United States Patent [19]

Muller

[11] **3,902,212**

[45] **Sept. 2, 1975**

[54] **BUILDING OF MULTISPAN BRIDGES OR THE LIKE WORKS, BY THE CANTILEVER METHOD**

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[73] Assignee: **Societe d'Etudes de Genie Civil et de Techniques Industrielles (GE.C.T.I)**, Paris, France

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[21] Appl. No.: **379,999**

[52] **U.S. Cl.** **14/1**; 52/745; 52/749; 212/1

[51] **Int. Cl.**[2] **E01D 1/00**

[58] **Field of Search** 52/749, 745; 14/23–25, 1, 7, 8; 212/1, 74

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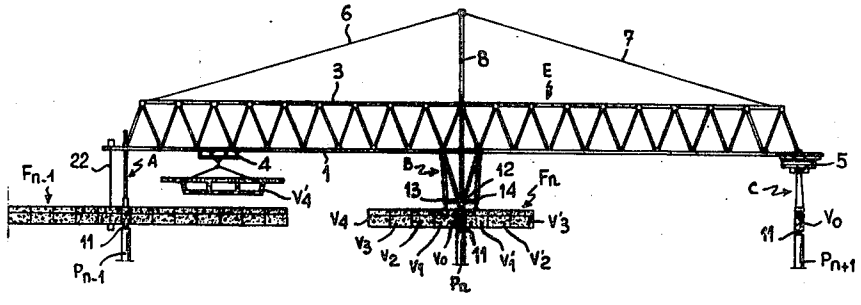
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Primary Examiner—Ernest R. Purser
Assistant Examiner—H. E. Radnazo
Attorney, Agent, or Firm—Wigman & Cohen

[57] **ABSTRACT**

A device for use in building the superstructure of a multispan civil engineering work, such as a bridge or elevated road or track, which superstructure comprises at least one beam extending on both sides of a pier and resting upon the latter, the said beam being produced in successive sections or voussoirs which are placed in position by cantilevering in opposite directions starting from an initial or pier voussoir which caps the said pier, the said device comprising a raised scaffold having a median support adapted to rest on the said pier, wherein the said median support comprises a central bearing member which is adapted to rest on the said pier voussoir and two additional bearing members which are adapted to respectively rest on the two first voussoirs which border on the said pier voussoir, and wherein means are provided for anchoring said additional bearing members to the respective voussoir on which they are adapted to rest.

3 Claims, 7 Drawing Figures



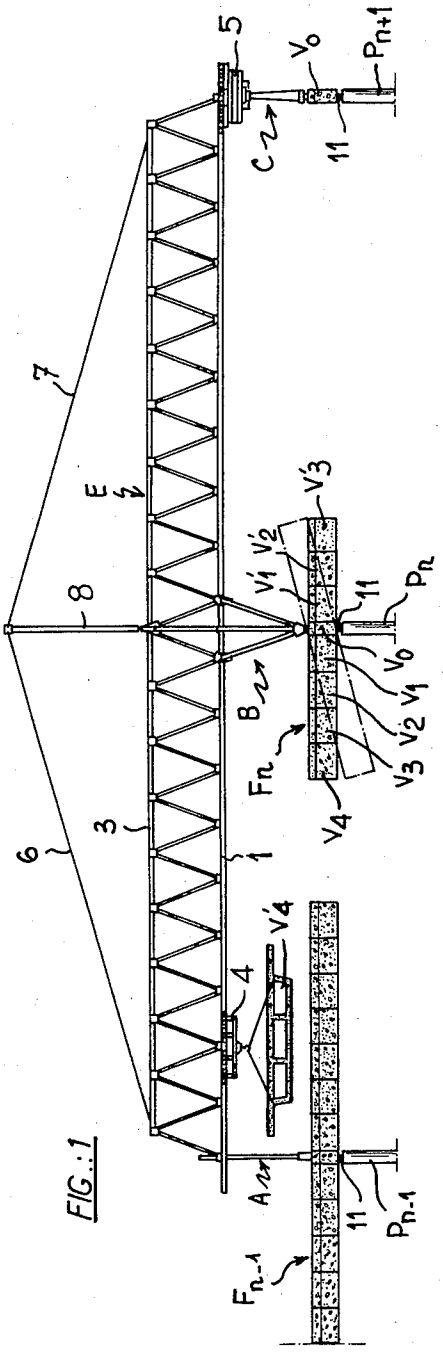

5
V_o
P_{n+1}
C
11
7
E
8
V'_3
V'_2
V'_1
11
P_n
V_o
B
V_1
F_n
V_2
V_3
V_4
6
3
1
V'_4
4
A
11
P_{n-1}
F_{n-1}

FIG.: 1

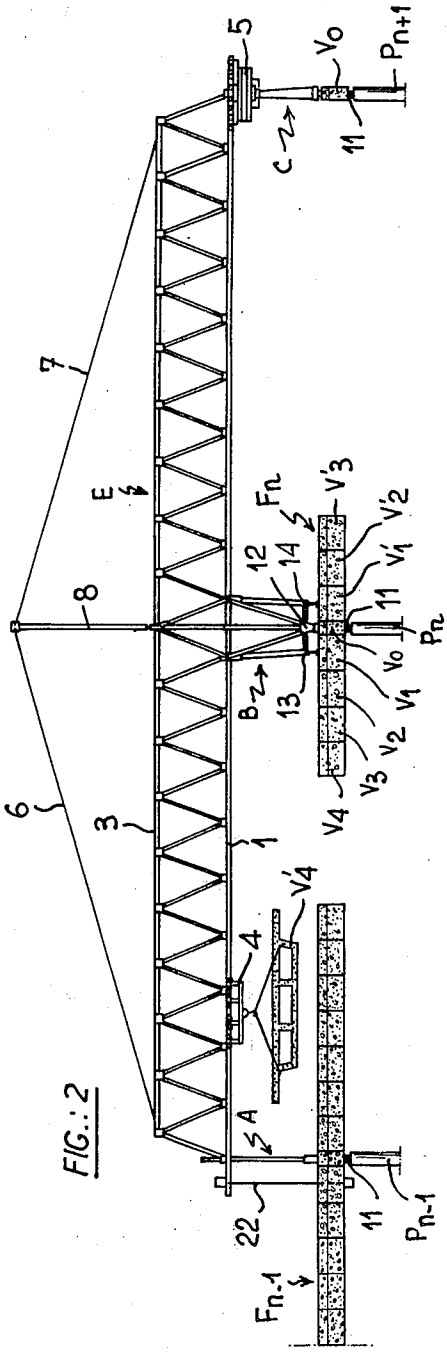

5
V_o
P_{n+1}
C
11
7
E
F_n
V'_3
12
14
V'_2
V'_1
8
11
P_n
V_o
B
13
V_1
V_2
V_3
V_4
6
3
1
V'_4
4
A
22
11
P_{n-1}
F_{n-1}

FIG.: 2

FIG.: 3

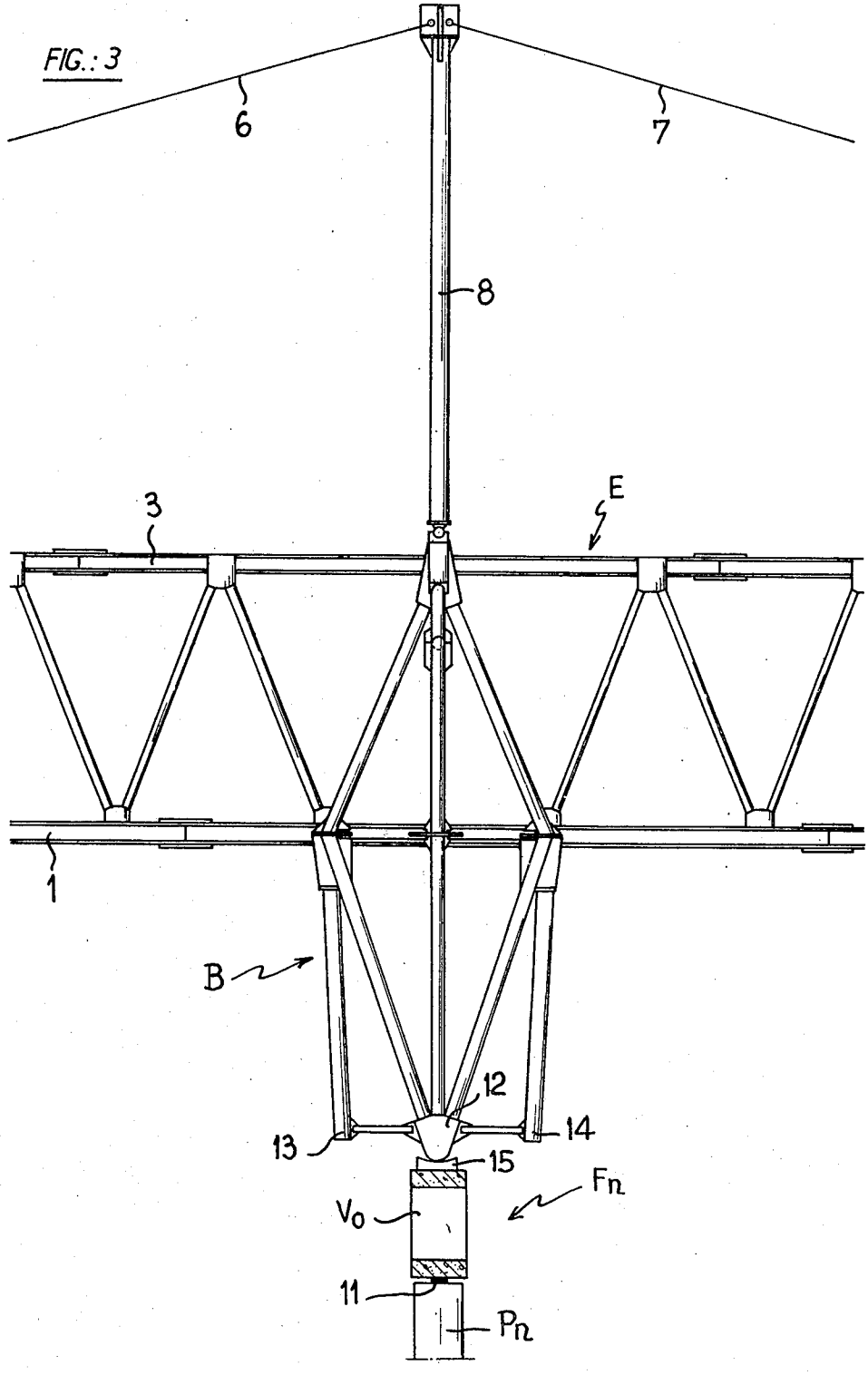


FIG.:4

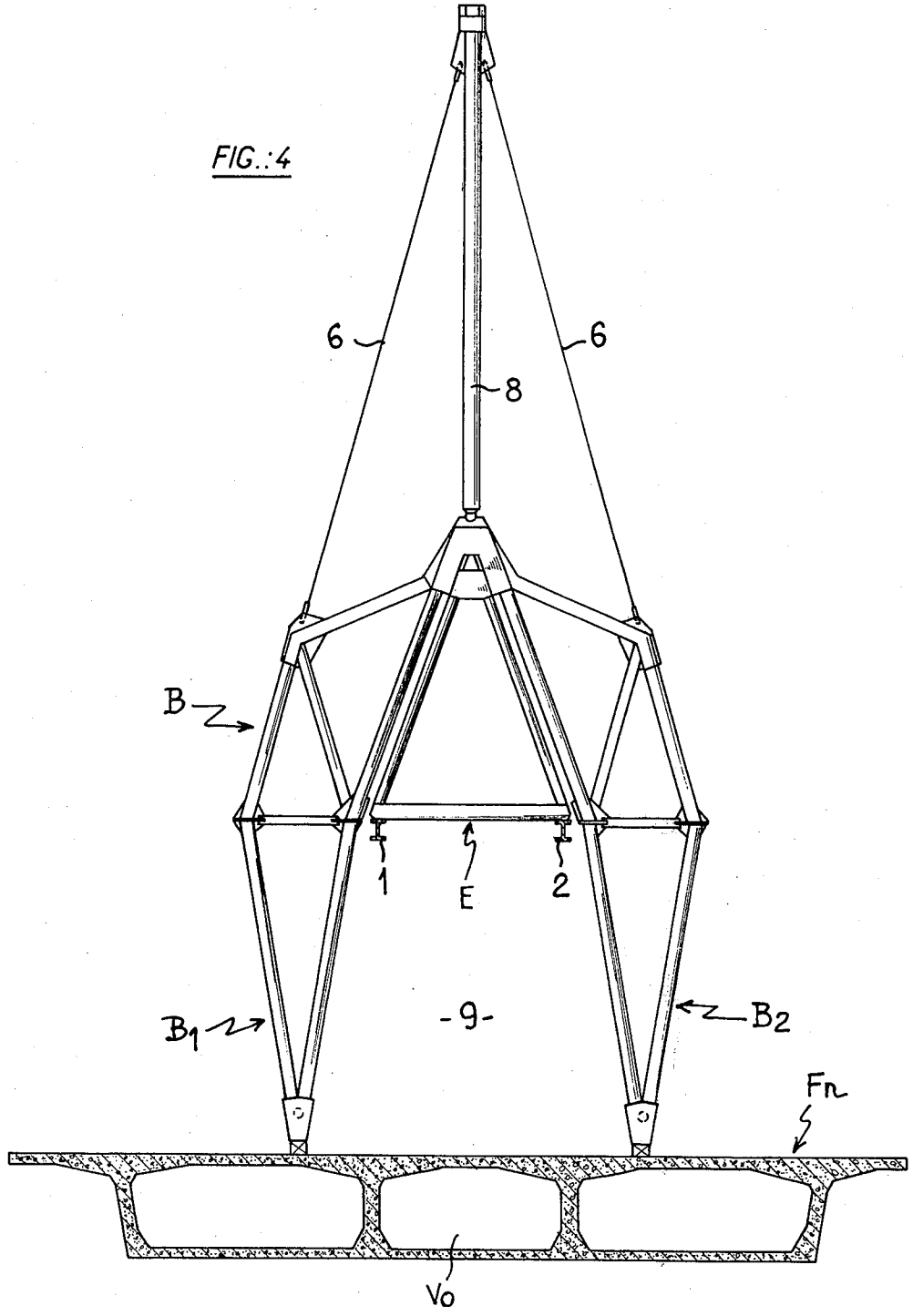


FIG.:5

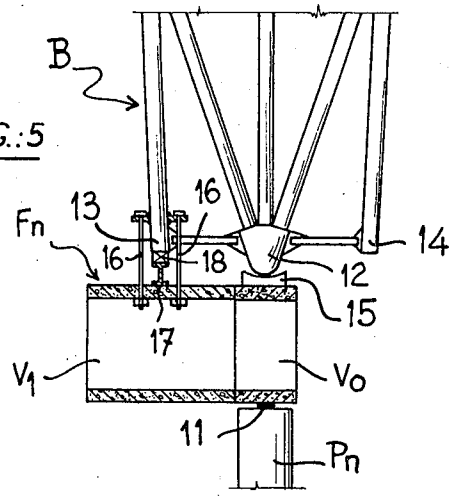

B
13
16
Fn
16
18
12
14
15
17
V1
Vo
11
Pn

FIG.:6

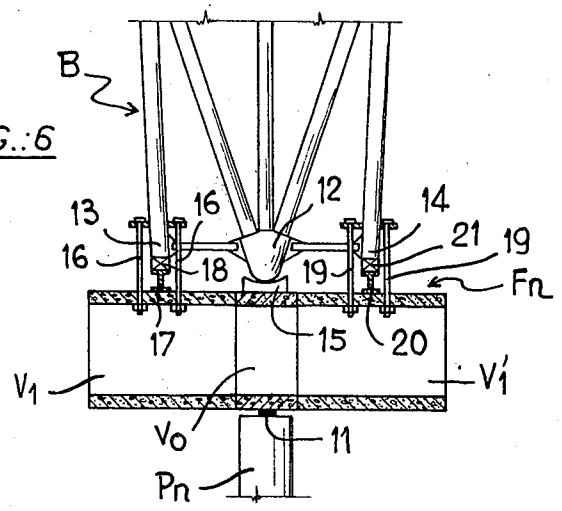
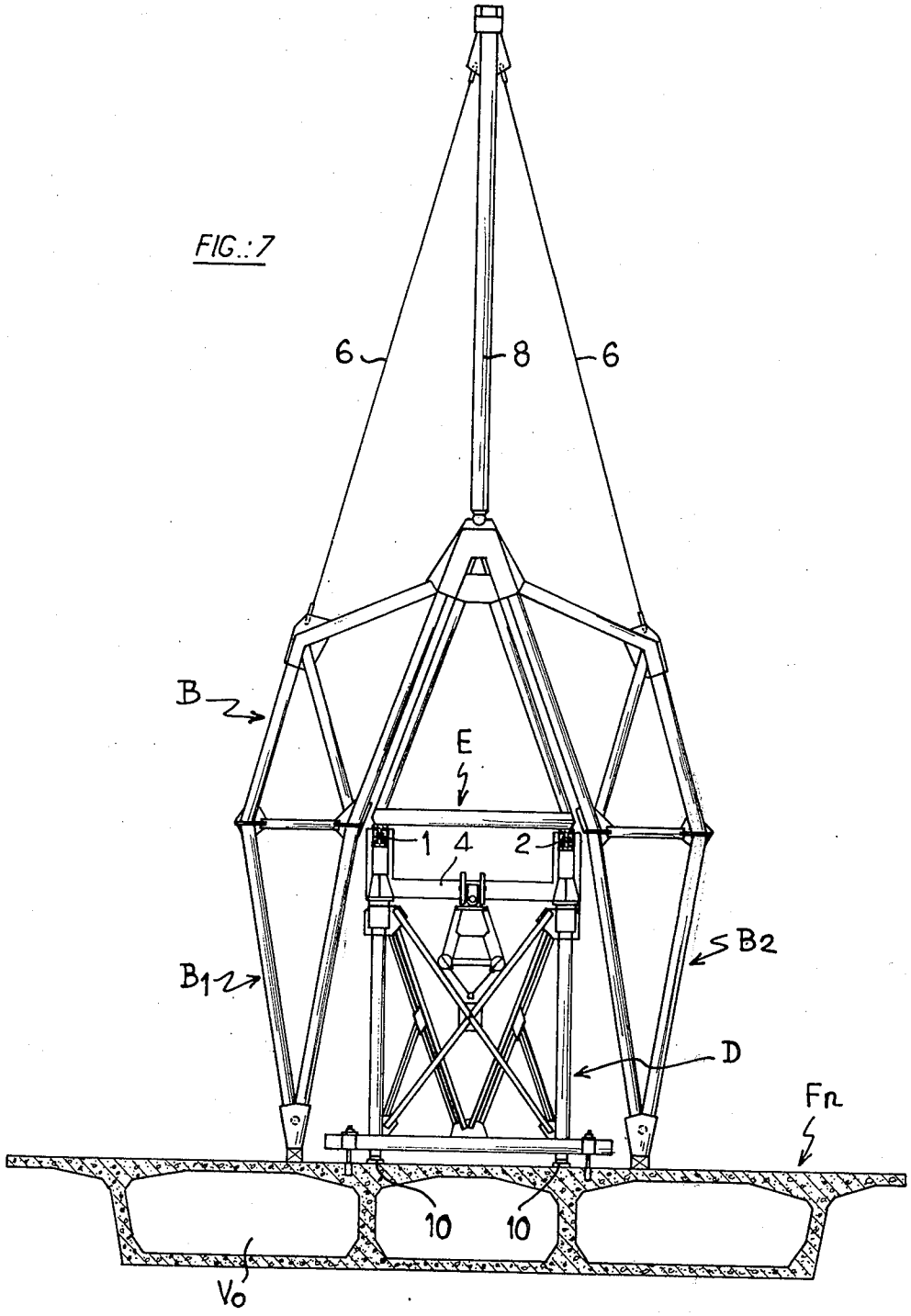

B
13
16
12
14
16
18
19
21
19
Fn
17
15
20
V1
V1'
Vo
11
Pn

FIG.: 7



BUILDING OF MULTISPAN BRIDGES OR THE LIKE WORKS, BY THE CANTILEVER METHOD

BACKGROUND OF THE INVENTION

The present invention relates to the building of a superstructure of a multispan civil engineering work, such as a bridge or an elevated road or track, which structure comprises at least one two-arm beam resting on a pier, the term "beam" designating the assembly constituted by the two portions or arms of superstructure — each substantially equal to half a span — which extend on both sides of the said pier.

A known technique for building the superstructure of a multispan bridge or the like work consists in producing the said beam in successive sections or voussoirs which are placed in position by cantilevering on both sides of an initial voussoir — or pier voussoir — which caps the said pier.

It is known that the building of elevated civil engineering works which have to project over a very busy road, rail, river or sea thoroughfare, may pose certain problems because of the fact that access to the subjacent ground is either difficult for an assembling device such as a scaffold or else the said subjacent ground must remain clear. This is why it has already been proposed, for the purpose of effecting the transfer and/or positioning of the elements, for example prefabricated voussoirs, intended to constitute the successive sections of a beam, that use be made of a raised mobile scaffold, also called a launching girder, which comprises at least one end support and one median support. This scaffold, the length of which is at least equal to that of a span, can be displaced along the portion of superstructure already completed, until it assumes a position in which it projects, in an overhanging manner, above the location for the beam to be constructed. In this position, it rests, by its rear support, on the said portion of superstructure which has already been completed, and, by its median support, on the pier relating to the beam to be constructed. A scaffold of this kind makes it possible to simplify, and speed up to a remarkable extent, operations involving the placing in position of very long superstructures.

As is already known, the assembling of successive sections or voussoirs by cantilevering in opposite directions starting from a previously erected pier has the essential advantage of making it possible to at least roughly balance against one another the overturning moments which occur on each side of the said pier because of the weight of the two arms of the beam. However, this balancing is completely achieved only if the operations for assembling the voussoirs at the end of each arm of the beam are carried out in a strictly symmetrical and simultaneous manner. In actual fact, the voussoirs are generally placed in position, in turn, on one side of the pier and then the other, so that a residual but substantial overturning moment continues to exist, which is generally reabsorbed by making provision for, at least temporary, bedding-in or anchoring of the pier voussoir on the head of the pier.

However, such bedding-in or anchoring may be inadequate or difficult to carry out, particularly in a case — which will be more particularly considered below — where the "width" of the piers considered in longitudinal direction of the bridge, as imposed upon the builder of the bridge or the like work, is too small. In a bridge of this kind having "thin" or "narrow" piers, the pier voussoir bridge generally rests on the pier via an articulation or pseudo-articulation (for example a plate made of an elastomer such as "Neoprene"), and its length (which is substantially equal to the width of the pier in question) is much less than that of the other voussoirs in the beam. The residual overturning moment alluded to herein above then tends to produce, about the said articulation or pseudo-articulation, a rocking movement of the beam, the construction of which is thus made more difficult.

SUMMARY OF THE INVENTION

The object of the present invention is to eliminate this difficulty and to permit, even in the case of a civil engineering work having "thin" piers, satisfactory stabilization of the beam under construction, in a case where the said beam is produced with the aid of a raised scaffold of the type mentioned above.

According to the invention, there is provided a device for use in building the superstructure of a multispan civil engineering work, such as a bridge or elevated road or track, which superstructure comprises at least one two-arm beam extending in a longitudinal direction substantially symmetrically on both sides of a previously erected pier and resting upon the latter, the said beam being produced in successive sections or voussoirs which are placed in position by cantilevering in opposite directions starting from an initial or pier voussoir which caps the said pier, the said device being of the kind comprising a raised elongated scaffold having a median support adapted to rest on the said pier, wherein the said median support comprises a central bearing member which is adapted to rest on the said pier voussoir and two additional bearing members which are adapted to respectively rest on the two first voussoirs which border on the said pier voussoir, and wherein means are provided for anchoring said additional bearing members to the respective voussoirs on which they are adapted to rest.

According to one embodiment of the invention, means are provided for adjusting the attitude of the said median support and causing it to occupy, either a first position in which it rests, via said central bearing member, solely upon the pier voussoir, or a second position in which it rests, via said two additional bearing members, solely upon the said two first voussoirs which border on the said pier voussoir.

Anchoring means may be provided, in the vicinity of an end support of the scaffold, for the purpose of connecting the said scaffold to a portion of superstructure which has already been completed.

The arrangements according to the invention thus make it possible to achieve the equivalent of temporary bedding-in of the beam under construction, not on the pier (which has been assumed to be too narrow to permit the implementation of effective bedding-in), but on the median support, the base of which has a width — defined by the distance separating the aforesaid two additional bearing members from one another — which is much greater than that of the pier. In spite of the small width of the pier and the presence of an articulation or pseudo-articulation, any inconvenient rocking movement of the beam under construction is thus prevented.

The present invention also relates to civil engineering works built with the device according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic view, in longitudinal elevation, of part of the superstructure of a civil engineering work, such as a multispan bridge, which is being built by means of a known scaffold;

FIG. 2 is a view which is similar to FIG. 1 but which illustrates a scaffold equipped with a median support according to one embodiment of the invention;

FIG. 3 is a larger-scale view of part of FIG. 2, showing the said median support in a first phase in the construction of a beam which constitutes part of the said superstructure;

FIG. 4 is a view, in transverse section, of the median support illustrated in FIG. 3;

FIGS. 5 and 6 are views of part of FIG. 3, which show the said median support in a second and third phase, respectively, in the construction of the beam; and

FIG. 7 is a view which is similar to that in FIG. 4 and shows, in addition, a device which makes it possible, in particular, to adjust the attitude of the said median support.

DESCRIPTION OF PREFERRED EMBODIMENTS

In the drawings, the reference symbols . . . P_{n-1}, P_n, P_{n+1} . . . have been used to indicate the piers of a multispan civil engineering work, such as a bridge or an elevated road or track. Resting upon these piers, which are assumed to have been beforehand, is a superstructure, such as the deck of a bridge, which comprises at least one beam F_n resting upon a pier P_n, the term "beam" designating the assembly constituted by the two portions of superstructure — each substantially equal to half a span — which extend on both sides of the said pier. The last beam, which is assumed to have already been completed, is indicated by the reference symbol F_{n-1}.

For building the beam F_n, use is made of an elongated horizontal scaffold E extending in the longitudinal direction of the two-arm beam F_n and above the same, and having a length which is greater than one span and is, for example, equal to the sum of the lengths of two spans. The scaffold E presents two end-regions and a median egion located between two end-regions and remote from said two end-regions. In the drawings this scaffold has the structure of a girder having a triangular cross-section (see FIG. 4), along the three edges of which lie booms 1, 2, 3, such as I-sections, which serve to ensure the strength of the scaffold. The booms 1 and 2 also constitute rolling tracks for carriages 4 and 5, the useful purpose of which will be indicted below.

The scaffold E is provided with supports A, B, C which comprise, in particular, an end support A extending from an end-region of the scaffold and a median support B extending from the median region of said scaffold. Both supports A and B are integral i.e. rigidly locked with the said scaffold. The support A constitutes a rear support by means of which the scaffold rests, in the position illustrated in FIG. 1, upon the beam F_{n-1} which constitutes part of the portion of superstructure already completed, while the supports B and C rest upon the piers P_n and P_{n+1} respectively. The support C is constituted by a detachable pillar upon which the rests via the carriage 5, while the said tower-scaffold rests upon the pier P_{n+1} via adjustable jacks which are not shown. The scaffold E may, where necessary, be guyed by means of ties 6 and 7 which are attached to a mast 8 surmounting the median support B.

In the position illustrated in FIG. 1, the beam F_n is in the process of being produced in successive sections or voussoirs V_1—V'_1, V_2—V'_2, . . . which are placed in position by cantilevering in opposite directions starting from an initial or pier voussoir V_0 which caps the pier P_n. As soon as it has been placed in position, each voussoir is made integral with its neighbours. It will be seen, in FIG. 1, that the last voussoir placed is the voussoir V_4, and that the next to be placed is the voussoir V'_4. The latter is illustrated-rotated by 90° — while being transported by means of the carriage 4. As shown in FIG. 4, the shape of the support B (like that of the support A, moreover) is so designed as to leave clear a space 9 which is intended to permit the passage of the voussoirs.

Once it is completed, the beam F_n is connected to the preceding beam F_{n-1} by means of a keying-up voussoir, and the mobile scaffold E is moved forward by the length of a span. For this purpose, a second pillar D which can be seen in FIG. 7, is brought into operation. This pillar D is supported — via adjustable jacks 10 — on that portion of superstructure (in this instance, the beam F_n) which has just been completed, and on the carriage 4. By acting upon the jacks 10, it is therefore possible to raise the unit constituted by the scaffold E and the supports A and B. In its raised position, the unit A-B-C is rolled along on the carriages 4 and 5 carried by the pillars D and C respectively, until the support A arrives vertically above the pier P_n, and the support B vertically above the pier P_{n+1}. The pillar C is then removed so that the carriage 5 is temporarily free and can be used to transport the pier voussoir V_0 which is intended to cap the next pier P_{n+2} (not shown). Once this pier voussoir has been placed in position, the carriage 5 once again works in conjunction with the pillar C in order to constitute the third support — vertically above the pier P_{n+2} — for the scaffold E. The latter is then in precisely the position illustrated in FIG. 1.

As shown in FIG. 1, the bridge or the like civil engineering work to be produced) comprises relatively "thin" or "narrow" piers on which the successive beams . . . F_{n-1}, F_n. . . rest via articulations or pseudo-articulations (such as plates made of "Neoprene") which are designated by the reference numeral 11. The length of the pier voussoir V_0 is substantially equal to the width of the pier P_n, and much less than that of the other voussoirs in the beam. The result of this is that it is difficult to achieve effective temporary bedding-in of the said pier voussoir on the head of the said pier, so that, when a voussoir such as V_4 is placed in position, the residual moment caused by the weight of this voussoir tends to produce a rocking movement — shown diagrammatically in broken lines in FIG. 1 — which thus makes construction of the beam much more difficult.

FIGS. 2 to 7 show certain arrangements — which constitute the object of the invention — with the aid of which this rocking tendency can be effectively counteracted.

As shown more particularly in FIGS. 3 and 4, the median support B which extends from the median region of the scaffold E and is integral therewith comprises two legs B_1, B_2 which are disposed on either side of the longitudinal plane of symmetry of the scaffold E, in

such a way as to form between them the aforesaid clear space 9 which is intended for the free passage of the voussoirs. Each of these legs is a compact, concentrated bearing unit, which is subdivided, at the bottom, into three longitudinally consecutive, adjacently grouped, bearing members 12, 13, 14, that is to say a central longitudinally-consecutive bearing member 12 which is located vertically above the pier voussoir V_0, and two additional bearing members 13, 14 adjacent said central bearing member 12 on either side thereof, which additional bearing members are respectively located vertically above the two first voussoirs V_1, V'_1 next consecutive to and immediately bordering on the said pier voussoir. The central bearing member 12 extends slightly further downwards than its two neighbours, and may advantageously be in the form of a ball which is adapted to work in conjunction with a bearing socket 15 carried by the pier voussoir V_0. Moreover, as shown in FIG. 2, anchoring means 22 are provided in the vicinity of the end support A, for the purpose of connecting the scaffold E to that portion of superstructure, F_{n-1}, which has already been completed.

More particular reference will now be made to FIGS. 3, 5 and 6 which show three successive phases in the operations involving the construction and stabilization of the beam F_n.

In FIG. 3, there has been illustrated the initial phase of these operations, in which each of the legs B_1 and B_2 — the combination of which constitutes the median support B — rests solely upon the pier voussoir V_0, the only one which is in place.

The next phase has been diagammatically illustrated in FIG. 5. The voussoir V_1 has just been placed in position and made integral with the voussoir V_0. In order to 0the unit V_0–V_1 from rocking, the voussoir V_1 situated vertically below the bearing member 13 is anchored to the latter by means of adjustable anchorage rods 16. The voussoir V_1 carries a section 17 which is situated opposite the lower face of the bearing member 13, and an adjustable wedging system 18, for example of the screw type, is placed in position between the said section 17 and the said bearing member 12.

In FIG. 6, the same operation has been shown, repeated for the voussoir V'_1 which is shown anchored to the bearing member 14 by means of adjustable anchorage rods 19. The lower face of the supporting part 14 is then situated opposite a section 20 carried by the voussoir V'_1, and an adjustable wedging system 21 similar to the wedging system 18 is placed in position between the said section 20 and the said bearing member 14.

At this stage, each of the two legs B_1 and B_2 is still resting — via the central bearing member 12 — only upon the pier voussoir V_0. The load is then transferred from said central bearing member 12 to the two additional bearing members 13, 14. For this purpose, after the adjustable anchorage rods 16, 19 have been slightly loosened, the unit constituted by the scaffold E and the median support B is raised slightly, by means of the jacks 10 (see FIG. 7), in such a way as to bring the ball 12 out of contact with the bearing socket 15. The two wedging systems 18 and 21 are next adjusted so that, when the support B is lowered again, it comes to rest solely via the two additional bearing members 13, 14 and the wedging systems 18, 21 upon the two voussoirs V_1—V'_1 which adjoin the pier voussoir V_0, while the central bearing member 12 remains out of contact with the socket 15. The adjustable anchorge rods 16, 19 are then tightened up again.

There is thus achieved the equivalent of temporary bedding-in of the beam F_n on the median support B, of which the width — which is defined by the distance separating the additional bearing members 13 and 14 from one another — is much greater than that of the pier P_n. The beam F_n is thus effectively stabilized, as shown by FIG. 2, in spite of the low width of the pier and the presence of the articulation or pseudo-articulation 11. The forces resulting from the residual overturning moment of the beam F_n are transmitted, via the median support B, to the scaffold E. They are then transferred to the portion of superstructure already completed, F_{n-1}, via the rear support A in the case of compressive forces, and via the anchoring means 22 in the case of tractive forces.

It should be clear that the embodiment described is only an example and that it would be possible to modify it, particularly by the substitution of technical equivalents, without thereby departing from the scope of the invention, as defined in the appended claims.

Thus, for instance, the invention also applies to works, the superstructure of which comprises a plurality of parallel beams, or to works comprising metal sections assembled by any known method, or to works of which the superstructure, instead of being made up of prefabricated voussoirs, is concreted in situ. The scaffold E would then be modified to support a concreting platform.

What is claimed is:

1. In combination with a superstructure of a multispan civil engineering work under construction, such as a bridge or an elevated road or track, which superstructure comprises at least one two-arm beam which extends in a longitudinal direction substantially symmetrically on both sides of a previously erected pier and rests upon the latter, which two-arm beam comprises a plurality of longitudinally-consecutive voussoirs including an initial pier-voussoir which caps the said pier and two first voussoirs respectively consecutive to and bordering on said pier-voussoir on either side thereof, a device for successively placing the voussoirs in position in cantilever fashion in opposite directions from said pier, said device being of the kind comprising an elongated horizontal scaffold extending in the longitudinal direction of the two-arm beam and above the same, said scaffold presenting two longitudinally-spaced end-regions and a median region located between and remote from said two end-regions, and an end-support extending from an end-region of the scaffold for supporting said scaffold on an already-completed part of the work, wherein the improvement comprises a median support integral with said scaffold and extending from the median region thereof for supporting said scaffold on the said pier, said median support being a compact concentrated bearing unit subdivided into three longitudinally-consecutive and adjacently grouped bearing members, namely a central bearing member overtopping the said pier-voussoir, and two additional bearing members located adjacent said central bearing member on either side thereof and respectively overtopping the said two first voussoirs next consecutive to and bordering on the said pier-voussoir, and means for anchoring said two additional bearing members to said two first voussoirs respectively.

2. A device as claimed in claim 1, further comprising means for adjusting the attitude of said median support and causing it to occupy either a first position in which it rests, via said central bearing member, solely on said pier-voissoir, or a second position in which it rests, via said two additional bearing members, solely on said two first voussoirs which border on the said pier-voussoir.

3. A device as claimed in claim 1, comprising further anchoring means for connecting an end region of said scaffold to an already-completed part of the work.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,902,212
DATED : September 2, 1975
INVENTOR(S) : Jean M. Muller

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 1, delete "bridge";

Column 3, line 32, before "beforehand" insert --erected--;

Column 3, line 47, change "egion" to --region--;

Column 3, line 68, before "rests" insert --scaffold E--;

Column 3, line 68, "tower" should be --pillar--;

Column 4, line 1, delete "scaffold";

Column 4, line 44, delete ")";

Column 5, line 35, change "O" to --prevent--;

Column 6, line 25, before "works" insert --civil engineering--.

Signed and Sealed this

seventeenth Day of *February 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks