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(71) Applicant: **Azzolini, Angelo Corrado**

I-25073 Bovezzo,
Brescia (IT)

(72) Inventor: **Azzolini, Angelo Corrado**

I-25073 Bovezzo,
Brescia (IT)

(74) Representative: **Vatti, Paolo, Dr. Ing. et al**
Fumero-Studio Consulenza Brevetti
Franz-Joseph-Strasse 38
D-80801 München (DE)

(54) Ouenching device to cool by contact the cast blanks in continuous casting plants.

(57) A quenching device with thin pads, to cool by contact the cast blanks in continuous casting plants, comprises thin self-adjusting pads, essentially consisting of a thin wall (7, 7A) combined with cooling ducts (8, 8A) which adhere to the inner surface of said wall (7, 7A), and fluid pressure means (6, 6A) associated to said pads in order to cause the outer surface of their thin wall (7, 7A) to adhere to the cast blank (G).

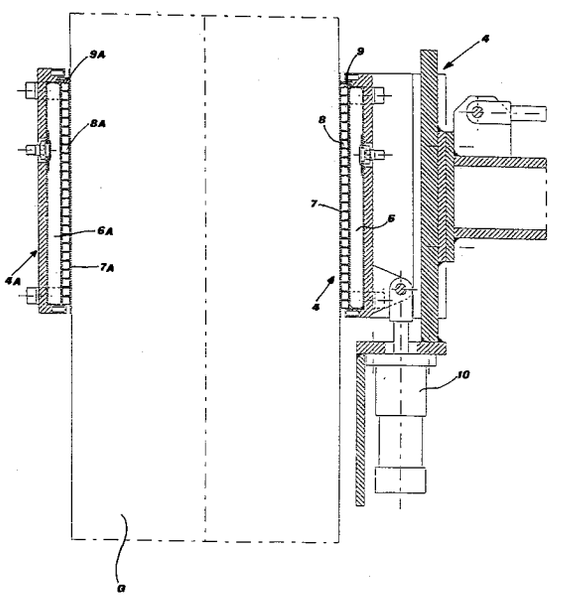

FIG.3

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The present invention concerns important improvements in continuous casting plants and it relates, in particular, to a quenching device comprising thin pads to cool by contact the cast blanks in said plants.

The continuous metal casting plants are known to comprise quenching systems to carry out the cooling by contact of the cast blanks (bars, billets, slabs). Such systems make use of devices which cause sliding and/or oscillating pads - provided with grooves into which circulates a cooling fluid (generally water) - to adhere onto said blanks.

In various respects, said systems are no doubt preferable - as far as efficiency and conduction of the process - to the more traditional spray quenching systems, or to the systems using mixed air-water jets; however, so far, such systems have suffered from the serious drawback of adopting quenching devices which make use of very heavy and thick cooling pads (independently from the various metallic or refractory materials from which they are made). For this reason, the movement of such pads has always been difficult to control and has required the use of very stout, bulky and complicated devices, which have turned out to be scarcely flexible and very costly. Above all, however, the cooling pads of the known quenching systems have difficulties in adhering and conforming to the surface of the cast blanks just on account of their considerable thickness and scarce mobility, thereby limiting the efficiency and uniformity of the quenching action as well as the possibility to regulate the same.

An interesting attempt has been made to overcome this last obstacle by creating a device equipped with pads which, though still being heavy and very thick, are apt to conform to the surface of the cast blanks far better than the conventional pads. In fact - in addition to the usual heavy and thick molten or forged body, provided with grooves for the cooling fluid - said pads comprise, in correspondence of the active part of said body, a thin sheet-metal lining which has its outer surface in contact with the blank to be cooled and which closes, with its inner surface, the open side of said grooves, thereby being directly hit by the cooling fluid circulating therein.

The use of said lining - which perfectly conforms to the surface of the cast blank, thanks to its scarce thickness - requires however the presence of sealing gaskets for the cooling fluid in correspondence of the active parts of the pad, between the periphery of said lining and its molten body; this has proved to be the weak point of the device, hence reproposing the whole problem.

The object of the present invention is to supply a quenching device to cool by contact the cast blanks in continuous casting plants, which allows to thoroughly eliminate the essential faults of the conventional contact cooling systems, by adopting cooling pads which are easy to control and which perfectly conform and adhere - while operating - to the surface of the cast blank.

This object is reached with a device using thin pads to cool by contact the cast blanks in continuous casting plants, characterized in that it comprises thin self-adjusting pads, essentially consisting of a thin wall combined with cooling ducts which adhere to the inner surface of said wall, and fluid pressure means associated to said pads in order to cause the outer surface of their thin wall to adhere to the cast blank.

According to a first preferred embodiment of the invention, the cooling ducts of the pads are independent from said thin wall and are pressed in contact with its inner surface by a hollow yielding structure under pressure, which also forms said pressure means.

In an alternative embodiment of the invention, the cooling ducts of the pads are instead in one piece with said thin wall, being formed by way of weld lines between the wall itself and a thin fellow wall associated thereto, onto which act said pressure means.

The invention will now be described in further detail, by mere way of example, with reference to the accompanying drawings, which show two preferred embodiments thereof and in which:

Fig. 1 is a diagrammatic plan view, from the top, of a first general configuration of the device according to the present invention;

Fig. 2 is a plan view, from the top, of a second general configuration of the device according to the invention;

Fig. 3 is a cross section view, with the pads shown in detail, of a first preferred embodiment of the device according to the present invention; and

Figs. 4, 5 and 6 are, respectively, a cross section view and two partial front views of pads according to a second preferred embodiment of the device of the invention.

As can be easily seen from fig. 1, the device of the present invention comprises, in a first configuration thereof, two semicylindrical units 1, 1A, pivoted together in 2. The two semicylindrical units, shown apart in the drawing, can then be drawn close so as to form a cylinder through which continuous casting is carried out by known means, generally indicated by 3, 3A. In fig. 2, the configuration of the device is still cylindrical, being formed of two identical semicylindrical units 4, 4A, shown in a closed position and in mutual engagement thanks to means 5, 5A. The units 4, 4A, can be drawn close or set apart thanks to means (not shown in the drawing) acting along the two arrows

F.

The cylindrical configuration taken up by the device according to the invention in the examples of figs. 1 and 2 is purely indicative. The device could in fact equally well comprise cooperating units having flat or prismatic surfaces, for slabs and square billets or for other shapes still of the cast blank.

Fig. 3 illustrates a first embodiment of the device according to the invention, which comprises semicylindrical units like those of fig. 1 or of fig. 2. In this embodiment, the semicylindrical units (1, 1A or 4, 4A) consist of structures, each housing a hollow yielding member 6, 6A, as a bladder of elastic material, and of thin-walled pads. Such pads are formed of a thin wall 7, 7A, and of a plurality of side-by-side cooling ducts 8, 8A, in contact with the inner surface of said thin wall 7, 7A. The pads bear with their outer surface onto the surface of the cast blank G. A cooling fluid flows through the ducts 8, 8A, while a pressure fluid is let into the bladders 6, 6A. The same pressure fluid let into the bladders 6, 6A, can also be used as cooling fluid in the ducts 8, 8A. The thin walls of the pads 7, 7A, engage with their projections 9, 9A, into corresponding cavities of the structures 4, 4A, so as to give to the device a proper steadiness.

The device can be either in a fixed position, or movable along the blank G, while carrying out the casting process. Also when it is movable and apt to be lifted or lowered - for example, in known manner, by a hydraulic ram 10 fixed to the semicylindrical unit or structure 4 (as seen in fig. 3), but also by other means, for example electromagnetically controlled - the device of the present invention can be kept motionless, or can be moved during the casting process, according to requirements.

While the device is working, with the two semicylindrical units 1, 1A or 4, 4A, drwn close so as to form a cylinder, a cooling fluid under pressure - for instance water - is sent into the bladders 6, 6A, and into the ducts 8, 8A. Under the fluid pressure said bladders expand, thereby pressing the pads with their thin walls 7, 7A, against the outer wall of the cast blank G, so as to obtain a perfect adherence of said walls to the blank itself. Through the ducts 8, 8A, the fluid cools the inner surface of the pad walls 7, 7A, and consequently, by conduction, the cast blank G. The engagement of the projections 9, 9A, of the pad walls 7, 7A, into the corresponding cavities of the structures 4, 4A, guarantees a steady positioning of the pads in the device, in respect of the cast blank G, even in the case of reciprocal movements between the device and the blank. The uniform pressure imparted by the bladders 6, 6A (into which acts the cooling fluid) onto the pads, causes their thin walls 7, 7A, to in turn impart a uniform and homogeneous pressure onto the cast blank G, to the outer surface of which they hence always keep perfectly adherent, while readily conforming to any possible irregularities thereof. This allows to operate with extremely high coefficients of heat transmission between the pads and the blank and to obtain a very efficient cooling of the cast blank.

According to the invention it is also possible, if required, to differentiate the pressure imparted by the pads on selected areas of the cast blank. For this purpose, it is sufficient to provide the device with supplementary bladders, suitably positioned.

The device according to the invention also allows to easily fulfil the most different operating conditions, in that it is possible to simply regulate the pressure imparted by the bladders 6, 6A, and thus the adherence of the pads onto the cast blank, and consequently the coefficients of heat transmission and the cooling action.

Finally, the device according to the invention combines lightness and easy control with a great simplicity of construction, guaranteed by a circulation of the cooling fluid which does not require any type of sealing gaskets in the hot working areas of the continuous casting plant.

A second embodiment of the device according to the invention is shown in figs. 4 to 6. According to this embodiment, the semicylindrical units 1, 1A (fig. 1) of the device carry, by way of suitable supports (not shown), thin-walled pads 11 formed of two thin, substantially parallel sheets 12, 13, joined together by spot weldings 14 - as shown in fig. 5 - or by seam welding, so as to create paths for the circulation of a fluid. The welding can be done with different techniques, for instance braze welding with a wire of silver alloys, or resistance welding. By suitably carrying out the welding, through a particular arrangement of the spots or seams, it is possible to obtain ducts 15 through which can flow the cooling fluid (usually water) and which may have the desired configuration, for instance that of a cooling coil 16, as shown in fig. 6. The configuration of the ducts 15, obtained in this manner, can be foreseen with extreme precision, according to planning requirements, as it suffers from no outflows by capillarity of the welds from the areas concerned, nor does it show any variations in the thickness of the weld and in the distance between the two joined sheets forming the pad. In this way, the cooling coil is obtained as an interspace between the two sheets forming the thin pad, and not as a separate piping.

During operation - which takes place in a fully similar way to that of the first embodiment described heretofore, and which provides equal performances - suitable means, as pressure bladders (not shown on the drawings), mounted into the semi cylindrical units 1, 1A, ensure the self-adjust-

ment of the thin-walled pads 11, so that they may perfectly adhere to the outer wall of the cast blank G. Also in this case, the cooling liquid is sent under pressure into the pressure bladders and, from here, into the ducts 15 of the pads 12. Obviously, any weldable material is suited for producing the pads 12 and, also in this case, there are no problems tied to the presence of sealing gaskets in the work area.

The differences in behaviour of the device according to the present invention, compared to those of known technique, are enormous. In fact, thanks to the extreme lightness of its thin pads, and to the consequent highly reduced inertias, the mechanical features of said device can be very simple and its movements very rapid, thereby notably reducing plant costs and considerably improving the cooling effects obtained. Said device also forms a positive improvement over the known devices due to the exceptional conformability of the thin pads to the surface and irregularities of the cast blank to be cooled; as seen, said conformability is facilitated by the uniformity of the pressure imparted by the bladders on the pads and by these latter onto the cast blank. This advantage is particularly felt for what concerns the increase in the values of the coefficient of heat transmission between the cooling pads and the cast blank: it is in fact possible to reach contact yields higher than 75% of the theoretical ones, and in any case equal to 2-3 times those of the conventional devices.

The device of the present invention allows to efficiently and fully overcome many of the drawbacks which are characteristic of the spray quenching systems of prior art. In particular, the use of the device according to the invention totally prevents: any violent thermal shocks on the skin of the product (cast blank), and the cracks, stresses and the like, which could derive therefrom; any anomalous strains on the skin of the product, which normally occur in the spaces between the means guiding the same and in the areas which are not properly covered by the spray cones; any surface segregations due to the temperature differences arising, inside the single spray cones or blades, between the single cones or blades in the interaxis among the rows of nozzles, between the centre and the edge of the slabs. It also helps to prevent the difficulties in controlling the exchange factors and the thermal fluxes by radiation, convection and evaporation, and the difficulties in following the internal phase variations (critical ranges, quench hardenings, and the like) in the product. It finally prevents the presence of undesired steam in the environment, clogging and corrosion of the nozzles, and all the problems connected therewith. Furthermore, the operations are far simpler, water consumption is reduced and it is easier to control the temperatures and the heat balances in operation.

Other advantageous aspects of the invention - also in respect of the previous devices with pads - lie: in the possibility to limit the amounts of cooling fluid in the circuit, by increasing its speed; in the possibility to insert between the pads and the cast blank screens to modulate heat transmission; in the temperatures reached by the pads, which are lower than the conventional ones, with a consequent further stability in their structure and dimensions, and a longer life thereof.

Finally, further advantageous performances of the device according to the invention result from the easiness in regulating the contact pressure between the cooling pads and the cast blank. Consequently, said device is particularly suited for automated plants, the operation of which is controlled by computers. It should be noted in particular that, in this context, the device allows to carry out the heat balance in real time, operating on substantially fixed parameters (not being tied to working uncertainties). Furthermore, the device can be easily adjusted to reduce the contact pressure between the pads and the cast blank in the treatment (or during steps of the treatment) of delicate alloys, with considerable improvements in the quality of the finished products (treated by using reduced heat flows).

It is understood that there can be other practical embodiments of the invention, differing from those described and illustrated, without thereby departing from its protection scope. For instance, the general configuration of the device may vary, and need not necessarily be cylindrical, but it could be flat or prismatic, or still different. Moreover, the hollow yielding structures of the device - instead of bladders of elastic material, as described heretofore - could consist of containers, even not yielding, of metallic or plastic material, or of some other material.

In an alternative solution - considered to be a variant of the embodiment shown in figs. 2 and 3 - one could even eliminate the thin walls 7, 7A, of the pads, and cause the cooling ducts 8, 8A, to adhere directly onto the cast blank G.

It is also understood that, although the device has been described for use especially in continuous casting plants, it could be equally applied - with all the advantages involved - to static casting plants.

Claims

1. Quenching device with thin pads to cool by contact the cast blanks in continuous casting plants, characterized in that it comprises thin self-adjusting pads, essentially consisting of a thin wall combined with cooling ducts which

adhere to the inner surface of said wall, and fluid pressure means associated to said pads in order to cause the outer surface of their thin wall to adhere to the cast blank.

2. Device as in claim 1), wherein the cooling ducts of the pads are independent from said thin wall and are pressed in contact with its inner surface by a hollow yielding structure under pressure, which also forms said pressure means.

3. Device as in claim 1), wherein the cooling ducts of the pads are in one piece with said thin wall, being formed by way of weld lines between the wall itself and a thin fellow wall associated thereto, onto which act said pressure means.

4. Device as in claim 1), wherein said pressure means consist of bladders of elastic material.

5. Device as in claim 1), wherein a single pressure fluid feeds said pressure means and flows through said cooling ducts.

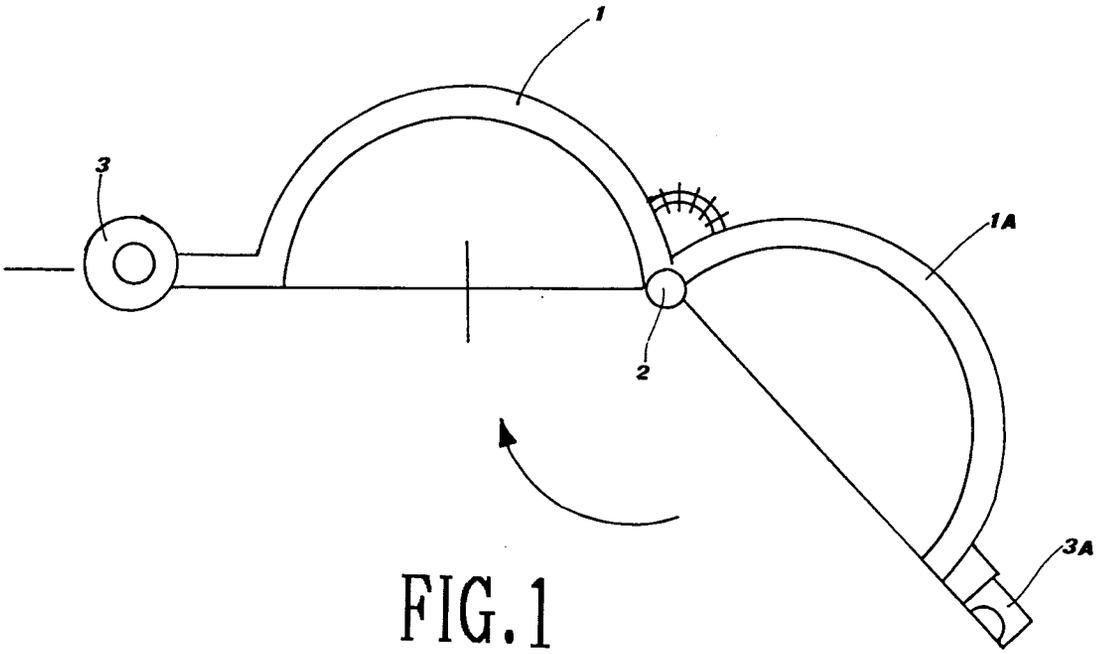

FIG.1

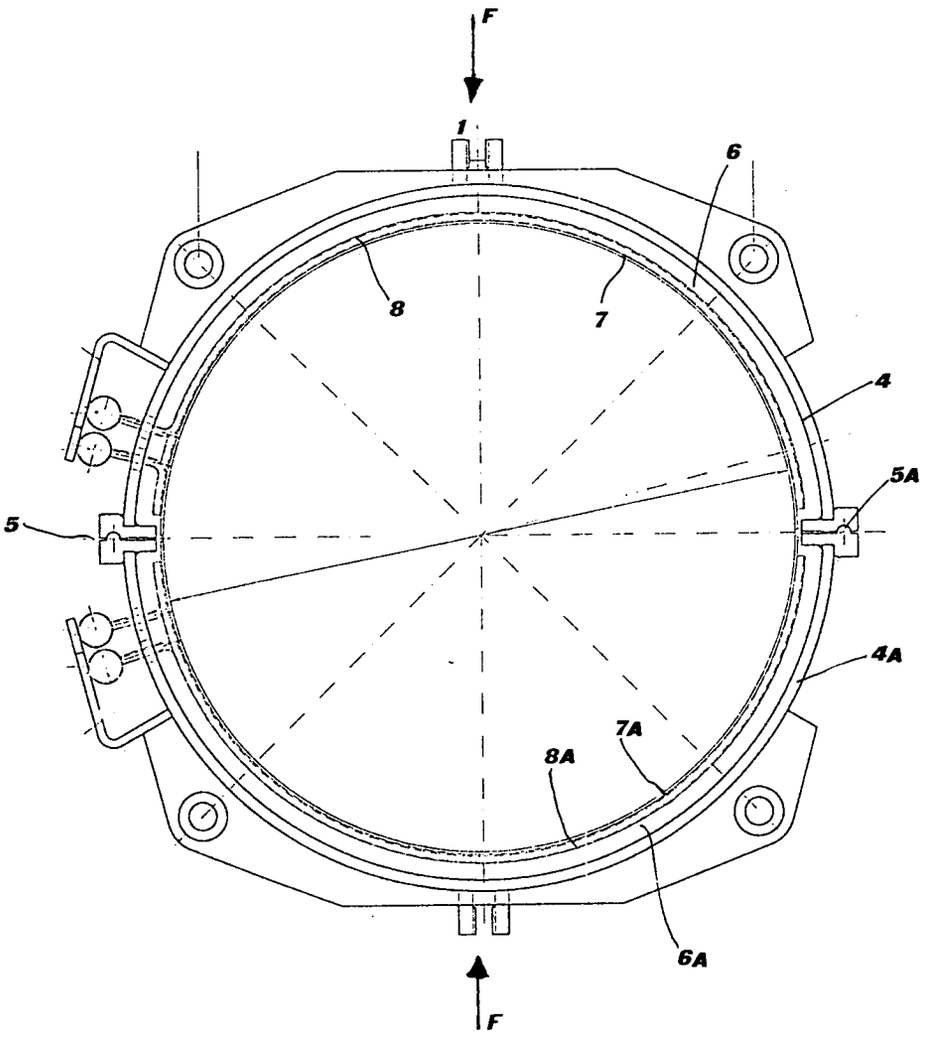

FIG.2

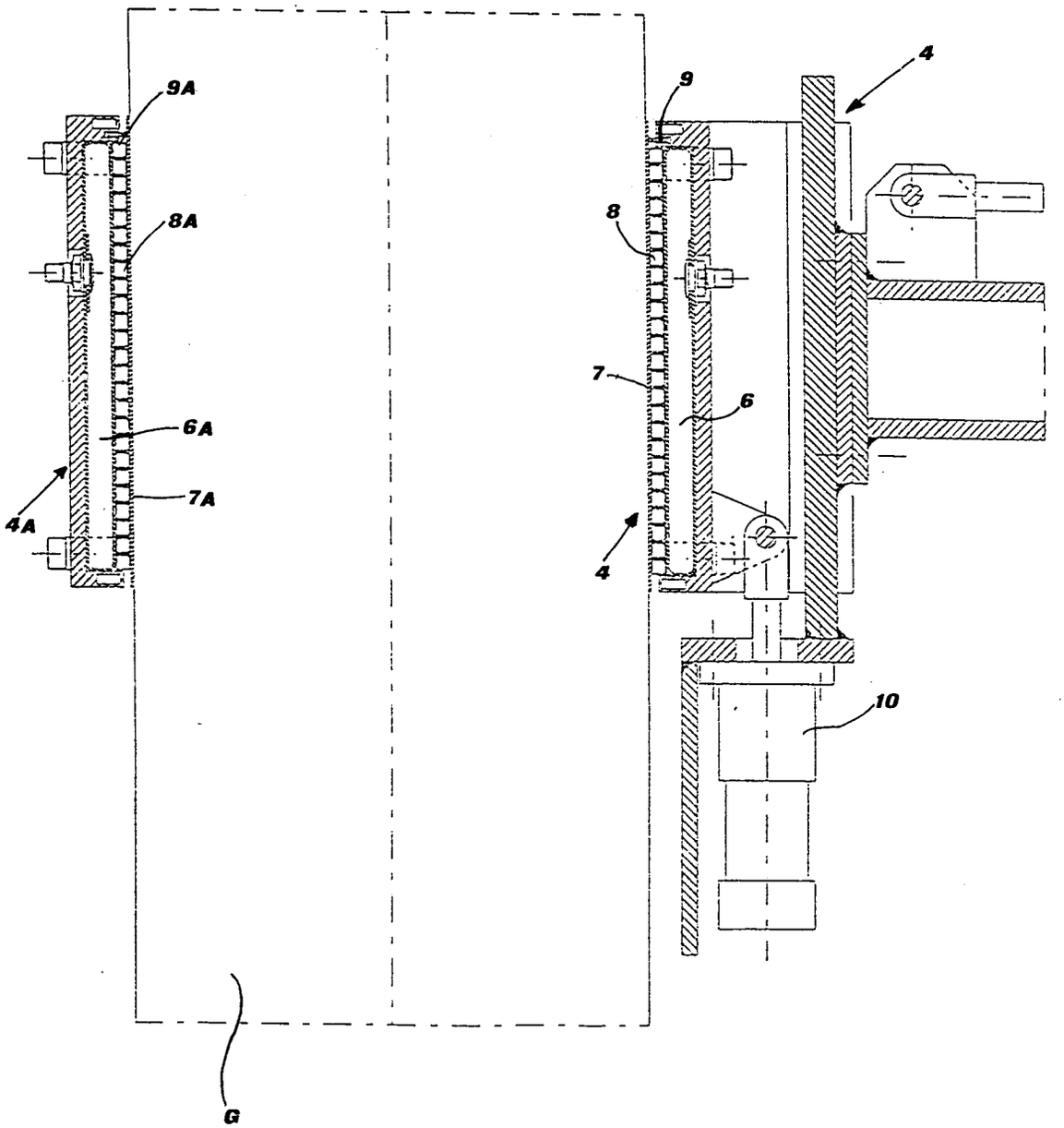

FIG.3

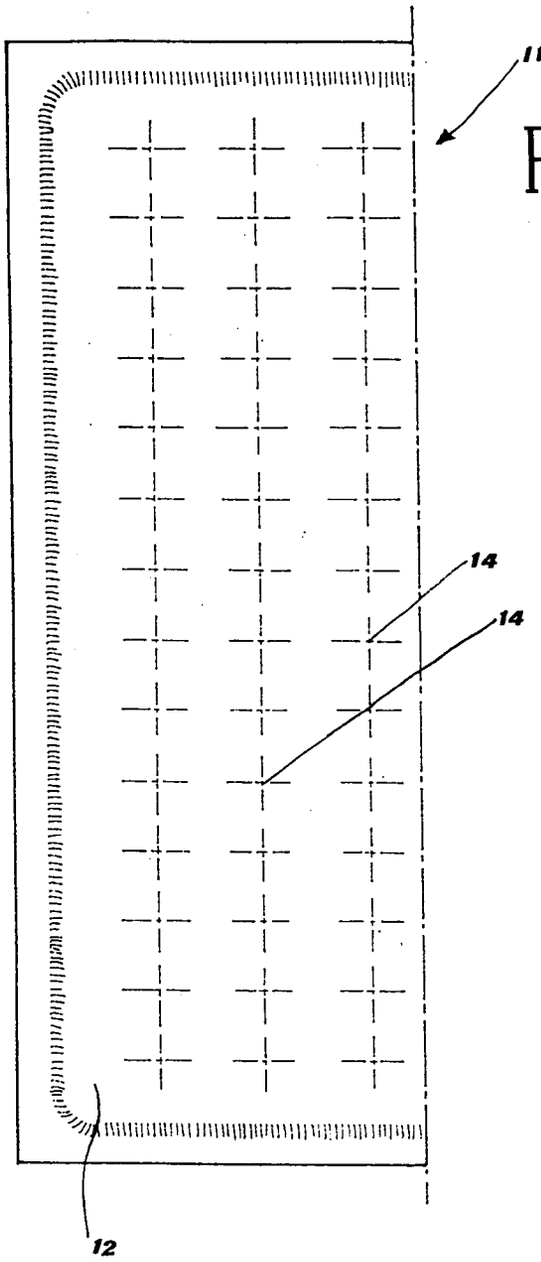

FIG.5

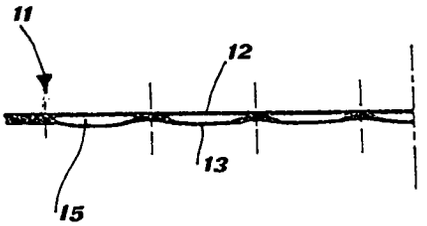

FIG.4

FIG.6