 3 an auxiliary construction 5 is let down vertically into the ground. This auxiliary construction 5 can consist of one element with a length of 12 to 16 meters or, if the trench 3 is deeper consist of several elements placed above each other, as represented in figures 14 and 15.

As especially appears from figures 9 and 10 in which a cross-section of an auxiliary construction is represented, each auxiliary construction 5 contains a hollow tubular base 6 to which protruding sleeves 7 connect on one side between which a slot 8 is formed. Two compressed air hoses 10, which form seals, are glued in semicircular notches 9 in the two sleeves 7 on the extremity of the slot 8.

The width of the base 6 is of course equal to the width of the trench 3. The two auxiliary constructions 5 are so placed in the trench 3 that the slots 8 are directed with their open extremity toward each other. If the auxiliary construction 5 consists of several elements not only the base 6 and the sleeve 7 of the elements located above each other are connected to each other but also the compressed air hoses 10 of these elements.

Before the two auxiliary construction 5 are let down into the trench 3, a joining construction 11 is coupled to each auxiliary construction 5 which, as especially appears from figures 9 and 10 consists of a stiff metal strip 12 with a gutter-shaped joining element with C-shaped cross-section 13 respectively 14 on both edges. The two joining elements 13 and 14 consist of round tubes which are cut open on the side away from the strip 12. One of the joining elements 13 extends into the slot 8 of the auxiliary construction 5. The compressed air hoses 10 of the auxiliary construction 5 are inflated so that not only the slot 8 is sealed but also the joining construction 11 is fixed to the auxiliary construction 5.

As soon as the two auxiliary constructions 5 are fixed with the joining constructions 11 in the slot 3, a length 15 of a supple foil of plastic such as polyethylene with high density starts to be lowered. As especially appears from figures 15 and 16, the foil is unwound from a drum 16 mounted on a vehicle 17. In order to facilitate the lowering the bottom of the length 15 is weighted with elements 18 of metal or concrete. The two edges of the length 15 are folded over and so attached to each other by means of sewing, gluing or fusing together, that a sleeve 19 is formed into which a perforated tube 20 is slid. This tube 20 is made of plastic, relatively stiff but still supple enough to be able to be wound up on the drum 16. The diameter of the perforated tube 20 is smaller than the inside diameter of the joining elements 13 and 14. The length 15 has such a width that the two sleeves 19 with a perforated tube 20 therein formed on their edges can slide into the joining elements 14 located outside the two joining constructions 11 as is represented in detail in figure 12. The tube 20 sits with some play in the joining element 14 but cannot get out of this joining element sideways because its diameter is greater than the slot in the joining element.

As soon as the length 15 has reached the bottom of the trench, the foil is cut off above the ground and the upper extremity of the length 15 rests on the bottom. The vehicle 17 with the drum 16 can now be removed.

Subsequently the joining connection is further finished by injecting a swelling and stiffening liquid 21 such as a polyurethane mixture into the perforated tube 20. This liquid fills the entire inner space of the sleeve 19 through the perforations of the tube 20 and with that, especially during the swelling, presses the sleeve 19 against the internal wall of the joining element 14 as represented in figure 13. After the swelling and stiffening of the liquid 21 the connection between the length 15 and the joining construction 11 is watertight.

If the length 15 was installed in a mixture of

bentonite and cement, then this mixture is allowed to harden or stiffen and then the first panel 22 is ready. If the slot 3 was only filled with bentonite 4 or a tixotropic liquid, then after the installation of the length 15 this liquid is replaced by another cement 23 which hardens or stiffens. After the hardening or stiffening the first panel 22 and the condition represented in figure 2 is obtained.

In entirely the same manner as described above a second panels 22 is made at a distance from the first panel 22 that is somewhat smaller than the width of a length 15. The manufacture of the second panel 22 is therefore also started with the digging of a trench 3 as represented in figure 3. After that 2 auxiliary constructions 5 are installed in this trench each of which is provided with a joining construction 11. Finally a length 15 of foil is installed between the joining constructions 11 after which either the original cement is allowed to harden or stiffen in the trench 3 if this was hardenable or stiffenable, or this original cement is replaced by new cement 23 which is hardenable or stiffenable which is then allowed to harden or stiffen. The condition represented in figure 4 with two completely formed panels 22 is obtained.

After the cement of the two panels 22 is sufficiently stiffened and hardened, a third trench 24 is dug out between the two formed panels 22 and in fact between the two neighboring auxiliary constructions 5 of these panels as represented in figure 5. This intermediate trench 24 is immediately filled with bentonite 4.

The intermediate panel 25 of the wall 1 is now formed in this intermediate trench as follows.

First of all the pressure is let out of the compressed air hoses 10 of the two auxiliary constructions 5 on both sides of the intermediate trench 24 and these auxiliary constructions 5 are removed as represented in figure 7. A lengthened intermediate trench 24 is now obtained into which the joining elements 13 extend, which were located in the last mentioned auxiliary constructions 5.

Into the intermediate trench 24 a length 15 is installed with edges formed by the sleeves 19 in which sits a perforated tube 20, in the joining elements 13 of the two aforementioned joining constructions. After filling these sleeves 19 with a dilatable and stiffenable liquid 21 such as a polyurethane mixture, a watertight connection of this intermediate length 15 and the two joining constructions 11 is obtained.

After the replacement of the bentonite 4 by a stiffenable or hardenable mixture 23 and the stiffening and hardening of this mixture, an intermediate panel 25 is obtained as represented in figure 7 and therefore a uninterrupted wall 1 in which a seal is continuously present, namely a seal formed by three lengths 15 and joining constructions 11 situ-

ated between the lengths.

On both sides of the wall 1 as represented in figure 7 this wall can now further constructed as desired whereby therefore each time a following panel 22 is made in the above mentioned manner at a distance from the last panel and thereafter an intermediate panel 25 is made between these two panels 22.

In a variant of the above described embodiment a length 15 of plastic foil is not used but a length of a metal foil. The metal foil must be sufficiently pliable in order to be able to be rolled up. The edges of the length are then not formed by sleeves but just folded over edges of the metal foil. Because these edges have sufficiently stiffness the perforated tube 20 can be omitted.

In another variant of the above described embodiment, an additional non-perforated supple tube is installed in the perforated tube 20 which at the bottom ends under the tube 20. During the lowering of the length 15 bentonite is pumped through this additional tube which blows clean the inside of the corresponding joining element 13 or 14 in which the sleeve 19 is installed and thereby facilitates the lowering. As soon as the length 15 has reached the bottom of the trench 3 or the intermediate trench 24, this additional tube is withdrawn from the ground under simultaneous injection of the swelling liquid 21 which fills the perforated tube 20 and fills the corresponding sleeve 19 through the perforations.

In yet another variant of the above described embodiment no separate joining constructions 11 are used which are brought into the ground with the auxiliary constructions 5. The length 15 must then be provided with a joining construction on both sides which is identical to the part of the above described joining construction 11 that extends into an auxiliary construction 5. The joining construction is then relatively supple since it must be capable of being rolled onto the drum 16.

Whatever the embodiment is, the procedure can be applied with relatively light cranes. The procedure can be utilized to any depth and on the spot welding is not necessary. The lengths 15 of foil can be taken relatively wide so that the number of connections between the lengths can be limited to a minimum.

The foil utilized for the length 15 is relatively inexpensive and, once it is in the ground in a hard or stiffened cement this foil is protected for ever and it can fulfill its watertight function.

The procedure is very fast and inexpensive.

The present invention is in no way restricted to the embodiments described above and shown in the figures, but such watertight walls can be implemented in different forms and dimensions and also the parts utilized in the procedure can take dif-

ferent forms and dimensions, without departing from the scope of the present invention.

Claims

1. Procedure for making a liquid-tight wall (1) in the ground (2), according to which procedure a trench (3) is made in the ground, the trench (3) is filled with cement (4), at least a length (15) of sealing foil and at least an auxiliary construction (5) for holding one side of the length (15) in the trench (3) are let down vertically, and the auxiliary construction (5) is later removed again from the trench (3) characterized in that first a trench (3) is dug in order to make a wall part, called panel (22) and filled with cement (4), two auxiliary constructions (5) are installed in this first trench (3) one at each extremity of the trench (3) with a slot (8) provided with a seal (10) over their height and on their sides facing each other and a length (15) of sealing foil is lowered between these auxiliary constructions (5) and a joining construction (11) lowered onto both edges thereof so that the length (15) is connected by its edges to the auxiliary construction (5), in each auxiliary construction (5) a joining part (14) of the joining construction (11) is present and the slots (8) in the sides of the auxiliary constructions (5) are sealed, a second trench (3) for a second panel (22) is dug at a distance which is almost equal to the width of the length (15) of sealing foil and is filled with cement (4), two auxiliary constructions (5) are installed therein in the manner described above with a length (15) of sealing foil between them which is connected to these auxiliary constructions (5) by joining constructions (11) of which a joining part (14) extends into the auxiliary constructions (5), subsequently an intermediate trench (24) which is filled with cement (4) is dug between the two trenches (3) and thus between two auxiliary constructions (5), after sufficient hardening or stiffening of hardenable or stiffenable cement (4 or 23) in the first and the second trench (3) the two auxiliary constructions (5) are removed from these trenches (3) and finally in the thereby enlarged intermediate trench (24), filled with cement (4), for a third panel (25) a third length (15) of sealing foil is installed with joining edges (19, 20) on its edges which work together with the joining parts (14) of the lengths (15) in the first and second trench (3) after which, in as far as necessary, the wall is made further by forming a following panel (22) each time at a distance of a panel (22) at the extremity of the trench (3), in the manner described above for a first or second panel (22), and subsequently forming an intermediate panel (25) between the two panels (22) in the same manner as a third panel (25).

2. Procedure according to claim 1, characterized in that the joining construction (11) of the lengths (15) is a separate joining element in a first and a second trench (3) in relation to the length (15), which joining element is installed with a joining part (14) in an auxiliary construction (5) and has a joining edge (13) on its edge lying opposite which works together with a joining edge (19, 20) on an edge of the length (15).

3. Procedure according to claim 2, characterized in that the joining construction (11) is installed in the trench (3) together with the corresponding auxiliary construction (5).

4. Procedure according to one of the claims 2 and 3, characterized in that the joining edge (19, 20) of the length (15) in the first and second trench is equal to the joining edge (19, 20) of the length which is installed in the third trench.

5. Procedure according to one of the claims 2 through 4, characterized in that the joining edge (19, 20) of a length (15) of sealing foil is formed by a folded over edge which forms a sleeve (19) and a relatively stiff tube (9) installed therein.

6. Procedure according to one of the claims 2 through 5, characterized in that the joining edge (19, 20) of a length (15) is sealed in a joining edge (13) of a joining construction (11) after the installation by means of a dilatable and hardenable liquid (21).

7. Procedure according to the claims 5 and 6 characterized in that as tube (20) in a sleeve forming edge (19) of a length (15) a perforated tube is utilized and the dilatable hardenable liquid (21) is injected through this perforated tube.

8. Procedure according to one of the claims 5 and 7, characterized in that in order to facilitate the lowering of the length (15) into the tube (19) of a joining edge (19, 20) of the length (15) an additional tube is installed along which a lubricating liquid is squirted for cleaning the joining edge (13) of the joining construction (11) into which the joining edge (19, 20) of the length (11) must be brought.

9. Procedure according to one of the claims 2 through 8, characterized in that as joining construction (11) an element is utilized consisting of a relatively stiff strip (12) which carries a gutter-shaped joining element (13 and 14) on both edges which has the shape of a tube which is cut open on the side away from the strip (12) and through which the joining edge (19, 20) of a length (15) can not get out sideways.

10. Procedure according to one of the preceding claims, characterized in that as length (15) a length of rollable foil is utilized which is unwound from a drum (16), which foil is provided with weighting elements (18) in order to facilitate the lowering into a trench (3 or 24).

11. Procedure according to one of the preceding claims, characterized in that as auxiliary construction (5) an element is utilized that has a base (6), two protruding parts (7) standing thereon between which a slot (8) is formed for a joining construction (11) while the seal (10) is formed by two compressed air hoses (10) which are installed in notches (9) in the protruding parts (7), in the slot (8).

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12. Procedure according to one of the preceding claims, characterized in that the trench (3 or 24) is first filled with bentonite or analogue liquid and after the installation of a length (15) in this trench (3 or 24) this liquid is replaced by a stiffenable or hardenable liquid (23).

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13. Procedure according to claim 1, characterized in that in the first and the second trench (3) a length (15) of foil is installed which is provided with the auxiliary construction (5) on its edges, which auxiliary construction (5) is brought with a joining part into an auxiliary construction (5) which joining part then after the digging of an intermediate trench (24) and the removal of the auxiliary construction (5) is made to work together with a joining edge (19, 20) of the length (15) which is installed in the intermediate trench for the formation of the third panel (25).

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14. Wall manufactured according to the procedure according to one of the preceding claims.

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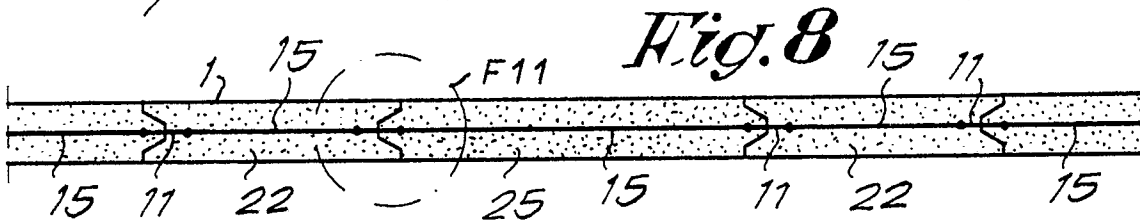
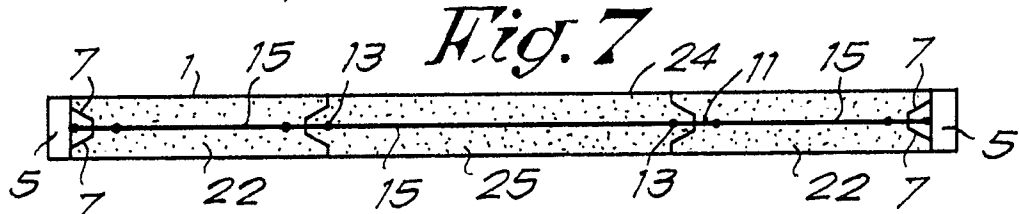
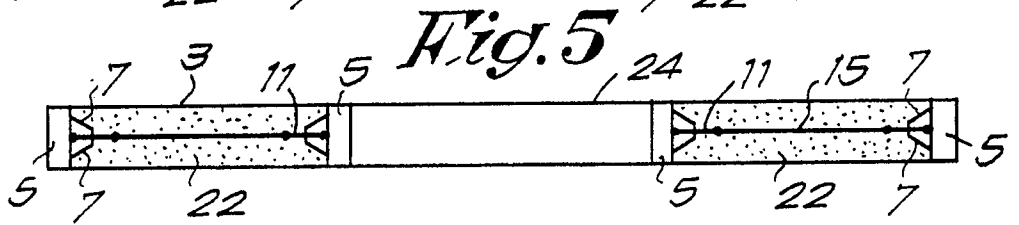
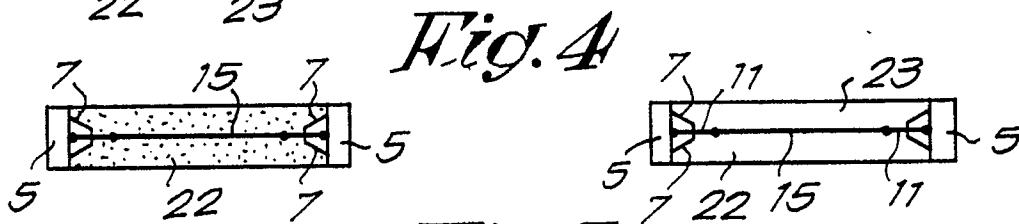
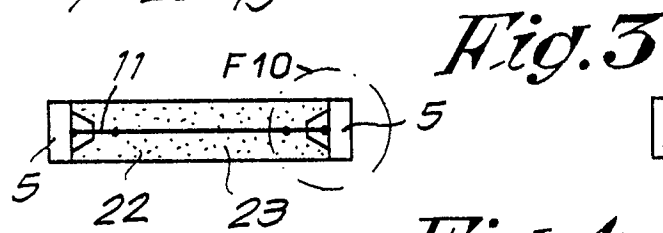
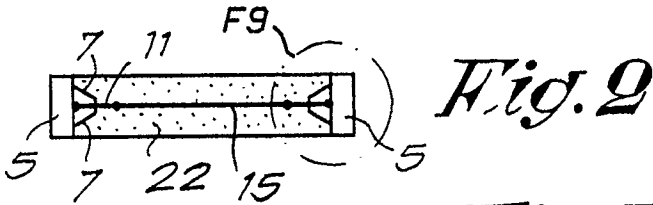
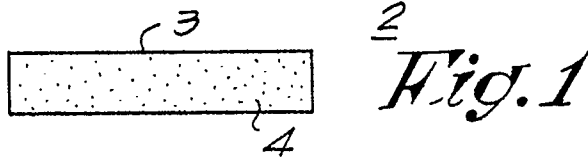
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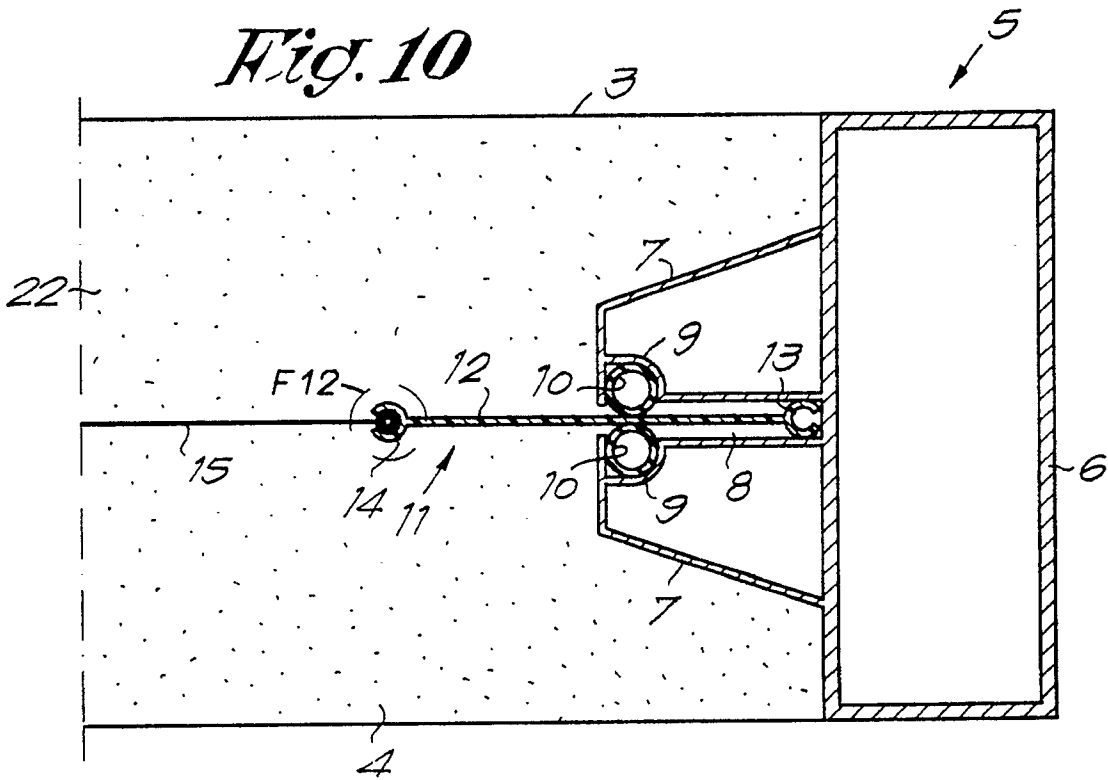
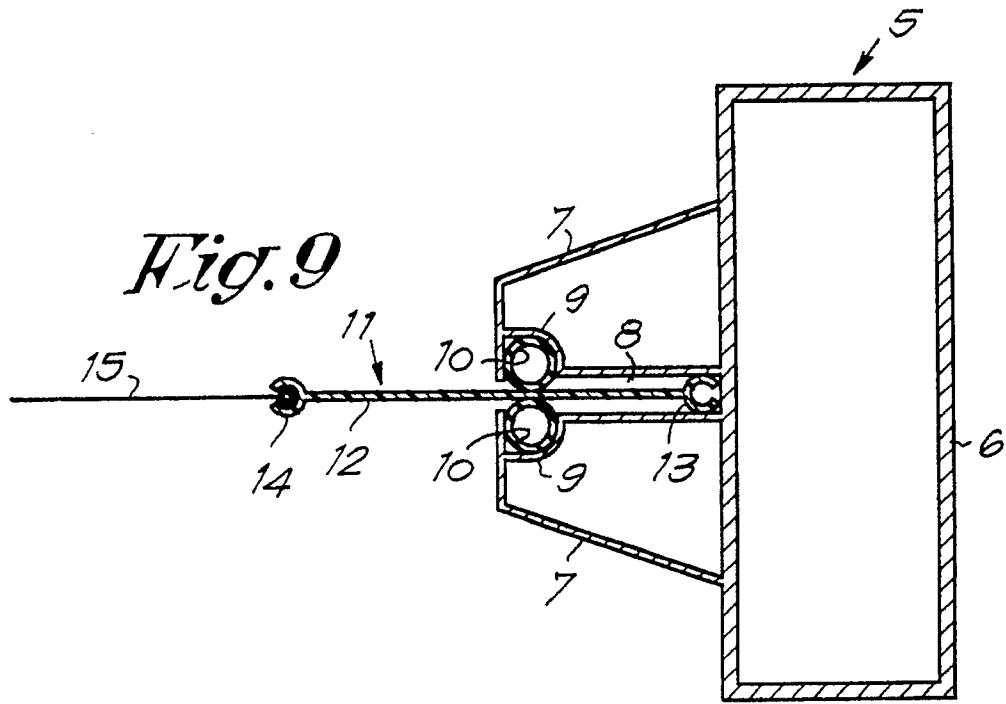
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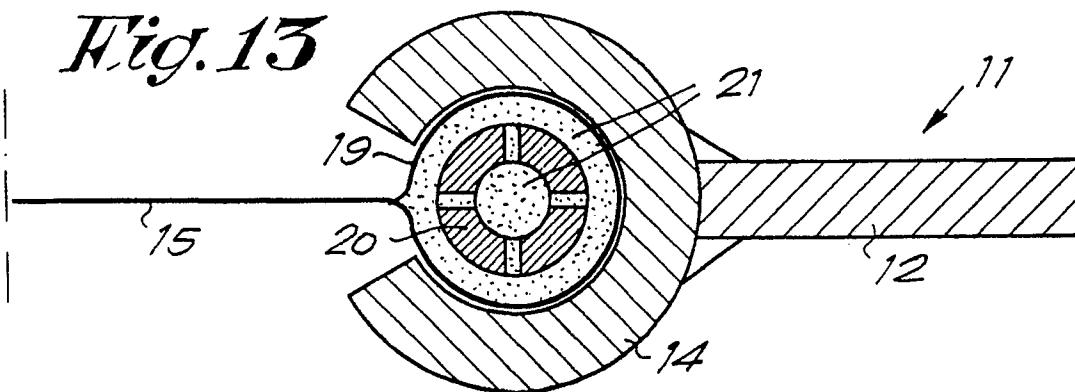
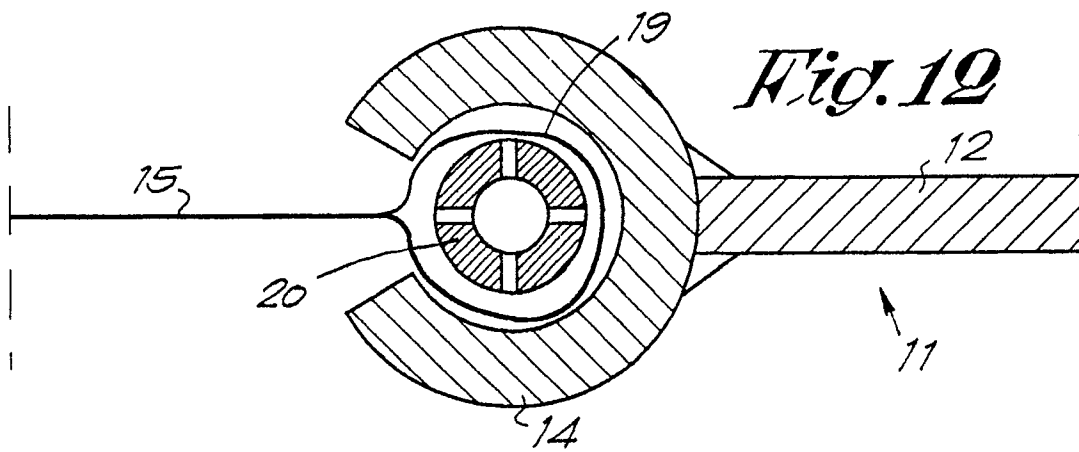
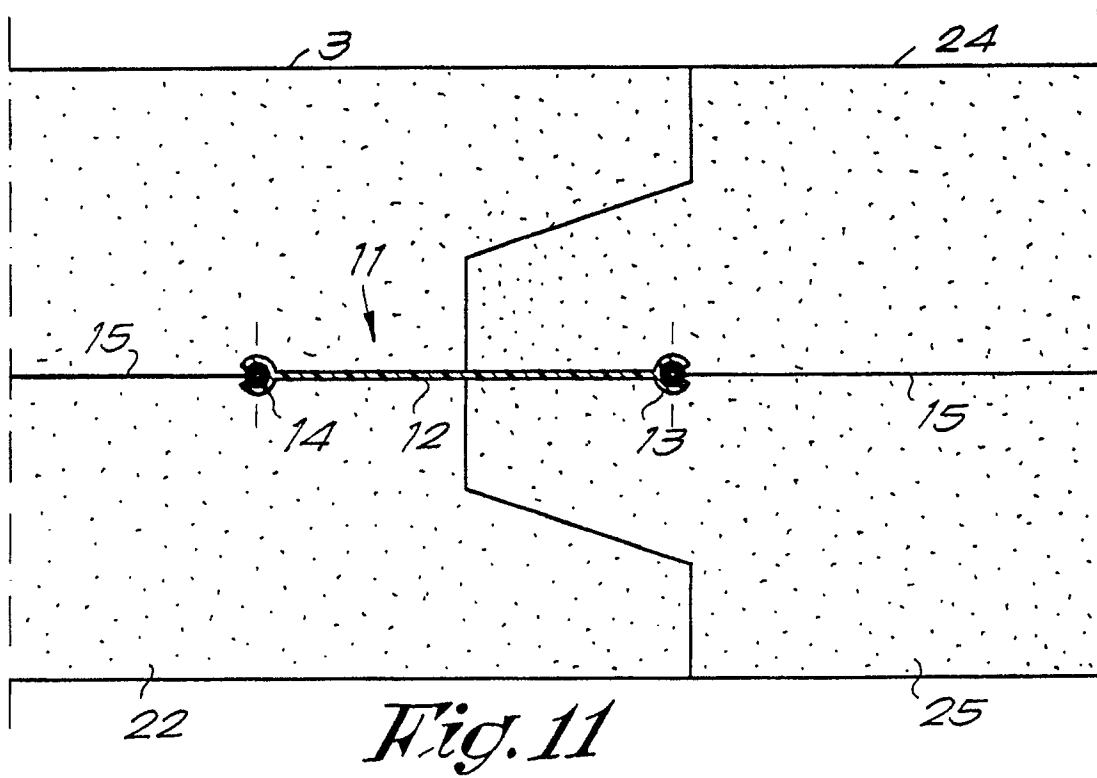


Fig. 14

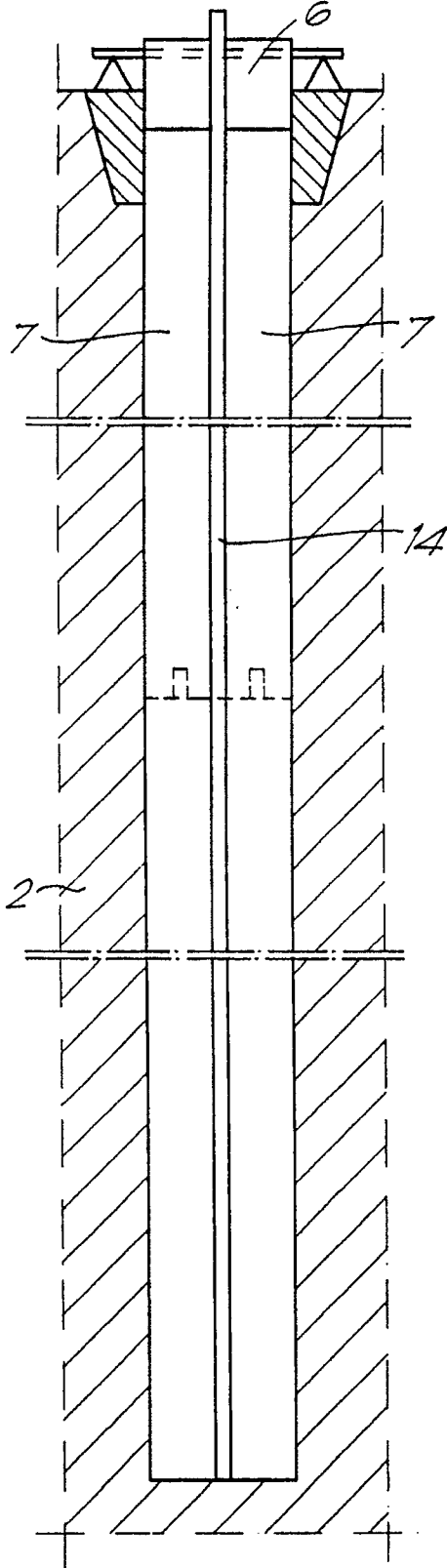


Fig. 15

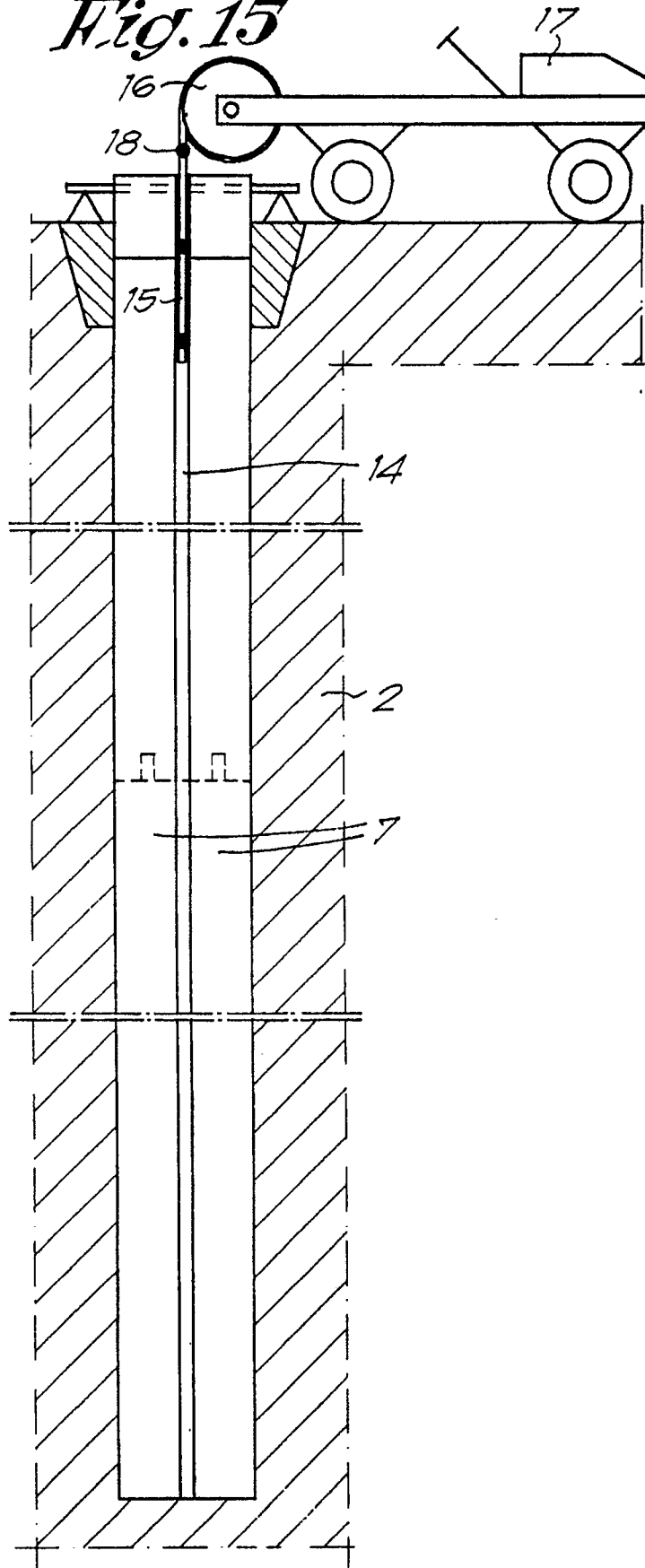
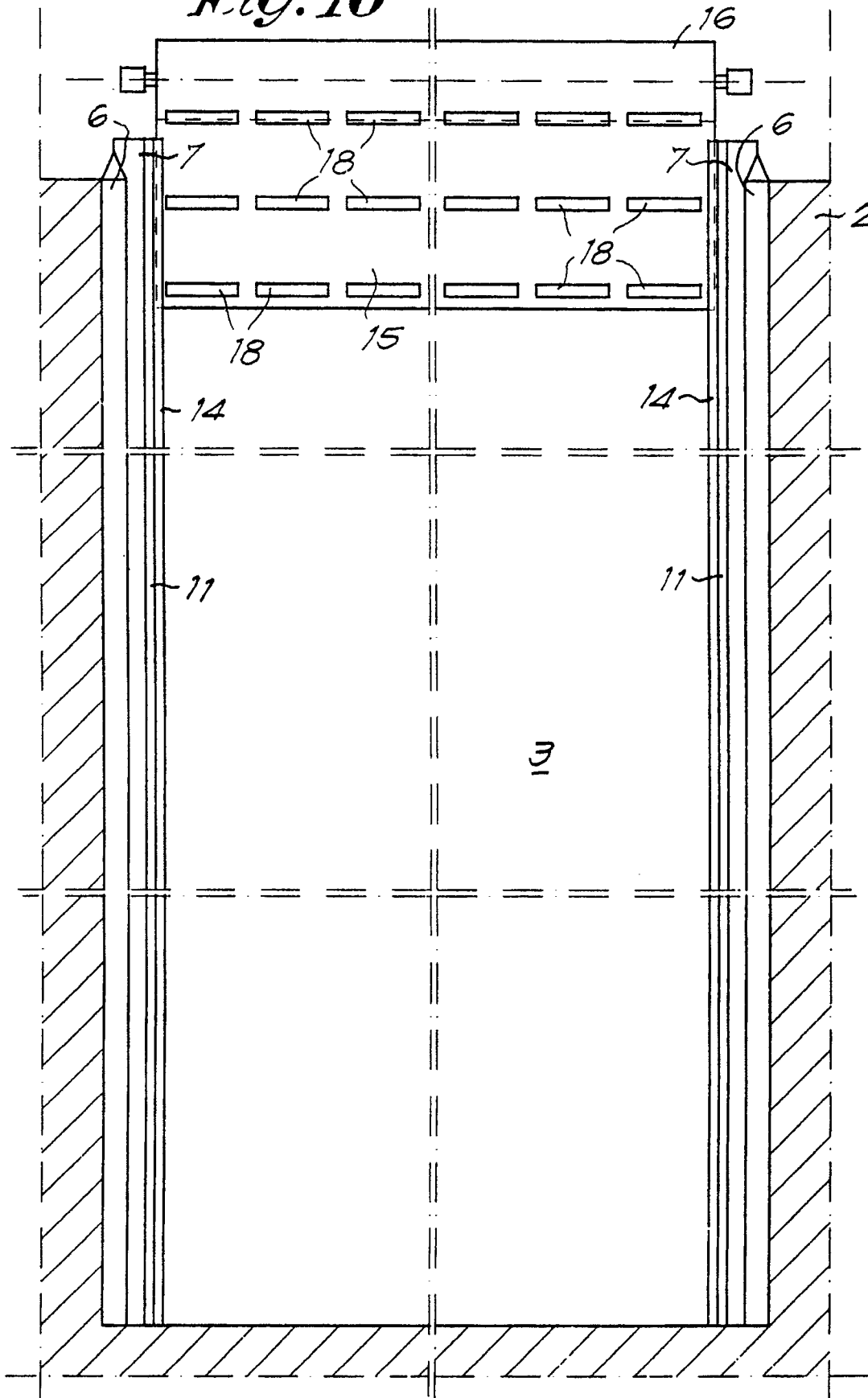


Fig. 16





DOCUMENTS CONSIDERED TO BE RELEVANT			EP 90201590.8
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Y	<u>DE - A1 - 3 727 202</u> (HELD) * Abstract; fig. 1,2,4,5; column 5, lines 49-54; columns 6-7; claims *	1-3, 10,12	E 02 D 19/18 E 02 D 31/04
A	--	4,6	
Y	<u>DE - A1 - 3 430 791</u> (ZÜBLIN AG) * Claims 1-3; pages 8-9; fig. 1-4 *	1-3, 10,12	
A	--	4,6	
Y	<u>DE - A1 - 3 430 790</u> (ZÜBLIN AG) * Abstract; claims 1-18; fig. 2,3,5; pages 12-13 *	1-3,12	
A	--	4,6,9	
Y	<u>DE - A1 - 3 432 706</u> (ZÜBLIN AG) * Claims; page 7, lines 18-20; page 8, lines 1-2; pages 12-13; fig. 1-3,6-8 *	1-3,12	TECHNICAL FIELDS SEARCHED (Int. Cl.) E 02 D
A	--	4	
A	<u>EP - A2 - 0 198 666</u> (FINIC B.V.) * Abstract; claims; fig. 1,2, 4,5 *	1,2,4, 5	

The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 20-09-1990	Examiner LANG
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p>			