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(57) Disclosed is a method of constructing a concrete deck (2) of a structure in which, in the finished construction, the deck is supported by spaced-apart pillars or piers (1), the method enabling concrete slipforming or jumpforming techniques to be used in the construction of the deck. In the method, members which when finally in-situ are to form a deck supported on spaced-apart uprights are formed in upright position (member 2E/F in Fig. 2) by one or other of these techniques each adjacent an upright (1E) that is finally to support it, and the member is then pivoted (member 2D/E in Fig. 2) about its adjacent upright (1D) to move it to its final position (member 2C/D in Fig. 2).

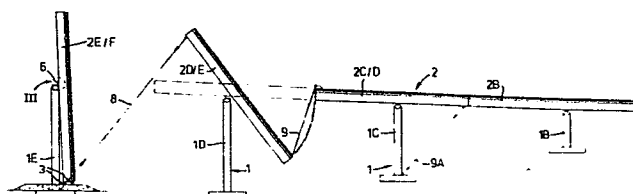


FIG. 2

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DECK CONSTRUCTION

5 This invention relates to the construction of
decks of structures where the deck is to be supported by
spaced - apart upright pillars or piers. In particular
the invention is concerned with the construction of
bridge decks.

As is well known, concrete is a favoured
constructional material and an advantageous method
of constructing upright concrete pillars or piers
10 is to utilise either the so-called slipforming
technique, or the so-called jumpforming technique.
An advantage of these techniques is that they avoid
the need to use elaborate moulds and falsework such
as is required, for example, when casting in-situ
15 concrete deck parts which are to be supported by spaced-
apart uprights and which have configurations that do
not lend themselves to the use of slipforming or
jumpforming. Even if the formation of such parts
can be simplified by forming the parts away from
20 what are to be their final locations, for example as
proposed in British Patent Specification No. 1,000,949
to Paul Dupont, there remains the problem of moving
the parts into their final positions. By the present
invention the techniques of slipforming and jumpforming
25 are extended to the construction of concrete decks,
which when finally in-situ are supported on spaced-
apart uprights, in such a way that movement of

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each member of a deck from an upright position in which it is slipformed or jumpformed into a final position is accomplished in a simple manner and with a minimum of additional equipment.

5 According to the present invention there is provided a method of constructing a deck in concrete comprising forming in upright position by the slipforming technique or by the jumpforming technique a plurality of members; characterised in that each
10 member so formed is to be a member of said deck, and is so formed adjacent an upright that is to support it in its final position; and in that after its formation each so formed member is pivoted about the upright that is to support it for moving it into
15 a final position in which it is to become a part of the deck. In this way the benefits of slipforming or jumpforming are utilised in the formation of the deck members, and as each member so formed is formed adjacent an upright, the member only has to be pivoted
20 into its final position and the major component required to effect this pivoting, i.e. the upright, is itself a part of the finished construction. Furthermore, pivoting is facilitated by the fact that it takes place above a point in a mid-way zone of the member.

25 For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

30 Figure 1 is a side view, broken into three, of the approach part of a river bridge illustrating various stages in the construction of the bridge.

 Figure 2 is a side view on a larger scale than Figure 1 further illustrating how this part of the bridge is erected.

35 Figure 3 is a side view on a still larger scale showing in greater detail the area ringed at III in Figures 1 and 2,

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Figure 4 is a sectional view taken on the line IV-IV in Figure 3, and

Figure 5 is a sectional view taken on the line V-V in Figure 4.

5 The Figures relate to the approach spans of a road-carrying river bridge in which in the completed structure pairs of side-by-side uprights in the form of piers 1 carry a bridge deck 2. During construction the piers 1 are constructed in-situ, 10 in conventional fashion (for example by slipforming or jumpforming) on previously driven piles. In the particular bridge illustrated a first span 2A and part of a second span 2B of the bridge deck are also constructed in-situ on trestling so that first 15 and second piers 1A and 1B are spanned and in addition the deck extends towards the third pair of piers 1C. At the other end of the bridge approach a part span 2K is constructed in conventional fashion together with the main bridge spans. Construction of 20 the bridge deck at the approach part of the bridge is carried out making use of either the slipforming technique or the jumpforming technique and will now be described with reference to slipforming.

 Adjacent the third pair of piers 1C slip 25 forms are set-up on top of the pile cap on which the piers stand, or at beach level if there is a beach, in which case mass concrete walls or pillars are provided to carry loads down to the pile caps under the beach. The slip forms are positioned to form two 30 side-by-side upright concrete box beams 2C/D each disposed about one metre from the adjacent face of one or other of the piers, which beams are to become members of the deck. In the initial stage of slip-forming, temporary supports 3 are cast to some two 35 or four metres in height. Thereafter each box beam 2C/D is cast on these supports. - For each beam 2C/D slipforming is carried out continuously until the level

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of the top of the adjacent pier 1C is reached. At this point slipforming is stopped and a diaphragm section 4 is cast in the beam. Up to this level the beam is free standing but at this stage temporary wind bracing 5 is installed to transfer wind loads to the top of the adjacent pier. After construction of the diaphragm section, slipforming is re-commenced to complete the box beam.

As the box beam is formed the inside shutters of the slipforming equipment are moved in and out to accommodate changes in flange and web thickness and the sliding members are steered as necessary to form any required overall curvature to the beam in the longitudinal plane. Pockets are formed for providing a number of prestressing anchorages spread along the beam.

After slipforming has been completed the beam is prestressed by straight bars or tendons inserted into ducts cast in the beam. This prestressing is carried out from platforms lowered and raised inside the beam after completion of the slipforming.

In a similar manner to that just described, pairs of upright box beams 2D/F, 2E/F, 2F/G..... are constructed adjacent each pair of piers 1D, 1E, 1F..... The overall length of each beam is chosen in relation to the height of the adjacent pier and the acceptance load that can be applied during transfer of the beam to its final position. Pairs of beams can be constructed at all the pairs of piers before further work is carried out (as shown in Figure 1), or further work at each pier pair can be commenced once the pair of beams at that pier pair is completed. It should here be noted that, for simplicity, Figure 2 in particular is drawn as if there is only one beam and one pier at each pier location (and such could

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be the case in some constructions, as, equally, there could be more than two beams and piers at each pier location).

5 Transfer of each beam to its final position
is effected by pivoting the beam about the top of
the adjacent pier on rocker bearings 6 installed
at the diaphragm section 4. These bearings 6 are
adjacent what will be the final position of permanent
bearings constituted by plates 7 which serve as
10 shear plates at the start of the pivoting operation.

When the beams are ready for transfer to
their final position, and commencing with one of
the beams of the pair nearest the constructed
in-situ deck section at one end or the other of
15 the bridge approach (Figures 1 and 2 illustrate
the case where work is commenced at the deck spans
2A, 2B end), jacks (not shown) are installed at
the bottom of the first slipformed box beam to be
pivoted. Sets of cables 8 and 9 are connected
20 to extend from an upper zone (in the case illustra-
ted the top) of this beam (illustrated for one
of the beams 2D/E in Figure 2) away from the
already-constructed part of the deck down to the base
of the pier (pier 1E in Figure 2) that is next
25 adjacent the pier (1D in Figure 2) immediately
adjacent the beams; and from a lower zone (in the
case illustrated, the base) of the beam up to the
free end of the already-constructed deck part.
Further cabling 9A is installed between the free
30 end of the already-constructed span 2B and the
foot of the first free-standing pier 1C, this
being left in place whilst the beams are transferred
to their final positions and thereafter removed.
The wind bracing 5 is removed and using the cables
35 8 and 9 and the jacks the beam is tilted so that
the one metre gap between the beam and the
immediately adjacent pier is closed at the top of

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the pier (see beam 2E/F and pier 1E in Figure 2).
The rocker bearings 6 are installed, if not already
fitted and any necessary adjustments made to them,
to the bearing plates 7 and to landing stools 10
5 for the bearings 6 at the top of the pier.
Levelling screws 11 are provided to facilitate
such adjustment.

The jacks at the bottom of the beam are
relieved of load and pivoting of the beam is then
10 effected, utilising the cables 8 and 9, so that
the beam pivots about the top of its adjacent pier
with the bearings 6 rocking on the landing stools
10. At the completion of pivoting, the beam is
jacked up so that the rocker bearings 6 can be
15 removed and is then lowered so that the bearing
plates 7 come to rest on permanent bearings (not
shown) installed on the concrete pier. At this
stage the beam is tilted sideways to obtain any
camber required and is connected to the already-
20 constructed deck part. It will be noted that this
connection is made at approximately mid-span
between piers. The connection is made utilising
short lengths of prestressing bar after a tolerance
gap has been filled, in-situ, with concrete. Each
25 beam at a pair of piers is transferred to its
final position in this way before transfer of the
beams at the next pair of piers is commenced.

It is to be noted that the beams do not
exactly balance when they are pivoted, the degree of
30 out of balance being chosen so that maximum use is
made of the pier heights. The out-of-balance
load is finally taken at the cantilevered end
of the already-constructed deck part so that final
stress is not increased. Temporary dead load
35 bending moments do not exceed the dead load plus
live load moments for which the deck as a whole is
designed. As an example and considering, in the

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embodiment illustrated, one of the box beams 2D/E, the pier 1D is approximately 32.7 metres high and the overall length of the beam 2D/E is approximately 55.3 metres. The pivot point for the beam is at approximately 25.9 metres from what will be its cantilevered end so that the length of the beam on the other side of the pivot point is approximately 29.4 metres. The beam weighs approximately 1320 tons. For this beam the load in the cables 8 at the commencement of pivoting is 250 tons and is 0 tons at the end of pivoting (these cables being connected to what is then the cantilevered end of the beam). The load in the cables 9 is 0 tons at the commencement of pivoting, the load at this end of the beam immediately prior to making good its connection with the already-constructed deck part being about 70 tons.

Although construction of a bridge deck composed of side-by-side box beams supported on side-by-side pillars has been described it will be appreciated that other forms of deck could be constructed in the same way by forming in upright position by the slipforming technique a plurality of members, each member being formed adjacent an upright that is to support it in its final position, and pivoting each so-formed member about the upright that is to support it into a final position in which it is to become a member of the deck. Furthermore, although slipforming has been referred to throughout this detailed description is is repeated that jumpforming can be used instead.

CLAIMS

1. A method of constructing a deck in concrete comprising forming in upright position by the slipforming technique or by the jumpforming technique a plurality of members; characterised
5 in that each member (2C/D, 2D/E, 2E/F...) so formed is to be a member of said deck (2), and is so formed adjacent an upright (1C, 1D, 1E...) that is to support it in its final position; and in that
10 after its formation each so formed member (2C/D, 2D/E, 2E/F...) is pivoted about the upright (1C, 1D, 1E...) that is to support it for moving the member (2C/D, 2D/E, 2E/F) into a final position in which it is to become a member of the deck (2).

2. A deck construction method as claimed
15 in claim 1, wherein each said member (2C/D, 2D/E, 2E/F...) is formed spaced from its adjacent upright (1C, 1D, 1E ...); and wherein prior to said pivoting, jacking means is installed at the bottom
20 of the member, cables (8,9) are connected to extend from an upper zone of the member downwards and from a lower zone of the member upwards, and this jacking means and these cables are used initially to tilt the member to close the gap between it
25 and the adjacent upright at the top of the upright.

3. A deck construction method as claimed in claim 2, wherein after initially tilting the member, the jacking means is relieved of load and said
30 pivoting of each member is effected utilising the cables.

4. A deck construction method as claimed
in claim 1, 2 or 3, wherein said pivoting of each member is effected with the member supported from
35 the upright by bearings (6) carried by the member and rocking on landing stools (10) carried by the upright.

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5 5. A deck construction method as claimed
in claim 4, wherein after said pivoting has been
completed each said member is jacked, said bearings
are removed, and the member is lowered onto
permanent bearings carried by the upright.

10 6. A deck construction method as claimed
in any one of the preceding claims, wherein during
construction each said member is free-standing
until it reaches the top of the adjacent upright,
at which stage windbracing (5) is installed
between the member and the adjacent upright and
formation of the member is then continued, the
windbracing being removed prior to pivoting the
completed member for moving the member into its
15 final position.

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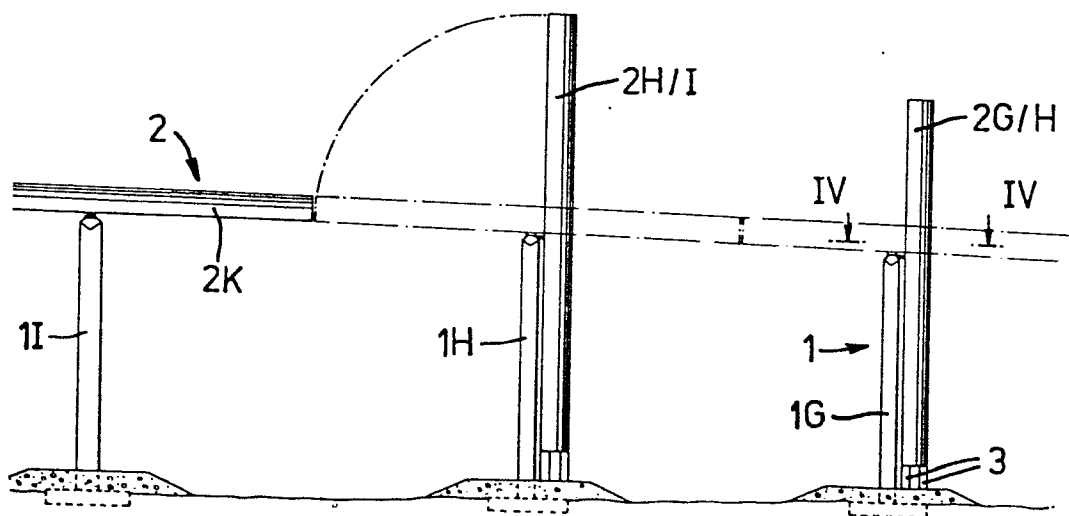
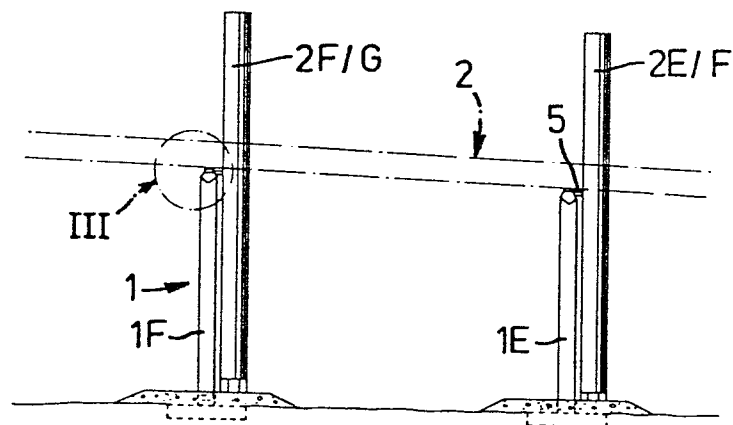
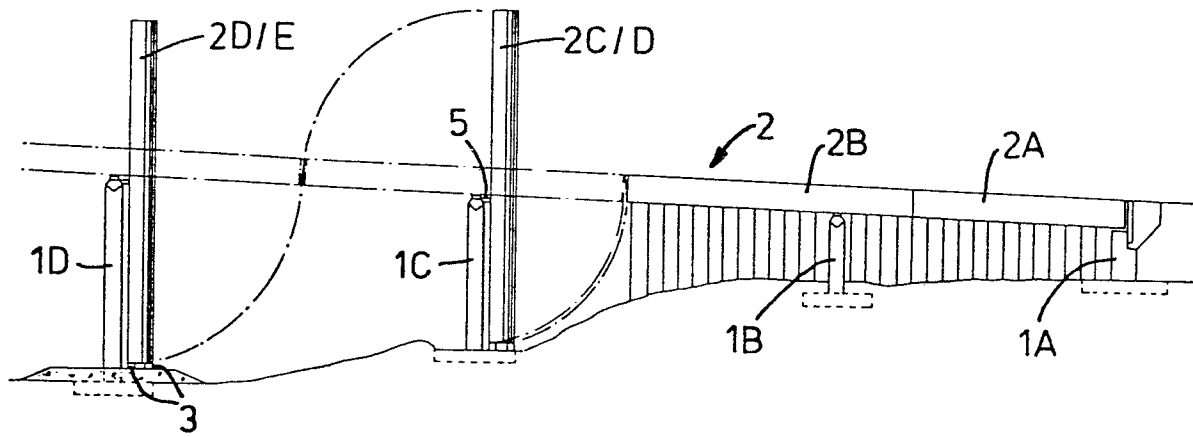


FIG. 1

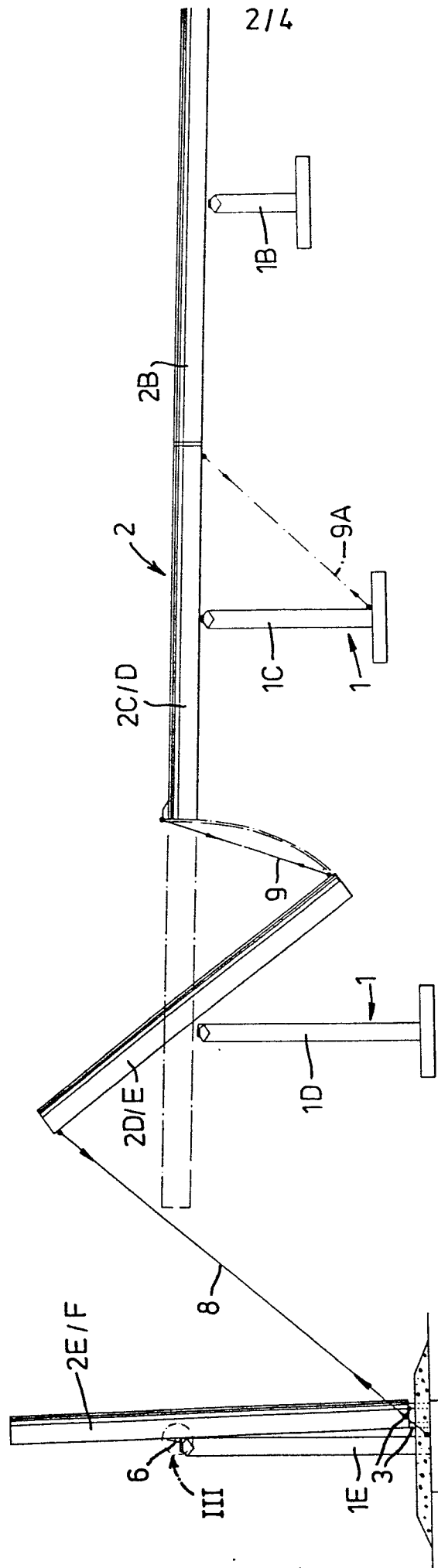


FIG. 2

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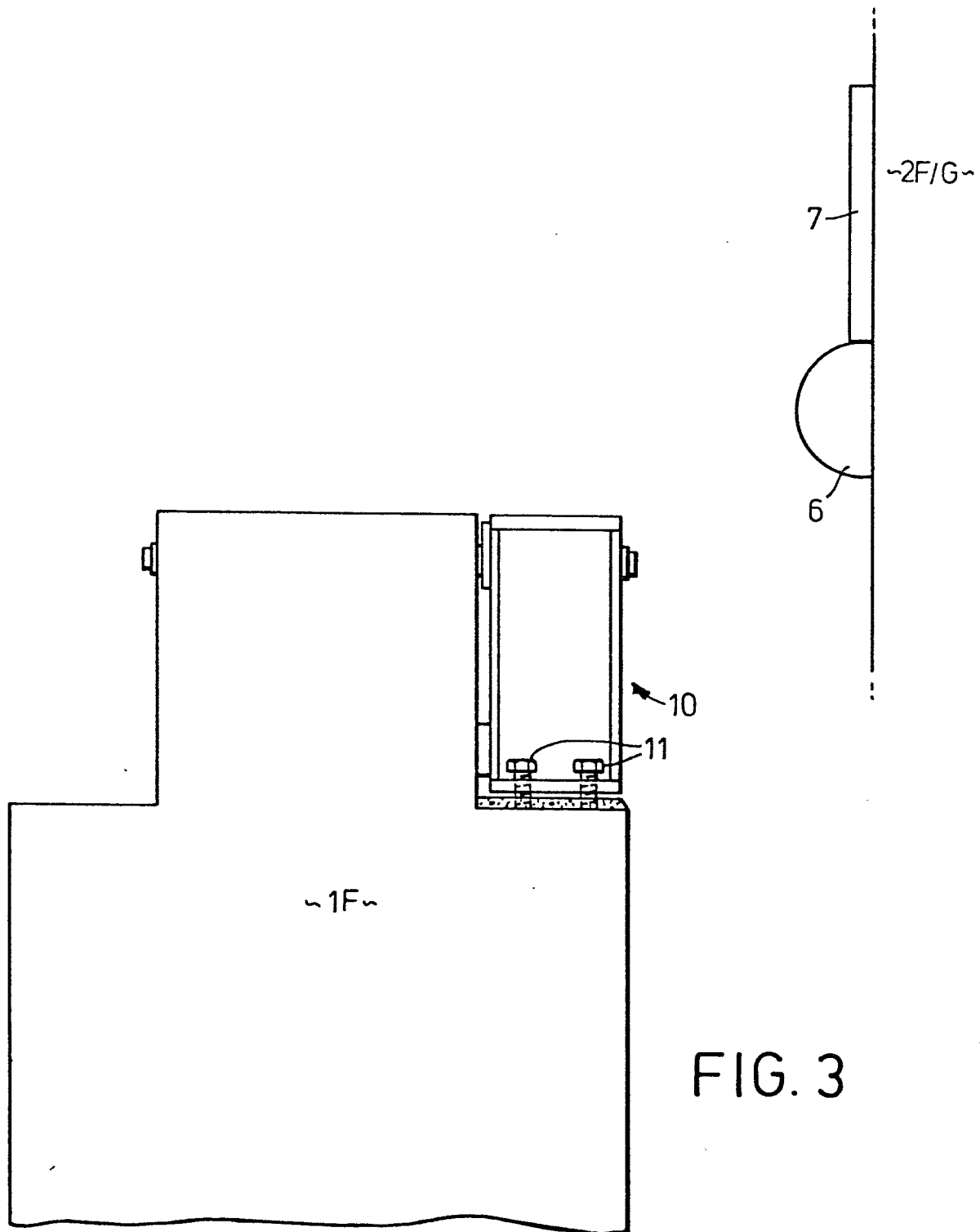


FIG. 3

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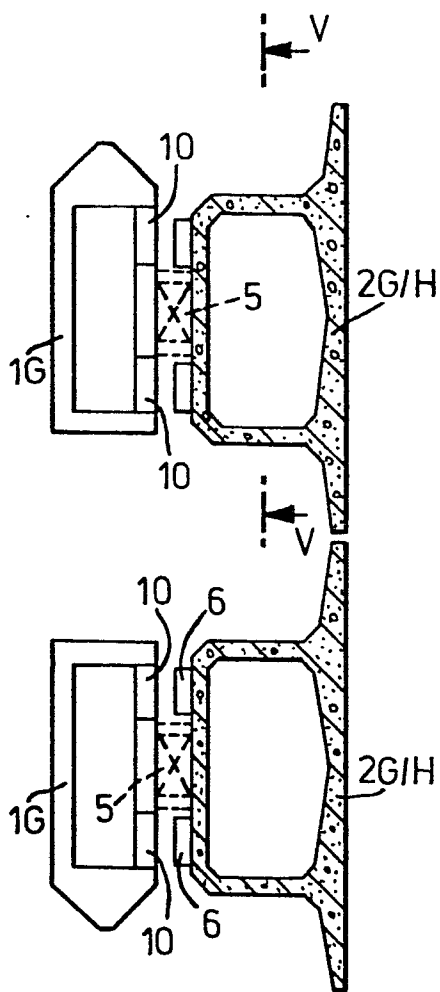


FIG. 4

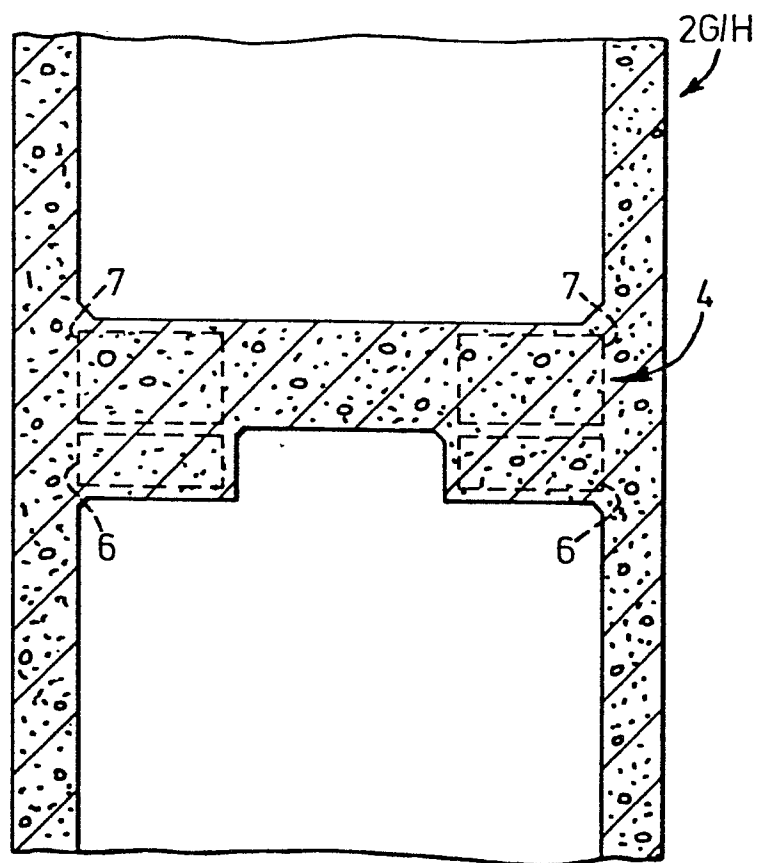


FIG. 5



European Patent
Office

EUROPEAN SEARCH REPORT

0023132

Application number

EP 80 30 2409.0

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate of relevant passages	Relevant to claim	
X	<u>DE - B - 1 684 464</u> (G. SCHULTZ - FADEMRECHT) * column 1, line 39 to column 2, line 57; fig. 1 to 7 * --	1-4	E 01 D 21/04
X	<u>DE - A1 - 2 422 984</u> (BAUGESELLSCHAFT H. RELLA & CO.) * page 2, paragraph 2 to page 6; fig. 1 to 7 * --	1,4,5	TECHNICAL FIELDS SEARCHED (Int. Cl.)
	<u>DE - A - 2 017 714</u> (G. SCHULTZ - FADEMRECHT) * pages 7 and 8 * --	1	E 01 D 7/00 E 01 D 21/00
A	<u>FR - A - 1 234 757</u> (P. DUPONT) * fig. 1 to 23 * --		
A	<u>AT - B - 202 587</u> (ALPENLAND BAUGESELLSCHAFT MBH) * fig. 1 to 4 * ----		
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			&: member of the same patent family, corresponding document
☒ The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Berlin		16-10-1980	PAETZEL