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(54) **PROTECTION PROCEDURE AGAINST CAPILLARY MOISTURE IN CONSTRUCTIONS WITHOUT SETTLEMENT OR CRACKS USING A LOAD-BEARING WATERTIGHT PLASTIC BARRIER PLACED IN MASSIVE WALLS**

SCHUTZVERFAHREN GEGEN KAPILLARE FEUCHTIGKEIT UNTER ANWENDUNG EINER TRAGENDEN WASSERDICHTEN KUNSTSTOFFSPERRE IN MASSIVWÄNDEN BEI KONSTRUKTIONEN OHNE SETZUNG ODER RISSE

PROCEDE DE PROTECTION CONTRE L'HUMIDITE CAPILLAIRE DANS DES CONSTRUCTIONS SANS AFFAISSEMENTS NI FISSURES, A L'AIDE D'UNE BARRIERE EN PLASTIQUE PORTEUSE ETANCHE A L'EAU PLACEE DANS DES MURS MASSIFS

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(73) Proprietor: **Oberknezev, Stevan**
21000 Novi Sad (YU)

(72) Inventor: **Oberknezev, Stevan**
21000 Novi Sad (YU)

(74) Representative: **Matschnig, Franz**
Patentanwalt,
Siebensterngasse 54,
Postfach 252
1071 Wien (AT)

(56) References cited:
WO-A-85/00395
GB-A- 2 105 772
GB-A- 2 198 469

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Description

[0001] A plastic profiled semi-rigid barrier was designed to provide damp walls with watertight protection, old buildings and monuments with a new damp-proof course that controls capillary moisturizing.

[0002] The field of the technical application of the invention consists

- Civil engineering
- rehabilitation of buildings affected by moisture attack
- rehabilitation and preservation of buildings and monuments of historical and cultural value
- protection of buildings from capillary moisture and groundwater
- post-constructional fitting of new waterproof barrier,
- post-constructional establishment of new damp-proof course for control of wall moisturizing by capillary and osmotic forces.
- Machine cutting of damp walls and insertion of a new damp-proof course; fitting of plastic profiled semi-rigid barrier to prevent capillary moisturizing.

[0003] Several methods are applied to rehabilitate and preserve civil engineering structures damaged by capillary moisture, particularly structures of historical value:

- Giovanni Massari Method

[0004] The technique is based -on penetrating the wall by overlapping sequences of horizontal holes bored with cylindrical, diamond-bit tools and injection of a flour and fine-grained Sand blend bonded with polyester resin. Note that the polymerization of the fill is completed in three to four hours. The disadvantages of this method include time-consuming and expensive boring of many holes, incomplete control of bore filling, limitations imposed by wall thickness (untreatability of walls thicker than 130 cm), and frequent fracturing and fissuring of the injected waterproofing system due to differential structure settlement. Also, the method is inapplicable to old structures built of different materials (brick + stone + brick) or to loose or insufficiently compacted walls.

- HW Method:

[0005] The rehabilitation is based on direct insertion (driving in) of corrugated prochrome steel sheets as moisture barriers with a vibrating power press through wall joints. The major disadvantage of this method is that the structure is subjected to serious vibrations that may damage its stability and load capacity. Also, the overlaps are often unreliable and provide incomplete protection in cases when any minor lack of unbroken unity allows moisture penetration. Added to the high cost of prochrome sheets, subsidence and resulting wall fracturing are other disadvantages of this method.

- COMER Method:

[0006] The wall is cut only at the joints; cutting widths range from 20 to 120 cm and cut heights from 8 to 14 mm. The cuts are fitted with waterproof material, either bituminous bands, technical PVC foils or plastoelastic fiberglass sheets (made of glass voile and epoxy resin). The bands are cut and placed to overlap for 5 to 10 cm. To prevent wall subsidence, plastic inserts, "zeppas", are fitted perpendicular to the wall axis as temporary load supports until the injected martar-plus-additive (expander) blend sets. The disadvantage of this procedure is that it does not allow rehabilitation of very massive walls, the thickness of which exceeds 130 cm. Nor can it be applied to stone walls or walls built in brick-and stone mix. Differential structure subsidence and fracturing of treated walls have been frequently observed as a result of fairly poor support of the walls by the inserted zeppas.

- UMIBLOK Method

[0007] The method requires horizontal, 12 to 16 mm high cuts in 20 to 50 cm wide intervals with self-propelled machines. After cleaning the cuts, viscous cement mortar, with accelerators and expanders added to the slurry, is injected. This is followed by successive assembling and fitting of UMIBLOK bars, an Operation that has to be completed before the slurry sets. The 8 mm high, PVC, UMIBLOK bars with rigid beveled profiles are extrusion products. The essential scope of their application is water proofing. The disadvantage of the method, other than that inherent to the UMIBLOK bar itself, specifically to its shape and structure, is that its sole purpose is waterproofing, the establishment of a damp-proof course. The load of the structure above the cut is to be supported by me injected mortar. Another disadvantage is the hazard of microfissuring. Last, but not least, the installation procedure is difficult and complicated because of new mortar properties. Additives are used t o accelerate bonding and the insertion of the bars has become a difficult task.

[0008] Other examples of damp proof courses and isolation methods can be found in GB 2198 469, GB 2105 772 and WO 85/ 00395.

[0009] GB 2 198 469 discloses a method of inserting a damp proof course in an existing wall comprising a slot generally horizontally along a mortar course through the wall, the length of the slot being no more than a self-supporting length of the wall. At least one substantially incompressible preformed plate is pressed into the slot, the plate having a thickness substantially equal to the vertical height of the slot and each plate pressed into the slot after the first interengaging with a previously-fitted

plate in a maisture-tight manner. These steps are repeated until a continuous slot has been formed along the length of the wall with a plurality of adjacent plates located in the slot. Disadvantageously, the slot has to be cut very accurate into the mortar course of the brickwork otherwise the plates will not fit in or will be loose-fitting. Additionally, the risk of microfissuring the plates during installation or afterwards because of subsidence of the wall is high, and therefore a leakage of the damp proof course is very probable.

[0010] GB 2105 772 describes a method of inserting damp-proof membrane in an wall by cutting out a portion of a mortar course to provide an aperture and inserting the membrane into the aperture, inserting spacing elements in the aperture at suitable intervals to inhibit or prevent closing of the aperture and filling the aperture with mortar.

[0011] WO 85/00395 discloses a method for post leak-proofing or new insulation wherein prefabricated insertion carrier elements configured as a grid and an insulating hardenable material is introduced into the opening of the insertion elements.

[0012] All of the listed problems and disadvantages, especially the risk of microfissuring, are successfully overridden by applying the new method and product described herein.

[0013] The technical solution provided by this invention consists of targeted, mechanical and stepwise cutting through damp walls of civil engineering structures and monuments attacked by capillary moisture and of furnishing the horizontal cuts with the proposed PVC barrier that acts as a new damp-proof course or waterproofing system, preventing wetting by capillary forces and subsidence that is commonly followed by fracturing of the treated walls.

[0014] The technical solution provided by the subject invention and technique is in that the damp walls are mechanically, in a stepwise procedure, bisected at the target level (wall thickness and building material are irrelevant issues in the application of this patent) and the damp-proof barrier is fitted as a new waterproofing system that prevents rising of capillary water and wall wetting. When the damaged wall is cut and the barrier installed, the system - owing to its inherent properties - assumes the load of the superposed section, prevents subsidence and possible fracturing or fissuring of the treated structures.

[0015] The gist of the invention and method is the plastic profiled semi-rigid barrier. Barrier joints are interlocked into a single and continuous horizontal plate that bars all moisturizing by capillary and osmotic forces.

[0016] The shape, structure and other relevant features of the barrier allow fitting into wet walls. The product - plastic profiled semi-rigid barrier - is patented conjointly with the method and procedure of rehabilitating buildings and monuments damaged by the harmful effects of capillary moisture.

[0017] The plastic profiled semi-rigid barrier solved two crucial problems:

a) once fitted into the wall cut, it acts as an impervious, waterproof barrier, and
b) prevents structure subsidence.

[0018] Structure rehabilitation and barrier installation are achieved applying the following procedure.

[0019] The walls wet with capillary moisture are bisected using one of the alternative cutting techniques:

1. classical brick and lime-mortar walls are cut with such electrical or power tools that are equipped with bar and Widia chain and that are operated at wall joints. Alternatively,
2. stone and mixed material (brick + stone) walls are cut with power tools and diamond wire saw at the target height regardless of the position of wall joints.

[0020] Cut height is a variable dependent on the cutting tool; cut heights may be 8.00; 9.00; 11.00; 12.00 or 16.00 mm (Fig. 3).

[0021] A high-pressure pump forces the viscous slurry of cement mortar with plasticizer and retarder added into the created cuts. The performance of these additives are opposite to those in the UMIBLOK method that employs accelerators and expanders. The here described method requires superplasttcizers and retarders to provide the viscous cement mortar with superplasticity and to prolong the wait-on-cement time for 8 to 10 hours.

[0022] Special and long enough 'needles' allow positive filling along and across the wall cut. The plastic profiled semi-rigid barrier joints are lightly hammered into the cuts filled with the cement slurry. The barrier joints are securely connected by male (MC) and female (FC) couplings. The injected mortar slurry completely coats and embeds the barrier so that, after cement Setting and crystallization, the components of the system create a strong, compact, monolith and watertight protection. Temporarily or until the injected slurry fully sets, the vertical fins (F) support the load of the structure above the cut Thus, the combined load capacity of the barrier and the injected mortar completely substitutes the wall joint.

[0023] The following figures present a nonrestrictive embodiment of the invention in full details:

Fig. 1 - Axonometric presentation of prefabricated plastic profiled semi-rigid barrier No.1.

Fig. 2 - Axonometric presentation of prefabricated plastic profiled semi-rigid barrier No. 2.

Fig. 3 - wall after fitting of plastic profiled semi-rigid barrier No. 2.

Fig. 4 - wall after fitting of plastic profiled semi-rigid barrier No. 2.

Fig. 5 - plastic profiled semi-rigid barrier No. 1 cross-section.

Fig. 6 - plastic profiled semi-rigid barrier No. 1 cross-section, coupling and coupling detail.

Fig.7 - plastic profiled semi-rigid barrier No. 2 cross-section.

Fig. 8 - plastic profiled semi-rigid barrier No. 2 cross-section, coupling and coupling detail.

[0024] Fig.1 shows a plastic profiled semi-rigid barrier L The plastic profiled semi-rigid barrier 1 is an extruder product made essentially in rigid polyvinylchloride (PVC) enriched with various additives to improve its mechanical properties like hardness, strength, toughness, elasticity, impermeability, and to enhance its resistance to the harmful action of aggressive chemicals like acids, alkalis and salts. Some additives serve to neutralize thermal effects; the UV stabilizator improves the resistance to ultraviolet radiation.

[0025] Fig. 2 shows another plastic profiled semi-rigid barrier 2 identical with respect to material composition, chemical and physical properties and mechanical performance to the barrier 1 described above. The shape and design of the female coupling (FC) make the only difference. In the case of this barrier 2 the FC is a semi-open sphere SS, stronger and more rugged. As the barriers are extruded, the length X of a barrier joint is not limited.

[0026] The profile, shape, size, number, height, thickness and spacing of the fins F are designed that way that the fins can assume the total load of the structure above the cut during barrier fitting. Also, their profile allows unobstructed penetration into the injected mortar throughout the fitting operation.

[0027] The plastic profiled semi-rigid barriers 1, 2 (Fig. 1 to Fig 8) are both designed and made so that their length X may be theoretically infinite. The barriers consist of a plane plate denominated a; their total width is W; their wall thickness t For the barrier to support the vertical load of the cut wall, the horizontal plan of the plate a is intersected with a sufficient number of vertical fins F, at intervals S or spacing. Barrier wall thickness is identical to the thickness of plate a. Total fin height is h. Fin spacing S and barrier wall thickness t are variables in function of the calculated load and static load capacity of the plastic profiled semi-rigid barriers No. 1 and No. 2. The barrier joints are interconnected via male and female couplings (MC and FC, respectively) to form a permanent and unbreakable tie.

[0028] The-male coupling MC is a cylinder, C its diameter is denoted d. Cylinder C is an integral part of the horizontal plate a, and its length equals the length of the barrier X.

[0029] On the other hand, the design of the female coupling FC depends on the barrier type.

1. In the case of the plastic profiled semi-rigid barrier 1 (Fig. 5 and Fig. 6) the coupling is a semi-open, rectangular, pentagonal box of infinite length X One end of the female coupling FC is made integral part of the barrier, or more specifically, of its horizontal plate a. The other end has two inward bent, semi-open claws K. The clearance c, between the tips of the claw K, corresponds to the diameter d of the cylinder C, increased for 0.50 mm (c = d + 0.50 mm). The distance c1 between the tips of the semi-open claw K, corresponds to the barrier wall thickness t, increased for 0.50mm (c1 = t + 0.50 mm). These tolerances completely satisfy and justify both of the set targets: ease of coupling and un breakable connection.

2. In the case of the plastic profiled semi-rigid barrier No. 2, (Fig. 7 and Fig. 8) the coupling cross-section is a spherical semi-open box of infinite length X. One end of the coupling is an integral part of the barrier plate as it is continuous with the plane of the horizontal plate a. The other end, designated SPH, is semi-open, spherical and bevel tipped. The diameter d of the SPH sphere corresponds to the diameter d of the cylinder C, increased for 0.50 mm (d1 = d + 0.50 mm). The clearance c2 of the semi-open sphere SPH corresponds to the barrier wall thickness t, increased for 0.50 mm (c2 = t + 0.50 mm). These tolerances completely satisfy and justify the two target functioms: ease of connecting the MC and FC set and positive, unbreakable connection.

Example

A Wall Cutting and Mortar Injection (Fig.3, Fig.4)

[0030] Let the wet wall be of brick and lime mortar and let the thickness of the wall be 130 cm. The wall is cut at the joint with Widia chain. In this case, the typical cut height is 12 mm.

[0031] The wall is cut in stages, cutting interval width being approximately 50 to 60 cm depending on the state of the wall. The total cut height is mechanically cleaned to remove mortar or brick partides, or their aggregates. A pressure pump forces additive enriched, cement-mortar slurry into the clean cut, the additives being superplasticizers and retarders.

[0032] The retarder allows ample wait-on-cement time and removes the risk of premature and uncontrolled cement mortar setting. The retarder postpones setting for some eight to ten hours making frequent pump cleaning unnecessary. The pumps are cleaned and washed once a day, by the end of the working hours.

B. Preparation and Installation of Plastic Profiled Semi-Rigid Barriers (Fig. 1 and Fig. 2)

[0033] Let the total plastic profiled semi-rigid barriers

in Fig. 1 and Fig. 2 width be w, their length X and fin F, height h.

[0034] In the example, cut height CH is set at 12 mm and wall thickness t at 130 cm. The barrier-joint length X is cut to DL = 140 cm (DL = L + 5 + 5 cm). The short joint is precision ground to h1 = 1220 mm.

[0035] When the height of the barrier joint is adjusted to h1 = 12.20 mm, the first joint is fitted into the cut (CH = 12.00 mm) infilled with the injected slurry, by lightly tapping with a hammer. The excess fin height Δh1 (Δh1 = 0.20 mm) completely prevents structure subsidence. The whole operation, from cutting through cleaning and joint preparation to installation, is easy and provides quick rehabilitation of extremely massive walls.

Claims

1. Horizontal waterproofing barriers or damp-courses designed for rehabilitation and preservation of civil engineering structures attacked by capillary moisture
   characterized in
   plastic profiled semi-rigid barriers (1, 2) made by extrusion of rigid polyvinylchloride (PVC) enriched with additives for improvement of physical and chemical properties, consisting of a horizontal plate (a) having a barrier wall thickness (t), of vertical fins (F) and of male and female couplings (MC, FC), wherein the length (X) of the plastic profiled semi-rigid barriers (1, 2) is infinite, the width (W) of the horizontal plate (a) ends into male (MC) and female (FC) couplings as integral parts of the horizontal plate (a), and the female coupling (FC) is designed to form an inward bent claw (K) with a claw clearance of c = d + 0,50 mm, wherein d represents the diameter of the cylindrical male coupling (MC), and a claw tip clearance c1 = t + 0,50 mm, or alternatively, the female coupling (FC) is a bevel ended semi-open sphere(SPH) with a diameter d1= d + 0,50 mm, wherein d represents the diameter of the cylindrical male coupling (MC), and a claw tip clearance c2 = t + 0,50 mm.

2. Fitting method for installation of plastic profiled semi-rigid barriers (1, 2) as claimed in claim 1 into horizontal cut walls of civil engineering structures comprising the following steps:

   mechanical cutting of a wet wall,
   mechanical cleaning of the cut of height (CH) from debris and dust,
   reducing the initial length (X) of the barrier(1,2) to the desired length (DL), wherein the desired length is defined by DL = L + 5 + 5 cm and L corresponds to the thickness of the wall,
   reducing the initial height (h) of the fins (F) to the desired height (h1) by precision grinding, wherein the fin height (h1) exceeds the cut height (CH) for 0,20 mm (h1 = h + 0,20 mm),
   filling the wall cut cement-mortar slurry by use of a slurry injection pump, wherein the mortar includes additives (plasticizers and retarders) for plasticity improvement and extension of the wait-on-cement time,
   interlocking the barriers (1,2) by way of their alternating male and female couplings (MC, FC),
   insertion of the barriers (1,2) into the wall cut of height (CH) filled with mortar slurry by light hammering.

Patentansprüche

1. Horizontale wasserundurchlässige Sperren oder Dämmschichten zur Sanierung und Erhaltung von Kunstbauten, die von kapillarer Feuchtigkeit angegriffen sind,
   dadurch gekennzeichnet, dass
   profilierte, halbstarre Kunststoffsperren (1, 2), hergestellt aus steifem, mit Additiven zur Verbesserung der physikalischen und chemischen Eigenschaften angereichertem Polyvinylchlorid (PVC) mittels Extrusion, und bestehend aus einer horizontalen Platte (a) mit einer Sperrwanddicke (t), vertikalen Rippen (F) und männlichen und weiblichen Anschlüssen (MC, FC), wobei die Länge (X) der profilierten, halbstarren Kunststoffsperren (1, 2) unbeschränkt ist, der Querschnitt (W) der horizontalen Platte (a) in männliche (MC) und weibliche (FC) Anschlüsse als integrale Teile der horizontalen Platte (a) mündet, und der weibliche Anschluss (FC) in einer Weise ausgebildet ist, die eine einwärts gekrümmte Kralle (K) mit einem Krallenabstand von c = d + 0,50 mm bildet, wobei d den Durchmesser des zylindrischen männlichen Anschlusses (MC) darstellt, und einem Krallenspitzenabstand c1 = t + 0,50 mm, oder alternativ dazu der weibliche Anschluss (FC) eine abgeschrägt endende offene Halbkugel mit einem Durchmesser d1 = d + 0,50 mm, wobei d den Durchmesser des zylindrischen männlichen Anschlusses (MC) darstellt, und einem Krallenspitzenabstand c2 = t + 0,50 mm ist.

2. Einbauverfahren zur Installation von profilierten halbstarren Kunststoffsperren (1, 2) gemäß Anspruch 1 in horizontale Wandeinschnitte von Kunstbauten mit folgenden Schritten:

   Mechanisches Schneiden einer nassen Wand,
   mechanisches Reinigen des Schnittes der Höhe (CH) von Schutt und Staub
   Reduzieren der ursprünglichen Länge (X) der Sperre (1, 2) auf die gewünschte Länge (DL), wobei die gewünschte Länge (DL) mit DL = L + 5 + 5 cm bestimmt ist und L der Dicke der Wand entspricht,

Reduzieren der ursprünglichen Höhe (h) der Rippen (F) auf die gewünschte Höhe (h1) mittels Präzisionsschliff, wobei die Rippenhöhe (h1) die Schnitthöhe (CH) um 0,20 mm überragt (h1 = h + 0,20 mm),
Befüllen des Wandschnittes (mit) Zementmörtel-Brei mittels einer Breiinjektionspumpe, wobei der Mörtel Zusätze (Verflüssiger und Verzögerer) zur Verbesserung der Fliessbarkeit und zur Verlängerung der Abbindezeit,
Verriegelung der Sperren (1, 2) mittels ihrer abwechselnd männlichen und weiblichen Anschlüsse (MC, FC),
Einsetzen der Sperren (1, 2) in den mit Mörtelbrei gefüllten Wandeinschnitt mit der Höhe (CH) mittels leichtem Hämmern.

Revendications

1. Barrières étanches à l'eau horizontales ou couches de barrage d'humidité conçues pour la réhabilitation et la préservation d'ouvrages de génie civil attaqués par l'humidité capillaire
caractérisées par
des barrières semi-rigides profilées en plastique (1, 2) fabriquées par extrusion de chlorure de polyvinyle (PVC) rigide enrichi d'additifs pour améliorer les propriétés physiques et chimiques, constituées d'une plaque horizontale (a) présentant une épaisseur de paroi barrière (t), d'ailettes verticales (F) et de raccords mâle et femelle (MC, FC), dans lesquelles la longueur (X) des barrières semi-rigides profilées en plastique (1, 2) est infinie, la largeur (W) de la plaque horizontale (a) se termine à l'intérieur des raccords mâle (MC) et femelle (FC) faisant partie intégrante de la plaque horizontale (a), et le raccord femelle (FC) est conçu pour former une pince (K) fléchie vers l'intérieur avec un jeu de la pince de c = d + 0,50 mm, dans lequel d représente le diamètre du raccord mâle cylindrique (MC), et un jeu radial de pince c1 = t + 0,50 mm, ou en variante, le raccord femelle (FC) est une sphère semi-ouverte terminée en biseau (SPH) avec un diamètre d1 = d + 0,50 mm, dans lequel d représente le diamètre du raccord mâle cylindrique (MC), et un jeu radial de pince c2 = t + 0,50 mm.

2. Procédé de montage pour l'installation de barrières semi-rigides profilées en matière plastique (1, 2) selon la revendication 1 à l'intérieur de parois découpées horizontalement d'ouvrages de génie civil comprenant les étapes suivantes :

découpage mécanique d'une paroi humide,
nettoyage mécanique de la découpe d'une hauteur (CH) des débris et de la poussière,
réduction de la longueur initiale (X) de la barrière (1, 2) à la longueur souhaitée (DL), dans laquelle la longueur souhaitée est définie par DL = L + 5 + 5 cm et L correspond à l'épaisseur de la paroi,
réduction de la hauteur initiale (h) des ailettes (F) à la hauteur souhaitée (h1) par rectification dans laquelle la hauteur d'ailette (h1) dépasse la hauteur de découpe (CH) de 0,20 mm (h1 = h + 0,20 mm),
remplissage de la découpe de la paroi avec une boue de mortier de ciment en utilisant une pompe d'injection de boue, dans lequel le mortier comporte des additifs (plastifiants et retardateurs) pour améliorer la plasticité et l'extension du temps de prise du ciment,
verrouillage des barrières (1, 2) par l'intermédiaire de leurs raccords mâle et femelle (MC, FC) alternés,
insertion des barrières (1, 2) à l'intérieur de la découpe de paroi d'une hauteur (CH) remplie de boue de mortier par léger martelage.

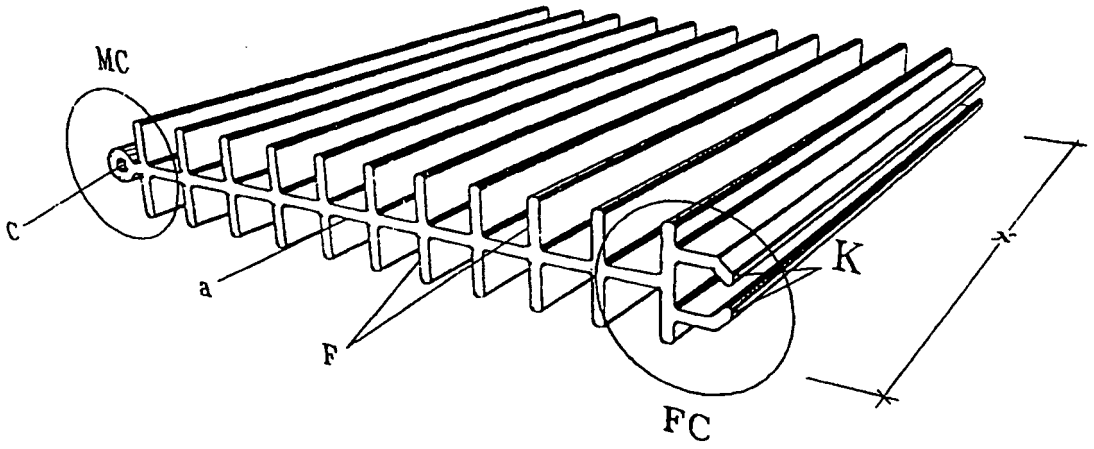


FIG.1

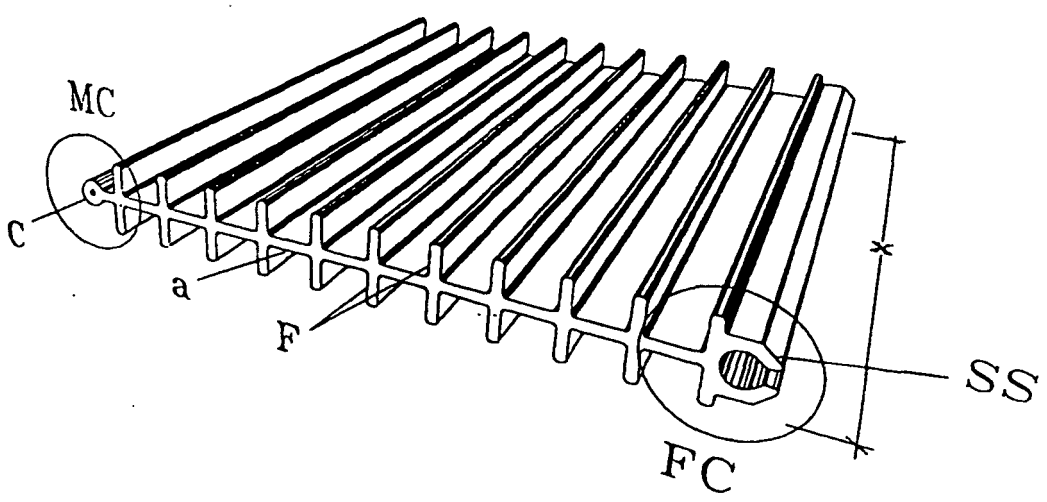


FIG.2

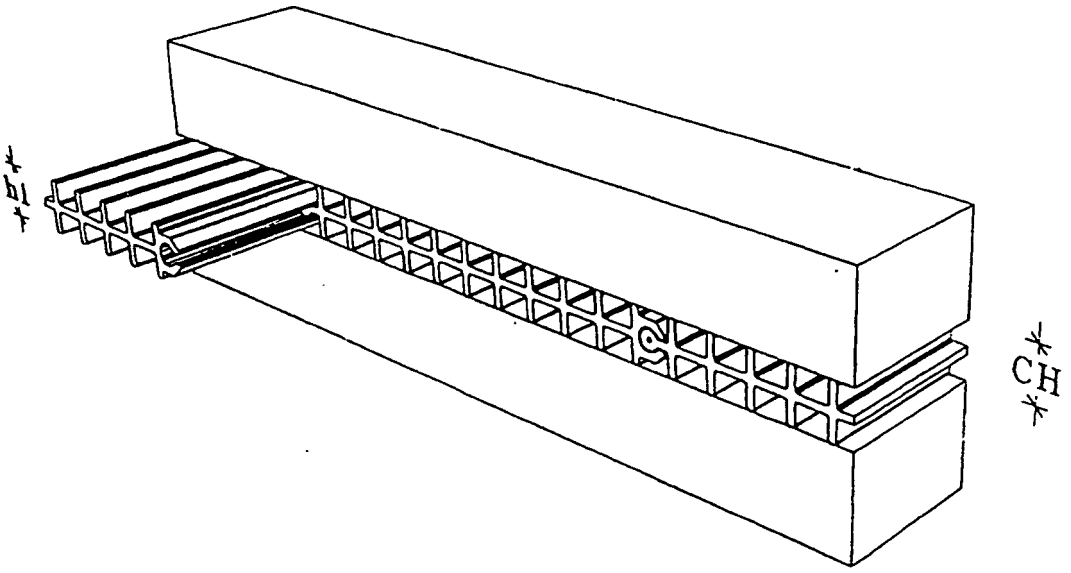


FIG.3

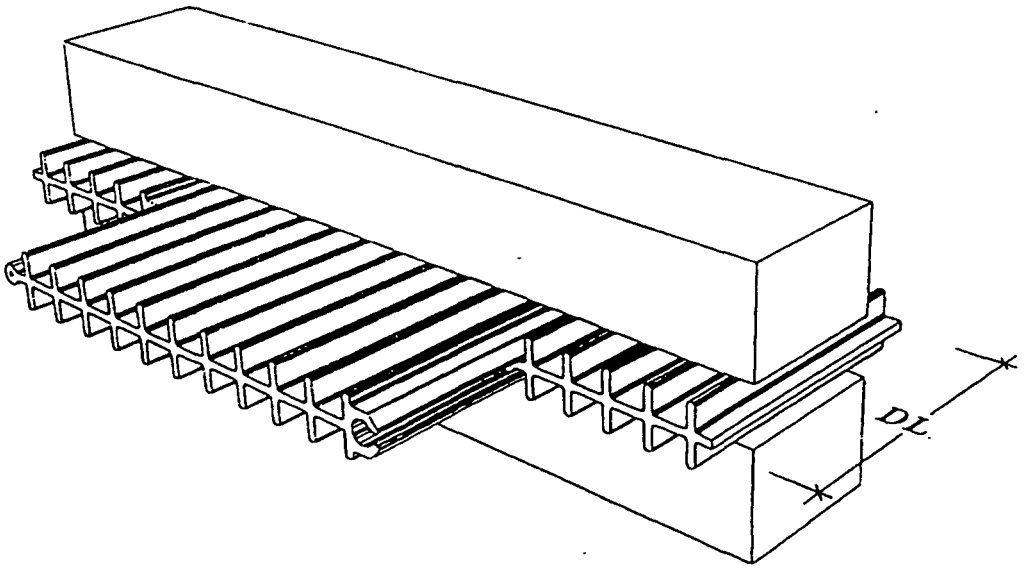


FIG.4

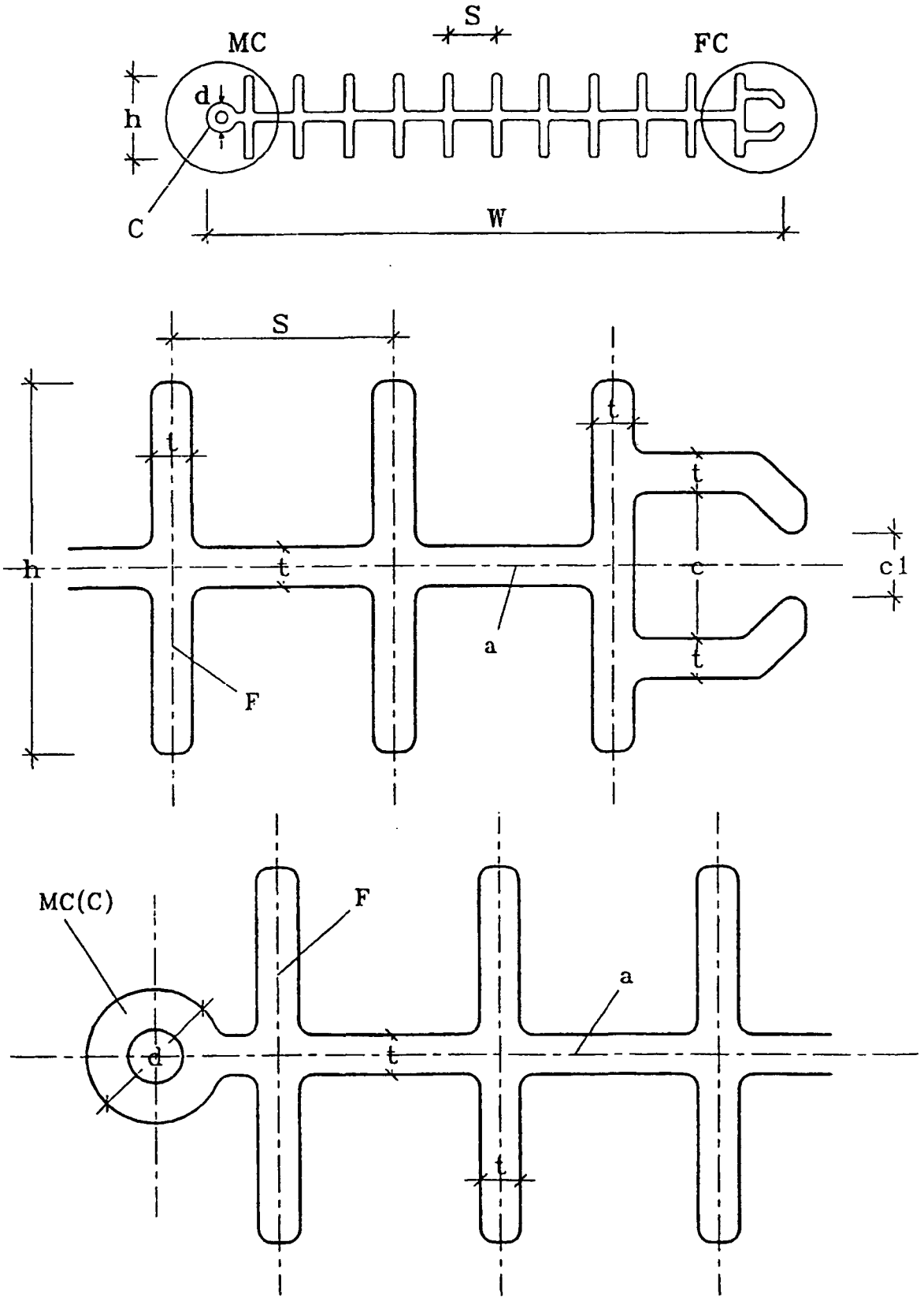
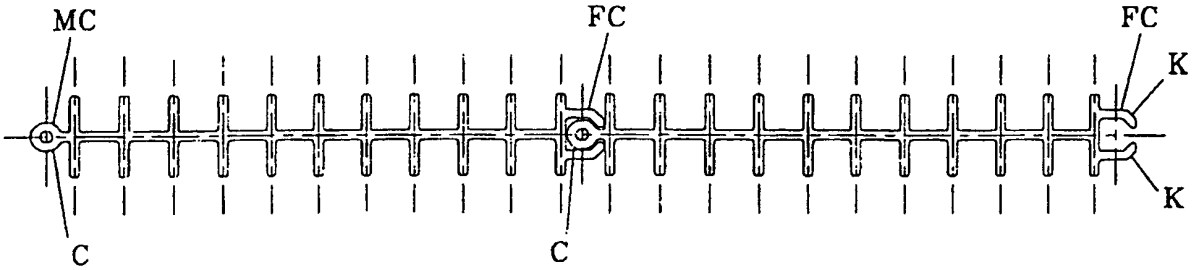


FIG.5



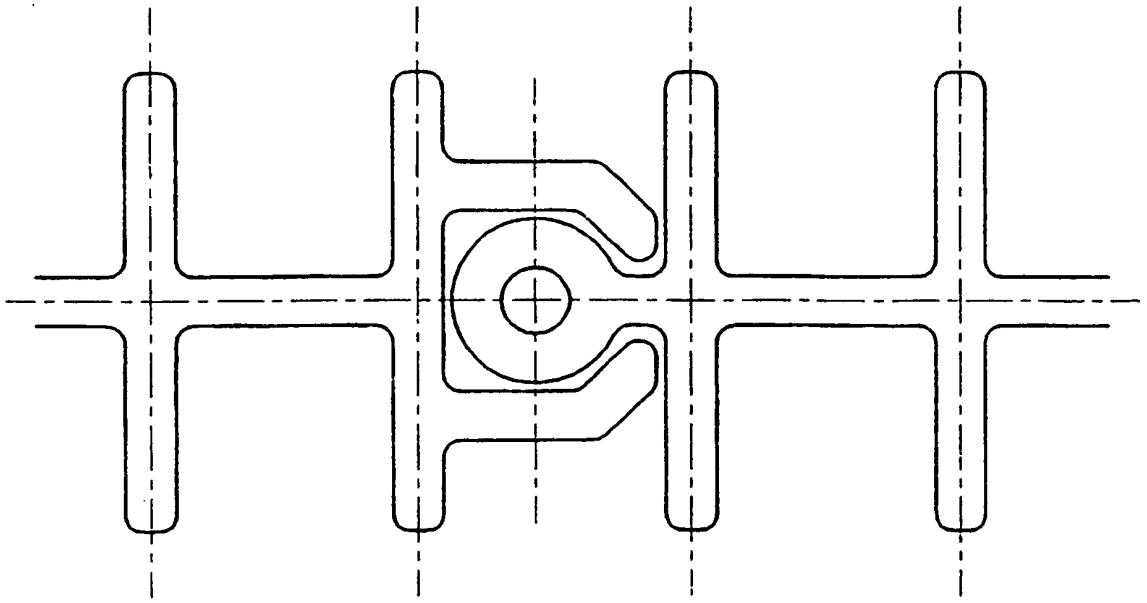


FIG.6

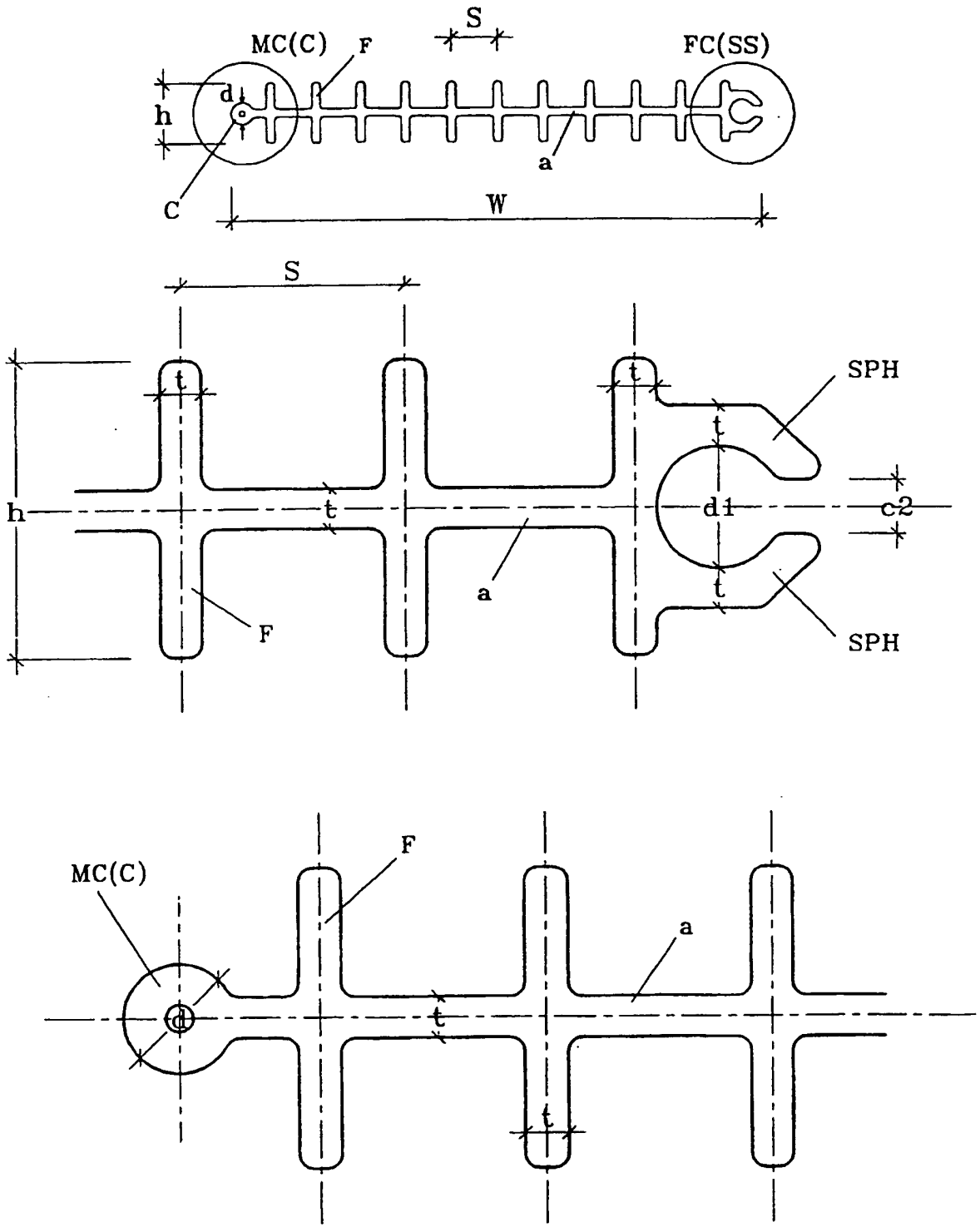
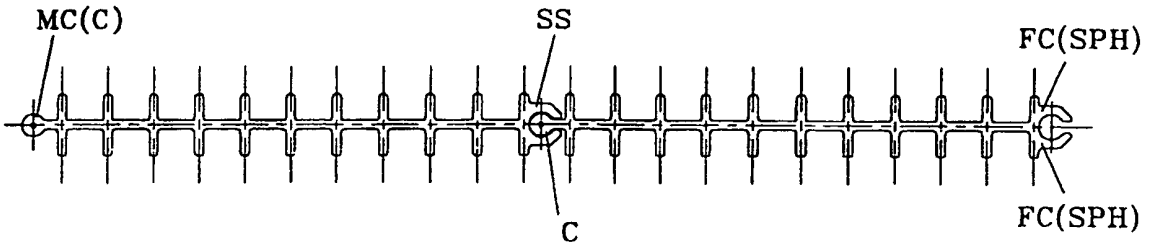


FIG.7



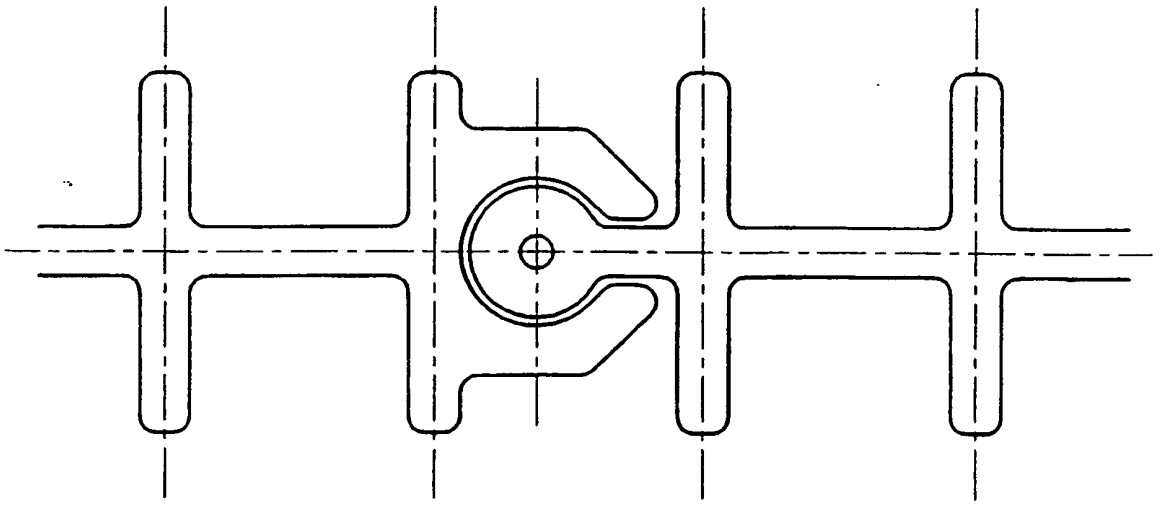


FIG.8