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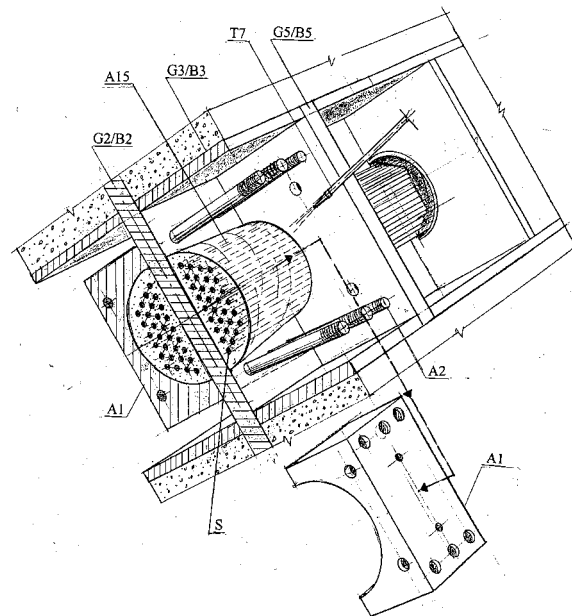
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(54) **Improved anchorage sockets for the "novel technique for stay cable system"**

(57) Main features of the auxiliary anchorage socket are:

- 1) A pair of half-cylindrical auxiliary anchorage heads A1 are fixed together to the web G2/B2 of steel I-girder, tie beam, anchoring bed or anchoring box by transverse bolts A2 and supported by the auxiliary anchorage plates G5/B5.
- 2) Inside each A1 there is a half-coned hole, in which the half number of strands S of a cable are bonded together by epoxy resin and/or other grouting material A15.
- 3) When eventual individual strand replacement comes, the A1 can be removed, so that the A15 with half-coned form appears under visible and touchable condition. According to the requirement of individual strand replacement, a part of or all of the A15 is removed by high-pressure water jetting T7 or similar measures, which don't injure the strands during epoxy removed.



III-III

Fig. 7

The principle of a pair of half-cylindrical anchorage heads fixed together by transverse bolts can be extension to the main anchorage socket, which therefore becomes hidden inside the outline of girders, to fulfil the special aesthetic requirements while keeping the original main advantages of the novel stay cable system.

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Description

[0001] The invention relates to the field of stay cable anchorage sockets for cable-stayed bridges.

[0002] A "Novel technique for stay cable system" ("original system" is abbreviated in the following discretion) has been created [European Patent, Application No. / Patent No.: 98119471.5-2303 / 1001089] by the same inventor as this patent, two of the features of which are:

1) Anchoring holes in anchorage sockets are divided into two symmetrical groups, so that main anchorage socket can reliably be arranged at bottom part of any kind of girders holding cable axis coincided with girder web and double half-cylindrical auxiliary anchorage sockets can be arranged on both sides of the web in steel I-girder, in anchoring tie beam or in steel anchoring bed.

2) Based on the help of auxiliary anchorage sockets, in which parallel strands are anchored or bonded individually, ordinary jaws can reliably be used in main anchorage socket while individual strand replacement is allowable.

[0003] As time goes on, two new requirements raise to the original system:

1) Individual strand replacement in both the anchored and bonded auxiliary anchorage sockets of the original system is carried out under indirectly visible and touchable condition. It is ideal if the individual strand replacement in auxiliary anchorage socket of the system becomes directly visible and touchable.

2) There is a special aesthetic requirement on some cable-stayed bridges that all the anchorage sockets should be hidden inside the outline of girders and the anchorage socket needn't to be tensioned at the girder site.

[0004] The aim of this invention is to fulfil these two requirements while keeping all the advantages of the original system.

1. Supplement general layout of the anchorage sockets at girder site

[0005] General layout of the anchorage sockets is no change from the original system at pylon site in any cases, or, at girder site without the special aesthetic requirement of anchorage sockets hidden inside the outline of girders. Supplement general layout occurs only at girder site if there is the above special aesthetic requirement.

[0006] When isolating cover plates G8/B8 are taken off, as illustrated in Fig. 1, for the cable attaching structure at steel I-girder Gs or steel anchoring box Bs for concrete girder, a pair of half-cylindrical main anchorage

sockets M are arranged just above the steel bottom flange G1/B1, on both sides of the steel web G2/B2 and supported by the main anchorage plates G4/B4. As the original system, above the main anchorage sockets M a pair of half-cylindrical auxiliary anchorage sockets A are arranged on both sides of the steel web G2/B2 and supported by the auxiliary anchorage plates G5/B5.

[0007] In order to reliably transmit cable force to and withstand internal forces in the concrete girder Gc, a steel anchoring box Bs, which consists of bottom flange B1, web B2, stiffening plates B3, main anchorage plates B4, auxiliary anchorage plates B5, studs B6, cable pipe B7 and isolating cover plates B8. B1 - B7 are cast into the concrete girder Gc and connects the reinforcements of Gc.

2. Improved auxiliary anchorage socket at girder site and pylon site

2.1 Structure of the improved auxiliary anchorage socket

[0008] Fig. 2 and 3 illustrate the structure of the socket, which consists the following parts:

1) A pair of half-cylindrical auxiliary anchorage heads A1 are fixed together to the web G2/B2 of steel I-girder, tie beam or anchoring bed of the original system or anchoring box Bs by transverse bolts A2 and supported by the auxiliary anchorage plates G5/B5. On the web G2/B2 boltholes are drilled for the passing through of transverse bolts A2.

2) Inside each half-cylindrical auxiliary anchorage head A1 there is a half-coned room to contain the half number of strands S of a cable.

3) A pair of cover plates A3 are fixed together to the web G2/B2 by transverse bolts A5. On the web G2/B2 boltholes are drilled for the passing through of transverse bolts A5.

4) The half-cylindrical auxiliary anchorage head A1 and cover plates A3 are fixed together to the auxiliary anchorage plate G5/B5, on which strand holes and boltholes are drilled for strands individually passing through and for deferent bolts passing through or fixed respectively, by longitudinal bolts A4.

5) On the outer site of cover plate A3 a isolating cover A6 made of HDPE or hard rubber is fixed to the cover plate A3 and the web G2/B2 by steel plate A7, steel bar A8, bolts A9, A10 and A11.

6) On the other side of the auxiliary anchorage plate G5/B5 a isolating cover A12 made of HDPE or hard rubber is fixed to the auxiliary anchorage plate G5/B5 and the web G2/B2 by steel plate A13 and bolts A14.

7) In the room between anchorage head A1, cover plates A3, auxiliary anchorage plate G5/B5 and web G2/B2, epoxy resin and/or other grouting material

A15 is injected by the grout hole A16 and vent-hole A17 to bond the stands S together with A1, A3, G5/B5 and G2/B2.

8) Diameter of strand holes on steel plate A7 and A13, auxiliary anchorage plate G5/B5 and cover plate A3 is bigger enough than the diameter of strand, while diameter of strand holes on isolating cover A6 and A13 is little smaller than that of stand to ensure strands touching only the soft material in the auxiliary anchorage socket.

9) In order to facilitate the eventual individual strand replacement, release agent is smeared on all the inside surfaces of anchorage head A1 and cover plates A3 as well as thread holes A18 and A19 are arranged on the auxiliary anchorage plate G5/B5 and anchorage head A1 respectively.

2.2 Construction procedure of auxiliary anchorage socket

[0009] Construction of the auxiliary anchorage socket is carried out with the following procedure:

1) Isolating cover A12 is fixed to the auxiliary anchorage plate G5/B5 and the web G2/B2 by steel plate A13 and bolts A14.

2) Isolating cover A6 is fixed to cover plate A3 by steel plate A7 and bolts A9.

3) Isolating cover A6 with cover plate A3 and steel plate A7 are erected and initially fixed to the web G2/B2 by transverse bolts A5, steel bar A8 and bolts A10.

4) Strands S are erected, tensioned and anchored in main anchorage socket M.

5) When the final cable force adjustment has been done, the anchorage head A1, transverse bolts A2 and longitudinal bolts A4 are erected, and then all the bolts A2, A4, A5, A10 and A11 are tightened up.

6) Epoxy resin and/or other grouting material A15 is injected into anchorage head A1 at grout hole A16 until the epoxy resin jets out from vent hole A17.

2.3 Procedure of eventual individual strand replacement of auxiliary anchorage socket

[0010] Fig. 4, 5, 6 and 7 illustrated the eventual individual strand replacement, which is carried out with the following procedure:

1) Bolts A11 and A10 are removed and released respectively.

2) Bolts A5 are removed.

3) Tool beam T1, tool bolts T2 and Teflon washers T3 are erected.

4) Cover plate A3 is pushed out of epoxy resin and/or other grouting material A15 and anchorage head A1 by screwing the nuts of bolts A4.

5) Bolts A4 are removed.

6) Tool beam T4, tool bolts T5 and Teflon washers T6 are erected.

7) Anchorage head A1 are drawn out of epoxy resin and/or other grouting material A15 and web G2/B2 by screwing the nuts of tool bolt T5.

8) The anchorage head A1 is removed and a half-coned epoxy resin and/or other grouting material A15 appears under directly visible and touchable condition. The removed anchorage head A1 is cleaned and release agent is smeared on its inside surface again.

9) According to the requirement of individual strand replacement, a part of or all of the half-coned epoxy resin and/or other grouting material A15 is removed by high-pressure water jetting T7 or similar measures, which don't injure the strands during epoxy removed.

10) A single strand jack in pylon releases and removes the strand, which should be replaced.

11) A new strand is erected, stressed and anchored on main anchor head by a single strand jack in pylon.

12) The anchorage head A1, transverse bolts A2, longitudinal bolts A4 and bolts A11 are erected back, then all the bolts A2, A4, A5, A10 and A11 are tightened up.

13) New epoxy resin and/or other grouting material A15 is injected into anchorage head A1 at grout hole A16 until the epoxy resin jets out from vent hole A17.

3. Main anchorage socket at the girder site

[0011] The principle of a pair of half-cylindrical auxiliary anchorage heads fixed together to the web G2/B2 of steel I-girder Gs or anchoring box Bs, by transverse bolts can be extension to the main anchorage socket. Fig. 8 illustrates the structure of the main anchorage socket, which consists of the following parts:

1) A pair of half-cylindrical anchorage heads M1 are arranged on both side of the web G2/B2 and supported by the main anchorage plates G4/B4 just above the steel bottom flange G1/B1.

2) The anchorage heads M1 are fixed together to the web G2/B2, on which boltholes are drilled, by transverse bolts M2.

3) Anchoring holes M3 are arranged in the anchorage heads M1 to individually anchor the stands by jaws.

Claims

1. A pair of improved half-cylindrical auxiliary anchorage heads A1 are fixed together to the web G2/B2 of steel I-girder, tie beam, anchoring bed or anchoring box by transverse bolts A2 and supported by

auxiliary anchorage plates G5/B5. On the web G2/B2 boltholes are drilled for the passing through of transverse bolts A2.

2. A pair of improved half-cylindrical auxiliary anchorage heads A1 as claimed in Claim 1, **characterised in that** inside each half-cylindrical auxiliary anchorage head A1 there is a half-coned hole to contain the half number of strands S of a cable. On all the inside surfaces of auxiliary anchorage heads A1 release agent is smeared, 5
3. A pair of improved half-cylindrical auxiliary anchorage heads A1 as claimed in Claim 1, **characterised in that** on the side of auxiliary anchorage heads A1 with biggest diameter of coned hole, a pair of cover plates A3 are fixed together to the web G2/B2 by transverse bolts A5. On the web G2/B2 boltholes are drilled for the passing through of transverse bolts A5. On all the inside surfaces of cover plate A3 release agent is smeared. 10
4. A pair of improved half-cylindrical auxiliary anchorage heads A1 and a pair of cover plates A3 as claimed in Claim 2 and Claim 3, **characterised in that** in the room between anchorage head A1, cover plates A3, auxiliary anchorage plate G5/B5 and web G2/B2, an epoxy resin and/or other grouting material A15 with half-coned form is injected by the grout hole A16 and vent-hole A17 to bond the half number of stands S of a cable together with A1, A3, G5/B5 and G2/B2. 15
5. An epoxy resin and/or other grouting material A15 with half-coned form as claimed in Claim 4, **characterised in that** in order to ensure the jetting quality of the epoxy resin A15, on the outer site of cover plate A3 a isolating cover A6 made of HDPE or hard rubber is fixed to the cover plate A3 and the web G2/B2 by steel plate A7, steel bar A8, bolts A9, A10 and A11 as well as on the other side of the auxiliary anchorage plate G5/B5 a isolating cover A12 made of HDPE or hard rubber is fixed to the auxiliary anchorage plate G5/B5 and the web G2/B2 by steel plate A13 and bolts A14. 20
6. A pair of cover plates A3 as claimed in Claim 3, **characterised in that** when eventual individual strand replacement comes, the cover plate A3 can be pushed out of epoxy resin and/or other grouting material A15 and anchorage head A1 by screwing the nuts of bolts A4, reaction force on which transmits through Teflon washers T3, Tool beam T1, tool bolts T2 and thread holes A18 to the auxiliary anchorage plates G5/B5. 25
7. A pair of improved half-cylindrical auxiliary anchorage heads A1 as claimed in Claim 2, **characterised in that** when eventual individual strand replacement comes, the auxiliary anchorage heads A1 can be drawn out of epoxy resin A15 and web G2/B2 by removing the bolts A4 and the nuts of bolts A2 and by screwing the nuts of tool bolts T5, which connect the thread holes A19 of auxiliary anchorage heads A1 and reaction force on which transmits through Teflon washers T6, Tool beam T4 to the stiffening plates G3/B3. 30
8. An epoxy resin released cover plate A3 and a removed half-cylindrical auxiliary anchorage heads A1 as claimed in Claim 5 and Claim 6, **characterised in that** a half-coned epoxy resin and/or other grouting material A15 appears under visible and touchable condition. According to the requirement of individual strand replacement, a part of or all of the half-coned epoxy resin and/or other grouting material A15 is then removed by high-pressure water jetting T7 or similar measures, which don't injure the strands during epoxy removed. 35
9. A pair of improved half-cylindrical auxiliary anchorage heads A1 are fixed together to the web G2/B2 of steel I-girder Gs or anchoring box Bs by transverse bolts A2 and supported by auxiliary anchorage plates G5/B5 as claimed in Claim 1, **characterised in that** this principle can be extension to the main anchorage socket, which consists of the following parts: 1) A pair of half-cylindrical anchorage heads M1 are arranged on both side of the web G2/B2 and supported by the main anchorage plates G4/B4 just above the steel bottom flange G1 / B1. 2) The anchorage heads M1 are fixed together to the web G2/B2, on which boltholes are drilled, by transverse bolts M2. 3) Anchoring holes M3 are arranged in the anchorage heads M1 to individually anchor the stands by jaws. 40

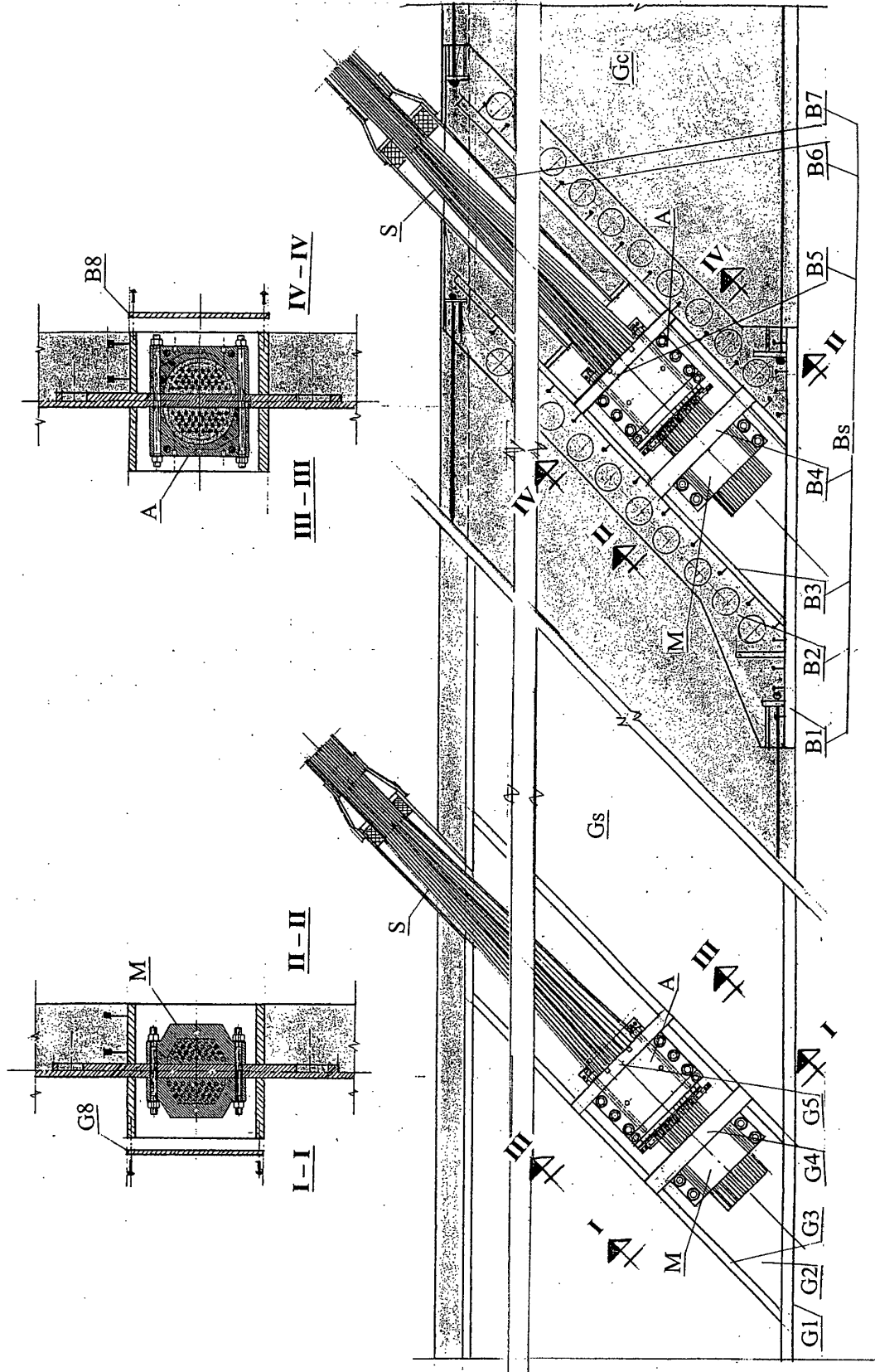


Fig. 1

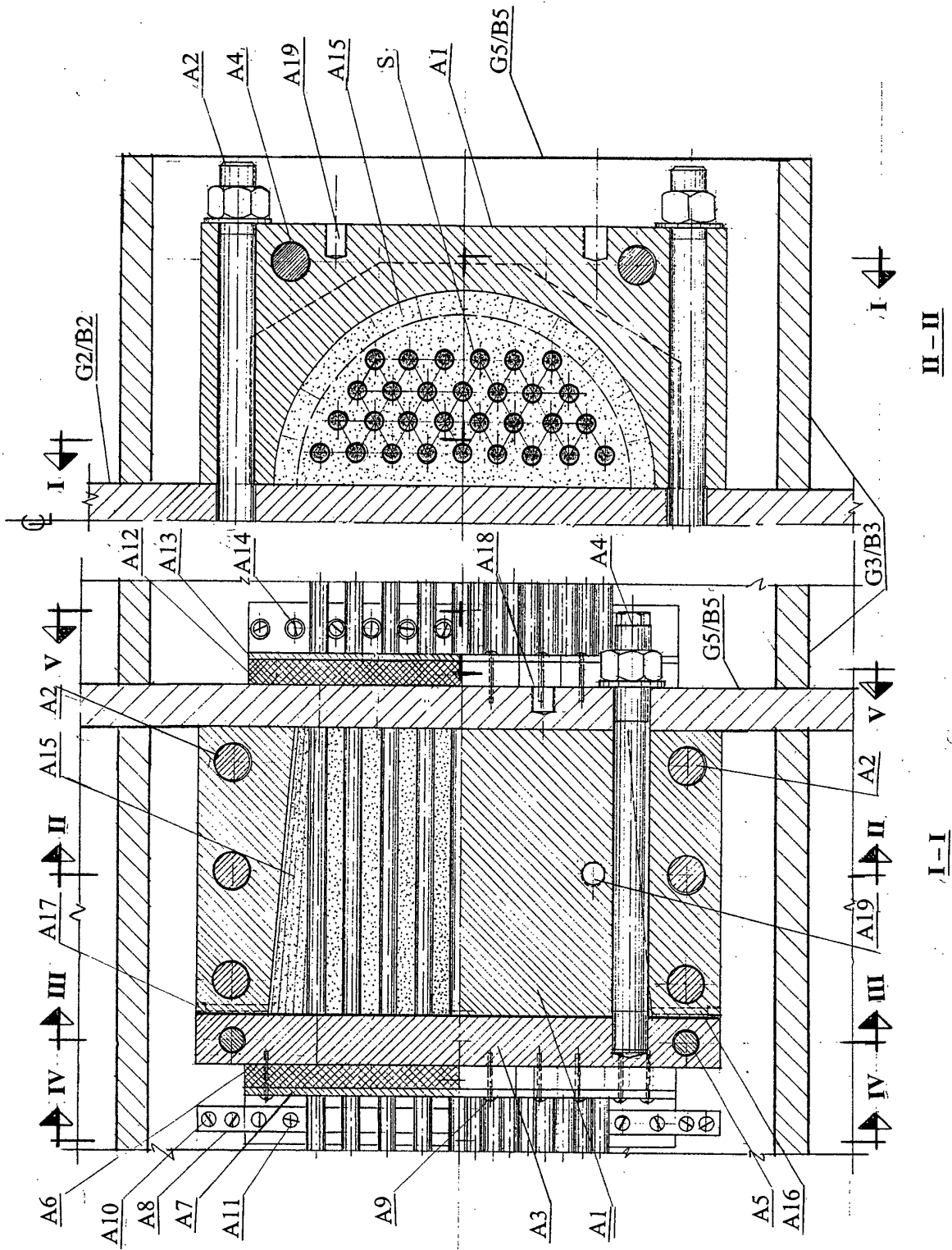


Fig. 2

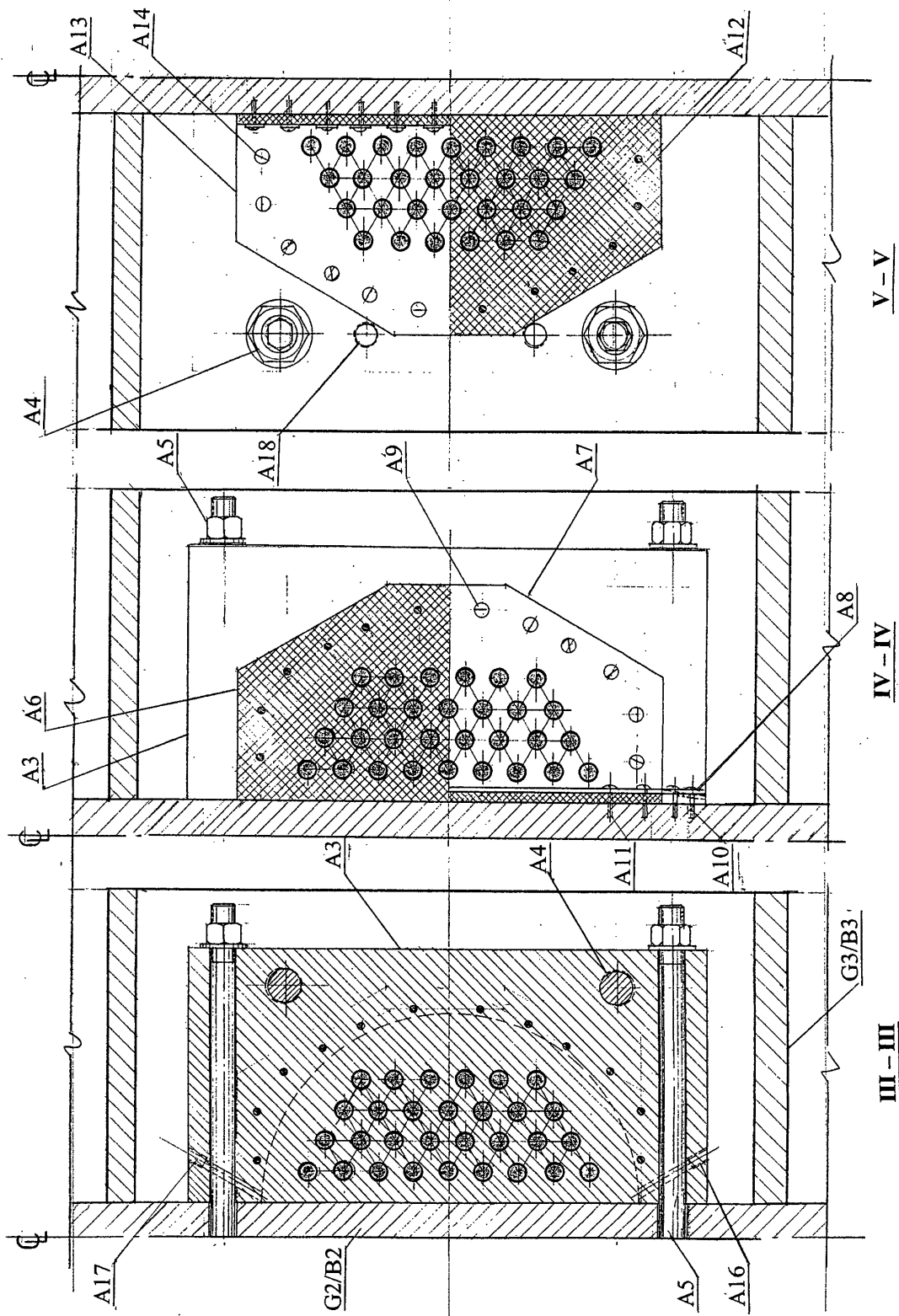


Fig. 3

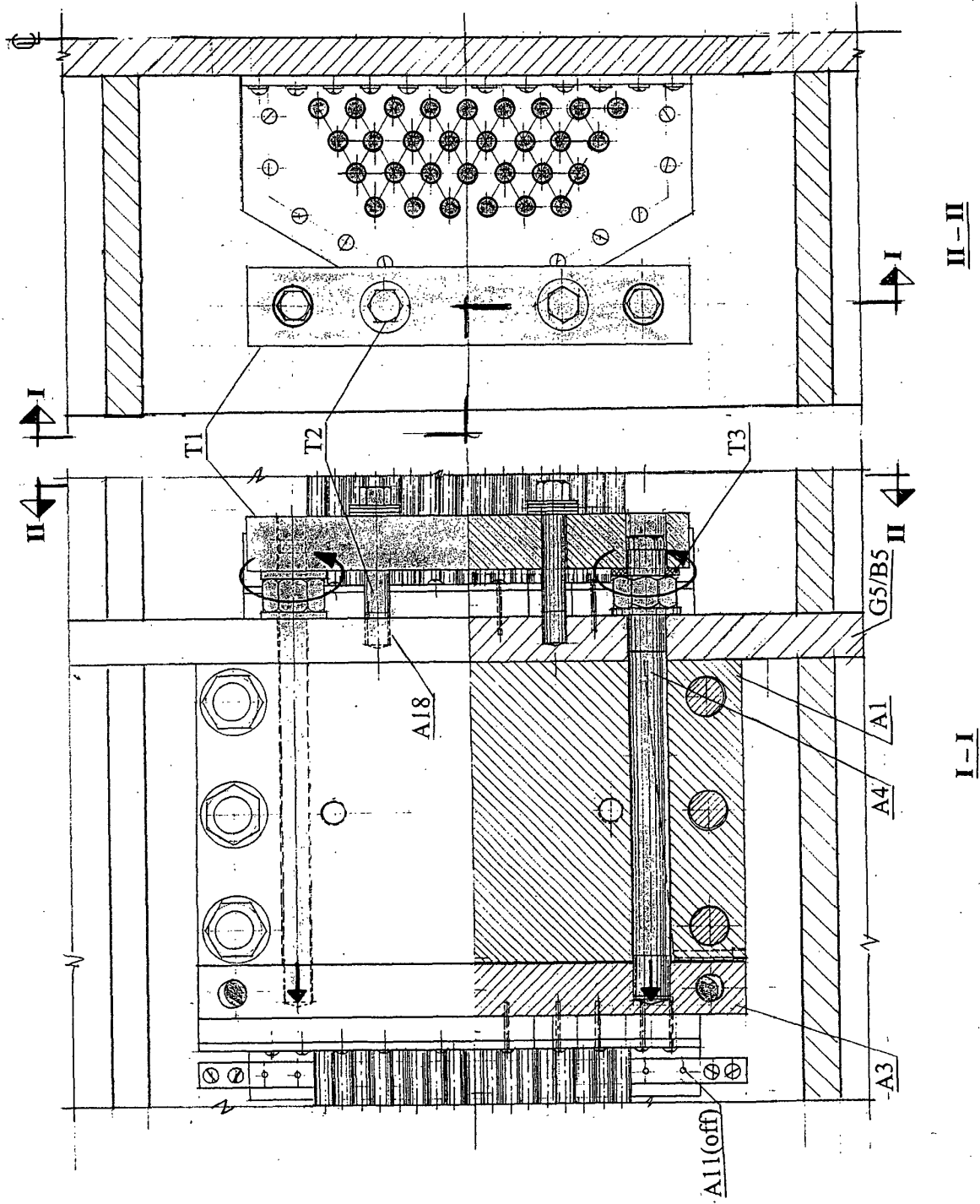


Fig. 4

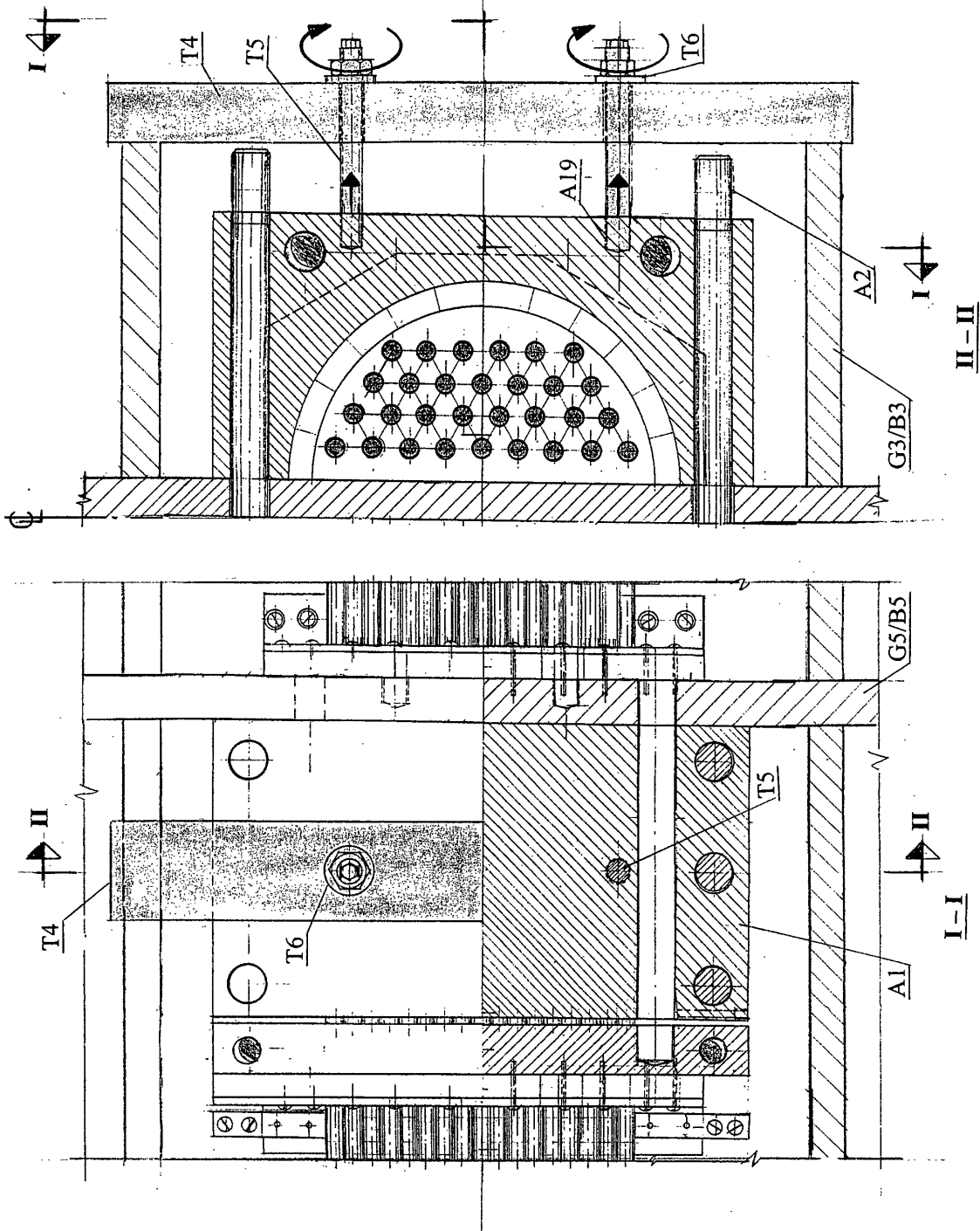


Fig. 5

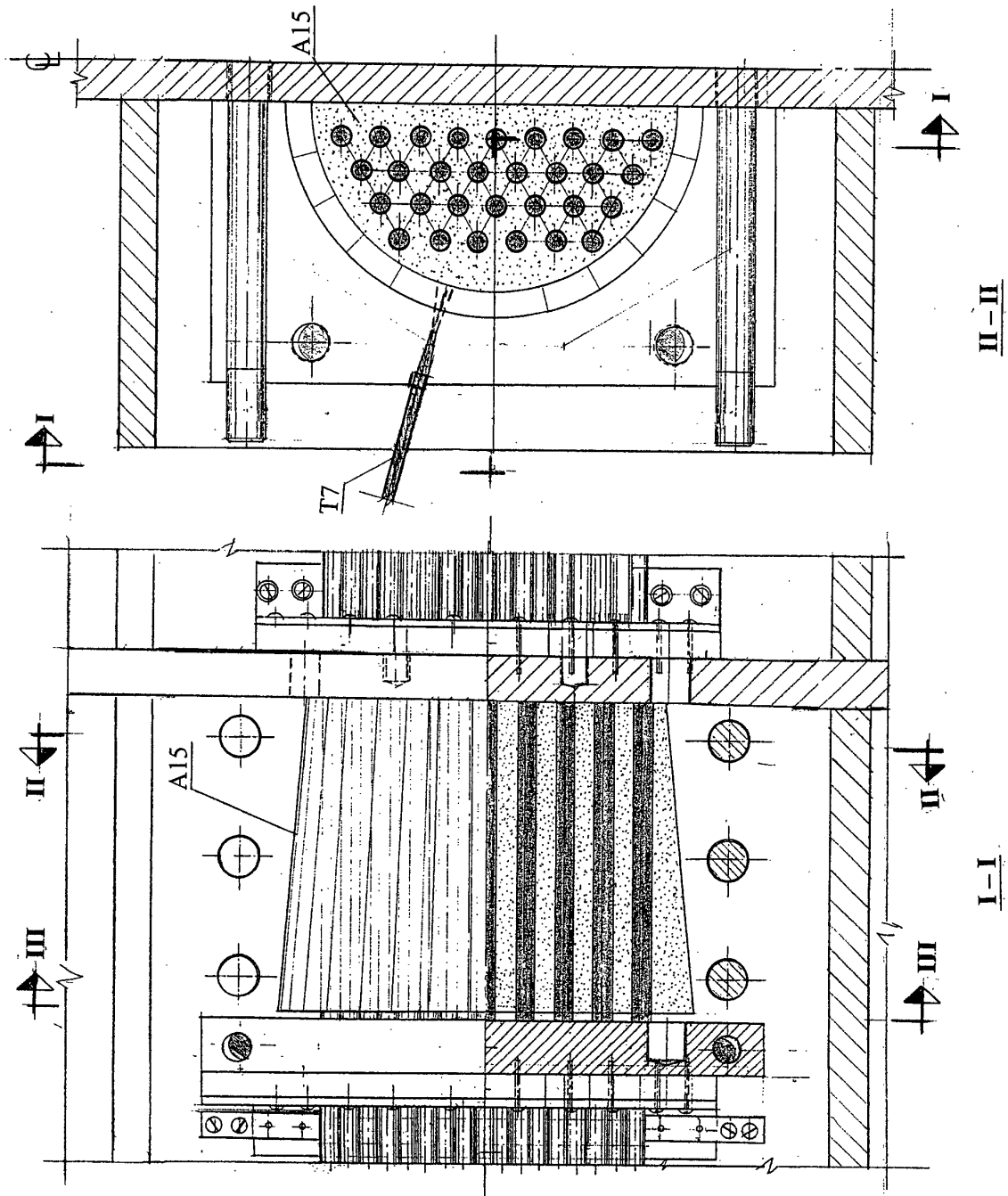
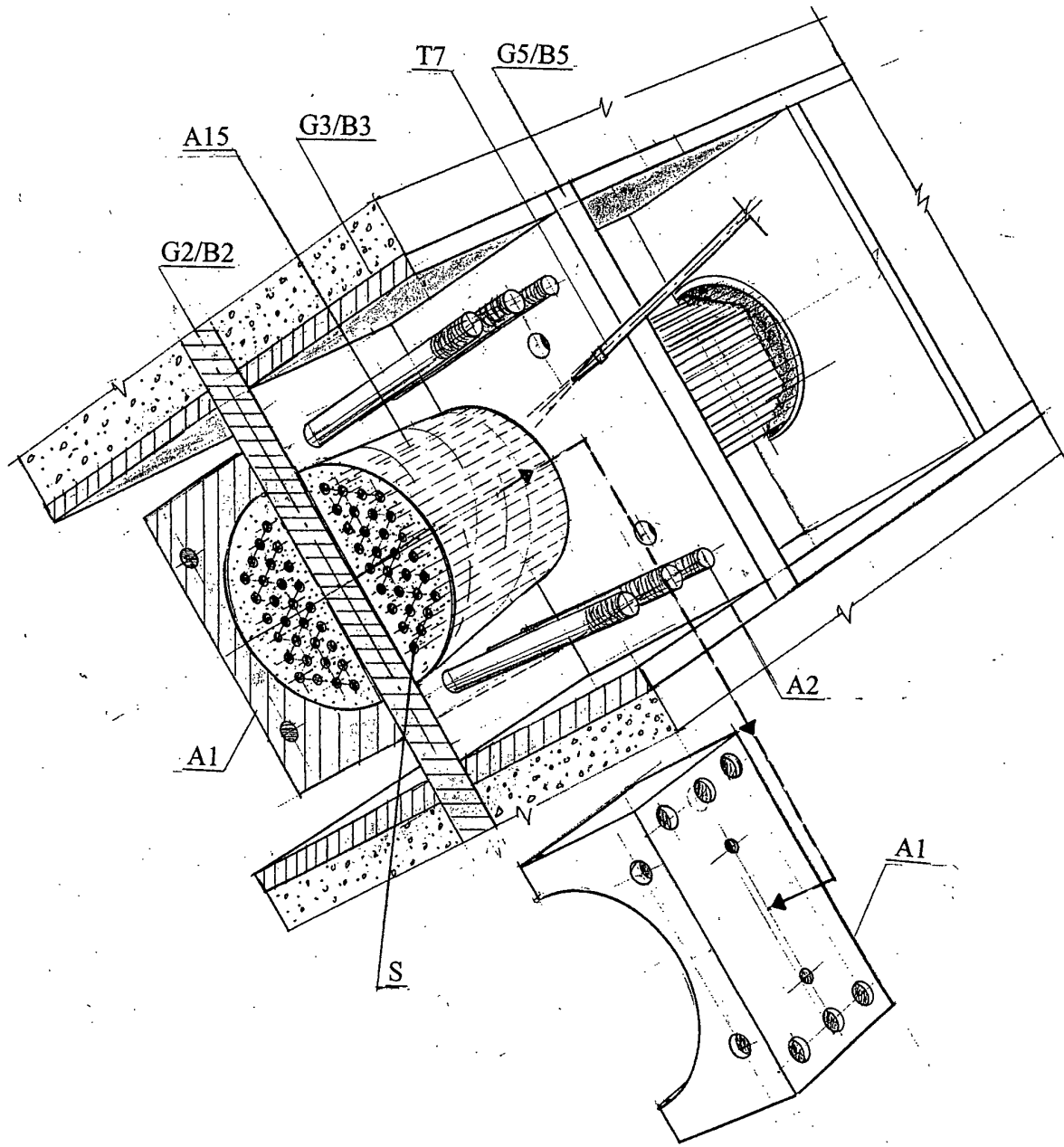


Fig. 6



III - III

Fig. 7

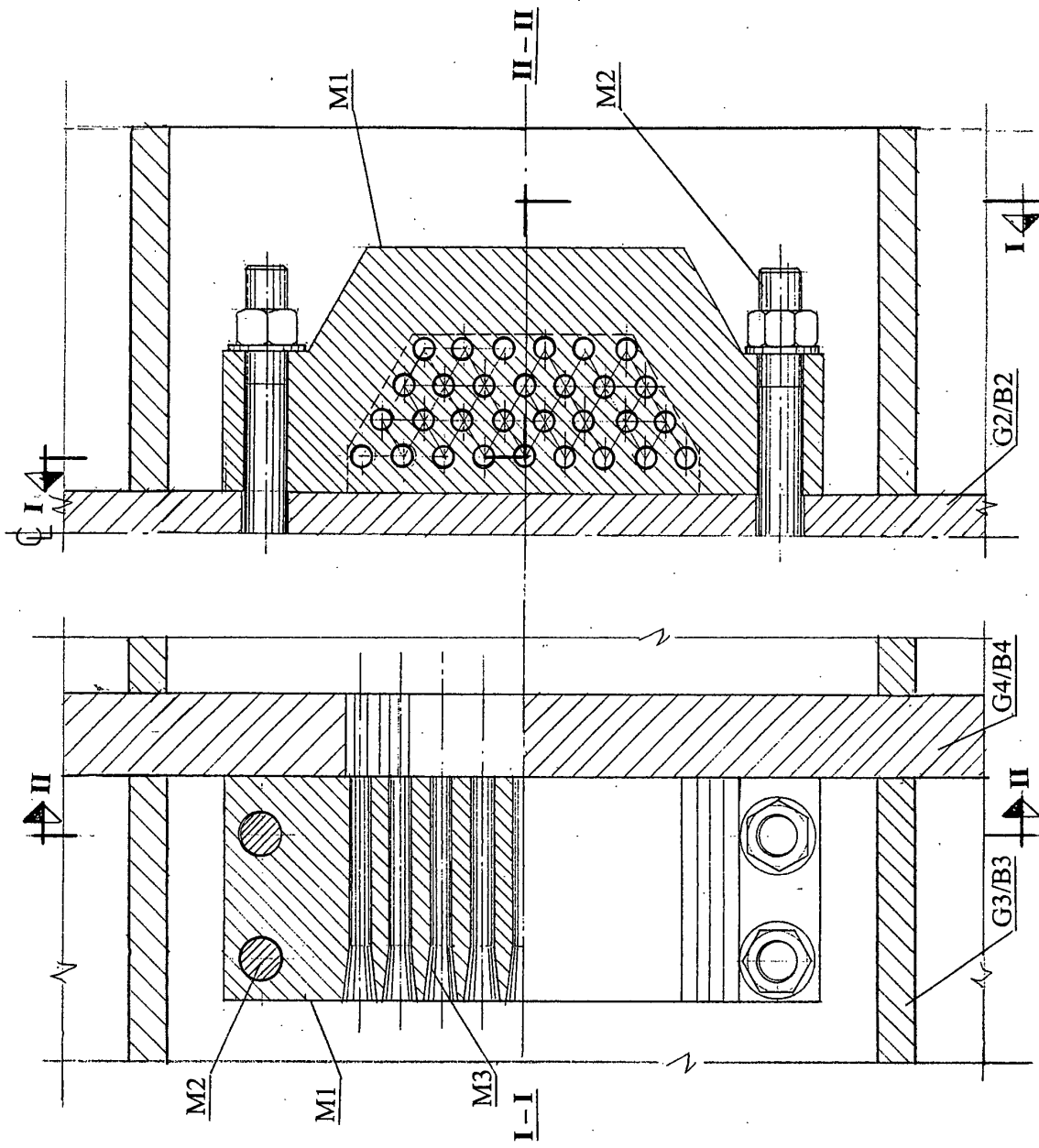


Fig. 8



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EUROPEAN SEARCH REPORT

Application Number
EP 02 02 9058

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,A	EP 1 001 089 A (HOU YINCHENG) 17 May 2000 (2000-05-17) * the whole document * -----	1	E01D19/14
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			E01D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 14 May 2003	Examiner Dijkstra, G
CATEGORY OF CITED DOCUMENTS 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		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	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 02 02 9058

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14-05-2003

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