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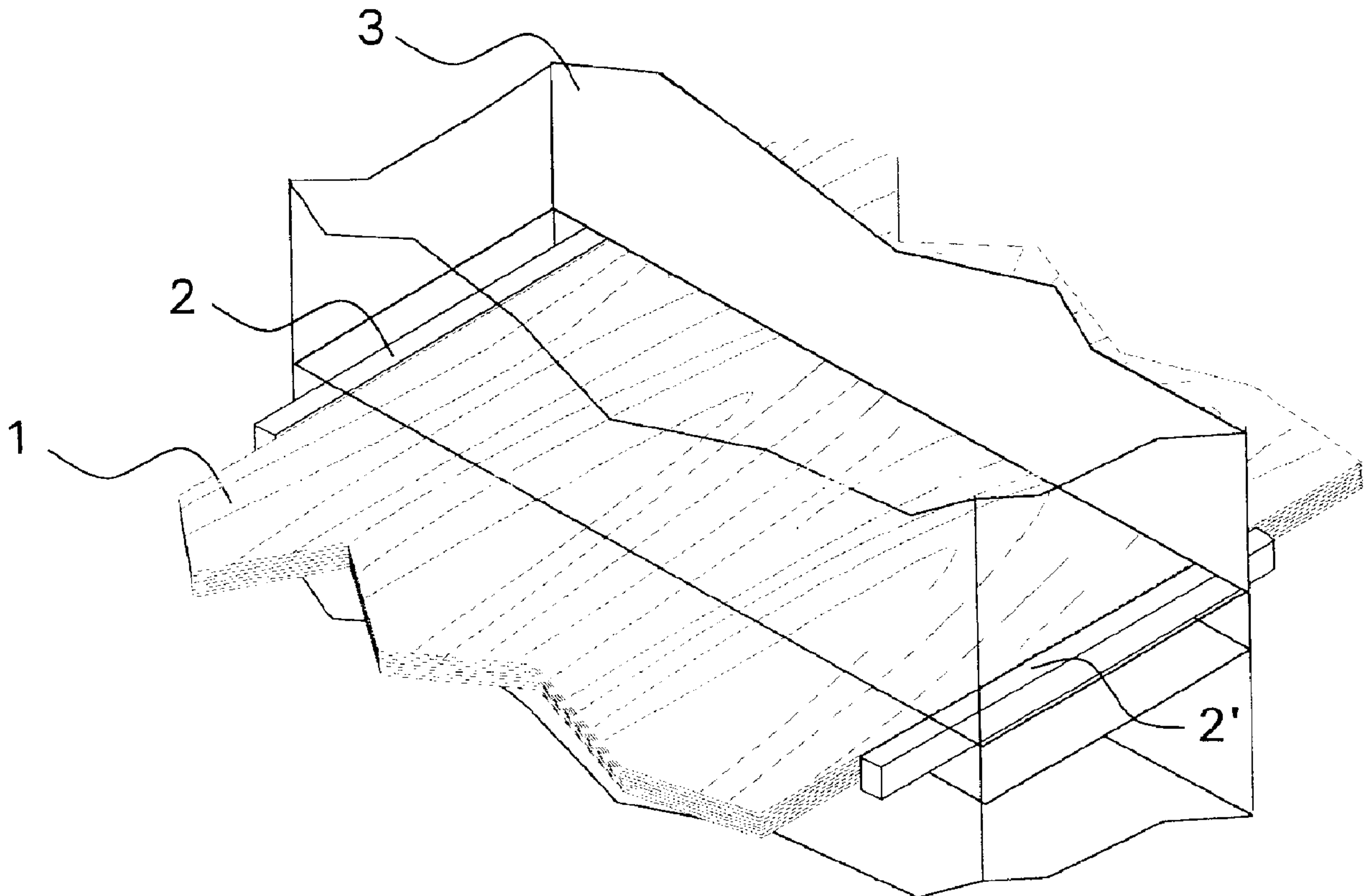
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(54) Titre : DISPOSITIF DE CHAUFFAGE DE PRODUIT DE PANNEAU COMPRENANT DU BOIS COLLE

(54) Title: APPARATUS FOR HEATING A BOARD PRODUCT INCLUDING GLUED WOOD



(57) Abrégé/Abstract:

The invention concerns an apparatus for heating a board product containing glued wood. The apparatus comprises a heating chamber through which the board product passes. The board passes through a heating field in the chamber provided by means of microwave energy applied perpendicular to the board plane. The clearance between both edges of the board, in the proceeding direction of the board, and the wall of the heating apparatus, respectively, is filled by a slide piece made of material having a small loss tangent and a low dielectric factor. The slide piece corrects the form of heating field in the plane of the board.

ABSTRACT

The invention concerns an apparatus for heating a board product containing glued wood. The apparatus comprises a heating chamber through which the board product passes. The board passes through a heating field in the chamber provided by means of microwave energy applied perpendicular to the board plane. The clearance between both edges of the board, in the proceeding direction of the board, and the wall of the heating apparatus, respectively, is filled by a slide piece made of material having a small loss tangent and a low dielectric factor. The slide piece corrects the form of heating field in the plane of the board.

APPARATUS FOR HEATING A BOARD PRODUCT INCLUDING GLUED WOOD

The present invention concerns an apparatus for heating a board product containing glued wood, primarily for affecting the hardening reactions of the glue, said apparatus applying the heating energy to the board product by means of an alternating electrical field at microwave frequency. Before the heating step, the board product has been manufactured to be continuous, and it is conveyed through a stationary heating apparatus. The board product generally comprises wood layers arranged parallel to the board, ply layers, the spaces between them being glued with glue to be hardened by means of heat. A typical product is the so-called LVL balk (Laminated Veneer Lumber). The invention is also applicable to other types of wood based board products, in which the glued wood component is bound to a solid board construction by hardening the glue. Before being transported to heating, the board product is usually exposed to pressure in order to get the glued wood components into a close contact and to remove air spaces disturbing the alternating electrical field in the board construction.

In an apparatus to be used for heating of this kind of a wood product, the alternating electrical energy is exerted to the board product to be heated perpendicular to the board plane, and the electrical field affecting the board has been formed by the device exerting the alternating electrical energy to the board so that the field affects in the plane of the board, in cross direction to the proceeding direction of the board. An alternating electrical field arranged in this way affects the material to be heated depending on its dielectric properties. For example the dielectric factor of the wood material of light and dry wood (moisture content 0%) is approximately 1.5 and respectively the loss tangent is approximately 0.02. With dense and damp wood (moisture content 100%) the dielectric constant is approximately 20 and respectively the loss tangent is about 0.25. On the average, with the sorts of wood to be used for board products, the respective values of dielectric constant range in the average humidity conditions from 2 to 4 and of loss tangent from 0.05 to 0.4. These values change to some extent, when the wood gets warm during the heating. With the glues used for board products these values are higher, for example dielectric values from 28 to 12 can be measured for phenol formaldehyde glue, whereby the higher value is received when the glue is in the room temperature and liquid. Thus, the heating effect of the alternating electric field

is more efficient for the part of the glue. This effect appears advantageously especially with board products, in which the glue is applied as layers parallel with the board (parallel with the alternating electrical field).

5 The heating effect caused by the electric field is distributed to the area of the board coherently (taken into account the differences between the wood material and the glue), in case that the edges of the board are in contact with the walls of the device, the device being dimensioned according to the used frequency and the nominal width of the board. In praxis, however, there must be left a running clearance between the edges of the board parallel with the proceeding direction and the walls of the device. The air gap formed in this way,
10 however, disturbs the formation of the alternating electrical field at its extreme ends, and as a result of that, the field at the edge areas of the board is formed narrower in the traveling direction of the board, and consequently the edges of the board get less of heating power, and the temperature remains lower than in the center areas of the board.

The problem mentioned above has been solved in accordance with the present invention by
15 providing each of the gaps between the edges of the board parallel with the proceeding direction and the walls of the heating apparatus with a piece positioned to fill substantially clearance-free the actual gap, said slide piece being made of material having a small loss tangent and a low dielectric factor.

By means of the arrangement described above, the disturbance caused by the air gap in the
20 formation of the electric field in the board product can be eliminated.

For the part of the dielectric properties of the material to be used for the slide piece, it must be taken into account, that in the alternating electric field it is practically free of losses, in other words, the loss tangent of the material is small and its dielectric constant has a very low value with frequencies of the alternating electric fields to be used. Standard frequency of the
25 alternating electrical field in the heating apparatus in question is 915 MHz. Alternatively also a frequency of 2450 MHz can be considered.

A suitable value for the dielectric constant ranges from 1 to 10 and the loss tangent is about 0.02 or below this value. In addition, the sliding properties and/or abrasion strength of the

material must be taken into account.

Suitable materials for the slides are different plastic materials and also ceramic materials having the above mentioned dielectric properties. Plastic materials include polytetrafluoroethylene (PTFE), polycarbonate (PC), polyphenylene sulfide (PPS),
5 polyvinylidene fluoride (PVDF). Usable material and the dimensioning thereof as a slide can be chosen by modeling the form of the alternating electrical field to be implemented with it. Other applicable materials have been listed in the enclosed attachment A, together with the loss tangent values of the materials.

One problem for implementing the apparatus is caused by the heat dissipating from the board
10 to be heated to the slides, as well as the heat formed eventually in the slide material itself by the electric field, eventually making the temperature of the slide material to rise in use. The rise of the temperature can have influence on the durability of the material and also on its behavior in the alternating electrical field. These problems can appear pronouncedly in equipment configurations, where the slides are incorporated in the heating apparatus. When
15 the slides are incorporated in the heating apparatus, the loss tangent of the material should not exceed the value 0.02.

The apparatus can alternatively be implemented so that the slide or a part thereof is formed as a band in a state of motion, following the board product to be heated pressed against its edge and sliding against the wall of the heating apparatus or a fixed part of the slide. In this
20 embodiment the band-like slide or a part thereof can be advantageously implemented as a loop circulating along an endless path, the returning path thereof being located outside the heating apparatus. There the required cooling can be arranged for the slide band, said arrangement increasing the selection of suitable slide materials.

One embodiment of the apparatus in accordance with the present invention is shown
25 schematically in Figure 1 of the enclosed drawings.

Figure 2 is a cross sectional view against the proceeding direction of the board, of the same apparatus,

Figure 3 shows the form of the alternating electrical field affecting the board, as a view perpendicular to the board plane in an apparatus, wherein the edges of the board are at a distance of an air gap from the walls of the alternating electrical field chamber, and

Figure 4 shows a corresponding alternating electrical field, the form thereof being aligned by
5 modifying measures of the apparatus in accordance with the invention.

In Figure 1, the board product 1 to be heated is in a continuous proceeding motion through the chamber 3 of the heating apparatus. In the chamber, the board is exposed, perpendicular to its plane, to high-frequency alternating electric energy, which, by means of the dimensioning of said apparatus, can be made to maintain a alternating electrical field, the
10 direction of which being at the plane of the board 1, transversal to its proceeding direction. Arranged between the side edges of the board 1 parallel to the proceeding direction and the walls of the chamber 3, there are slides 2 and 2', made of a material chosen to fulfill the properties as described above.

Figure 2 shows a cross-sectional view of the board with respect to the proceeding direction of
15 the board 1, showing the construction of a microwave chamber known in the art. The microwave energy to be exerted to the board 1 is applied from a wave slide 3' of a wave generator known in the art, for example at a frequency of 915 MHz. After the wave slide, the wave pattern is spread in an accurately dimensioned chamber 3 to stretch in the transversal direction of the board 1. In practice, a running clearance of a couple of millimeters must be
20 left between the side walls of the chamber 3 and the side edges of the board 1, whereby the air gap present in this clearance disturbs the prevailing standing microwave pattern 4 in the board in accordance with Figure 3, especially at the edges of the board.

By filling the clearance between the board 1 and the walls of the microwave chamber 3 with pieces 2, 2' made of a material having the right electrical properties, the prevailing
25 microwave pattern in the board 1 will be formed to a pattern 4' corresponding the dimensioning of chamber 3, said pattern 4' shown in Figure 4.

Attachment A

	Material	Loss tangent
	OM (polyacetal)	0,0011 - 0,007
5	POM-C (POM copolymer)	equal
	POM-H (POM homopolymer)	equal
	POM-H-PTFE	equal
	PC (polycarbonate)	0,0006 - 0,0015
	PETP (polyethylene terephthalate)	0,002
10	PEEK (polyethylene - ethylene ketone)	0,001 - 0,004
	PEEK-GF30 (fibre glass 30%)	0,001 - 0,004
	PPS (polyphenylene sulfide)	0,0004
	PEI (polyether imide)	0,014
	PSU (polysulphone)	0,0008
15	PI (polyimide)	0,005
	PE (polyethylene)	0,00015-0,0007
	PP (polypropylene)	0,00007-0,0001
	EVA (ethylene vinyl acetate)	0,0015
	PB (polybutene)	0,0007 - 0,001
20	PMP (poly-4-methylic pentene-1)	0,00007
	PS (polystyrene)	0,0001 - 0,0004
	SB, S, B (styrene, butadiene	0,0001 - 0,0005
	SAN (styrene/acrylonitrile)	0,004 - 0,005
	ASA (acrylonitrile/styrene/acrylate	0,009
25	PTFE (polytetrafluoroethylene)	0,00003 - 0,00007
	FEP (perfluoride ethylene propylene)	0,00003 - 0,00007
	PFA (perfluoride alkoxide polymer)	0,00009
	ETFE (ethylene/tetrafluoroethylene)	0,0006 - 0,005
	PCTFE (polychlorotrifluoroethylene)	0,001 - 0,01
30	ECTFE (ethylene/chlorotrifluoroethylene copolymer)	0,001 - 0,01

	PBTP (Polybutylenterephthalate)	0,0012 – 0,002
	PPO (polyphenyl oxide)	0,0004
	PES (polyether sulphone)	0,0008 – 0,001
	EP (epoxy)	0,001
5	CA (cellulose acetate)	0,007 – 0,013
	CAB (cellulose acetate butyrate)	0,005
	CP (cellulose propionate)	0,005 – 0,007
	Composites:	
10		
	G-Etronax EP FR 4 (glass fiber laminate)	0,005 – 0,008
	G-Etronax EP 11 (glass fiber laminate)	0,008 – 0,01
	G-Etronax EP 215 S (glass fiber laminate)	0,008 – 0,01
	G-Etronax EP SI (glass fiber laminate)	0,003
15	C-STOCK RH (polyimide-based)	0,0004 – 0,0009
	C-FOAM PK (polyurethane-based)	0,001
	C-FOAM PF (polyolefin-based)	0,0001
	C-CAST 235D (polystyrene-based)	0,002
	C-STOCK .0005	0,0005
20	ECFG	0,007
	OASIS 300TWN525 (polyimide + fluoropolymer)	0,01
	DiClad 522, 527 (woven glass fiber/Teflon)	0,001 – 0,0022
	DiClad 870 (woven glass fiber/Teflon)	0,0009 – 0,0013
	DiClad 880 (woven glass fiber/Teflon)	0,0008 – 0,0013
25	ROHACELL 31 (polymer, polymethacrylimide)	0,0001 – 0,0004
	ROHACELL 51 (polymer, polymethacrylimide)	0,0002 – 0,0004
	ROHACELL 71 (polymer, polymethacrylimide)	0,0003 – 0,0007
	ROHACELL 110 (polymer, polymethacrylimide)	0,0003 – 0,0007
	CuClad 250GT/GX (woven glass fiber/Teflon)	0,001 – 0,0022
30	CuClad 233LX (woven glass fiber/Teflon)	0,0013
	CuClad 217LX (woven glass fiber/Teflon)	0,0009

	AR320	0,0029
	IsoClad 933 (non-woven glass fiber/Teflon)	0,0014
	IsoClad 917 (non-woven glass fiber/Teflon)	0,0010
	DiClad 810 (ceramic filled Teflon)	0,0020
5	Epsilam 10 (ceramic filled Teflon)	0,0029
	AR 1000 (ceramic filled Teflon)	0,0035
	AR 600 (ceramic filled Teflon)	0,0035
	AR 450 (ceramic filled Teflon)	0,0026
	AR 350 (ceramic filled Teflon)	0,0026
10	CLTE (ceramic filled Teflon)	0,0025

CLAIMS

1. An apparatus for heating a board product containing glued wood, said apparatus comprising:

a heating chamber through which the board product passes, wherein said heating chamber contains a wave spreader arranged to apply a microwave frequency energy from a wave generator in a direction perpendicular to a board plane of the board product, said board plane being transverse to planes corresponding to edges of said board product, and wherein said wave spreader is arranged to spread a wave pattern of the microwave frequency energy such that the wave pattern stretches in a direction transverse to the direction in which the board product passes through the heating chamber; and

slide pieces substantially filling running clearances between respective side edges of the board and side walls of the heating chamber, wherein the slide pieces are made of a material having a small loss tangent and a low dielectric factor.

2. An apparatus according to claim 1, wherein the frequency of the heating electrical field fed to the heating chamber is alternatively 915 MHz or 2450 MHz, wherein the dielectric constant of the material of the slide pieces ranges from 1 to 10 and the loss tangent is ≤ 0.02 .

3. An apparatus according to claim 2, wherein the material of the slide pieces is polytetrafluoroethylene (PTFE), polycarbonate (PC), polyphenylene sulfide (PPS), polyvinylidene fluoride (PVDF), or ceramic material.

4. An apparatus according to claim 2, wherein the slide pieces are incorporated with the side walls of the heating chamber.

5. An apparatus according to claim 2, wherein the slide pieces or parts of the slide pieces are movable in the direction in which the board product passes through the heating chamber.

6. An apparatus according to claim 1, wherein the material of the slide pieces is

polytetrafluoroethylene (PTFE), polycarbonate (PC), polyphenylene sulfide (PPS), polyvinylidene fluoride (PVDF), or ceramic material.

7. An apparatus according to claim 6, wherein the slide pieces are incorporated with the side walls of the heating chamber.

8. An apparatus according to claim 6, wherein the slide pieces or parts of the slide pieces are movable in the direction in which the board product passes through the heating chamber.

9. An apparatus according to claim 1, wherein the slide pieces are incorporated with the side walls of the heating chamber.

10. An apparatus according to claim 9, wherein the loss tangent of the material of the slide pieces is ≤ 0.002 .

11. An apparatus according to claim 1, wherein the slide pieces or parts of the slide pieces are movable in the direction in which the board product passes through the heating chamber.

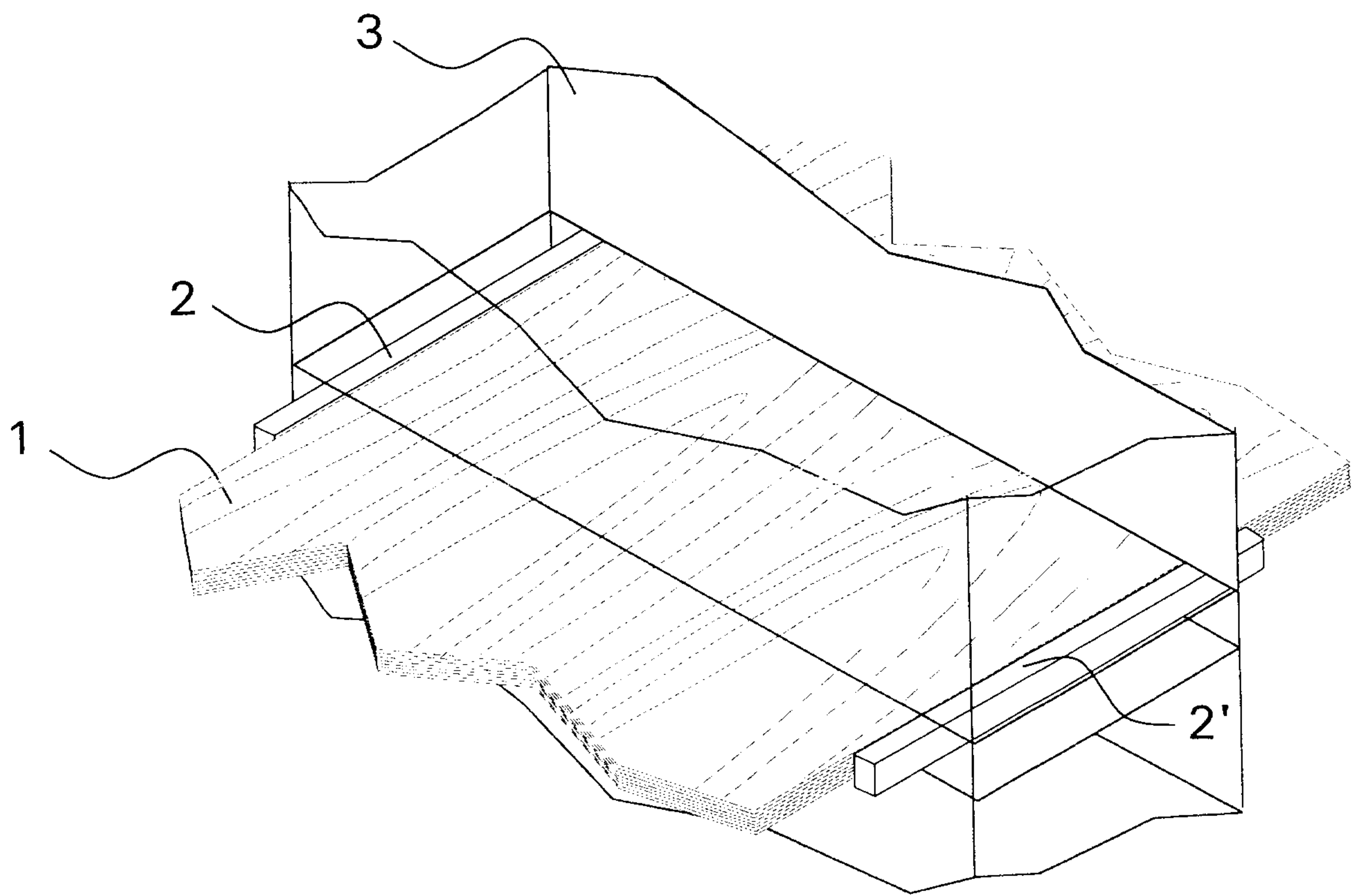


Fig. 1

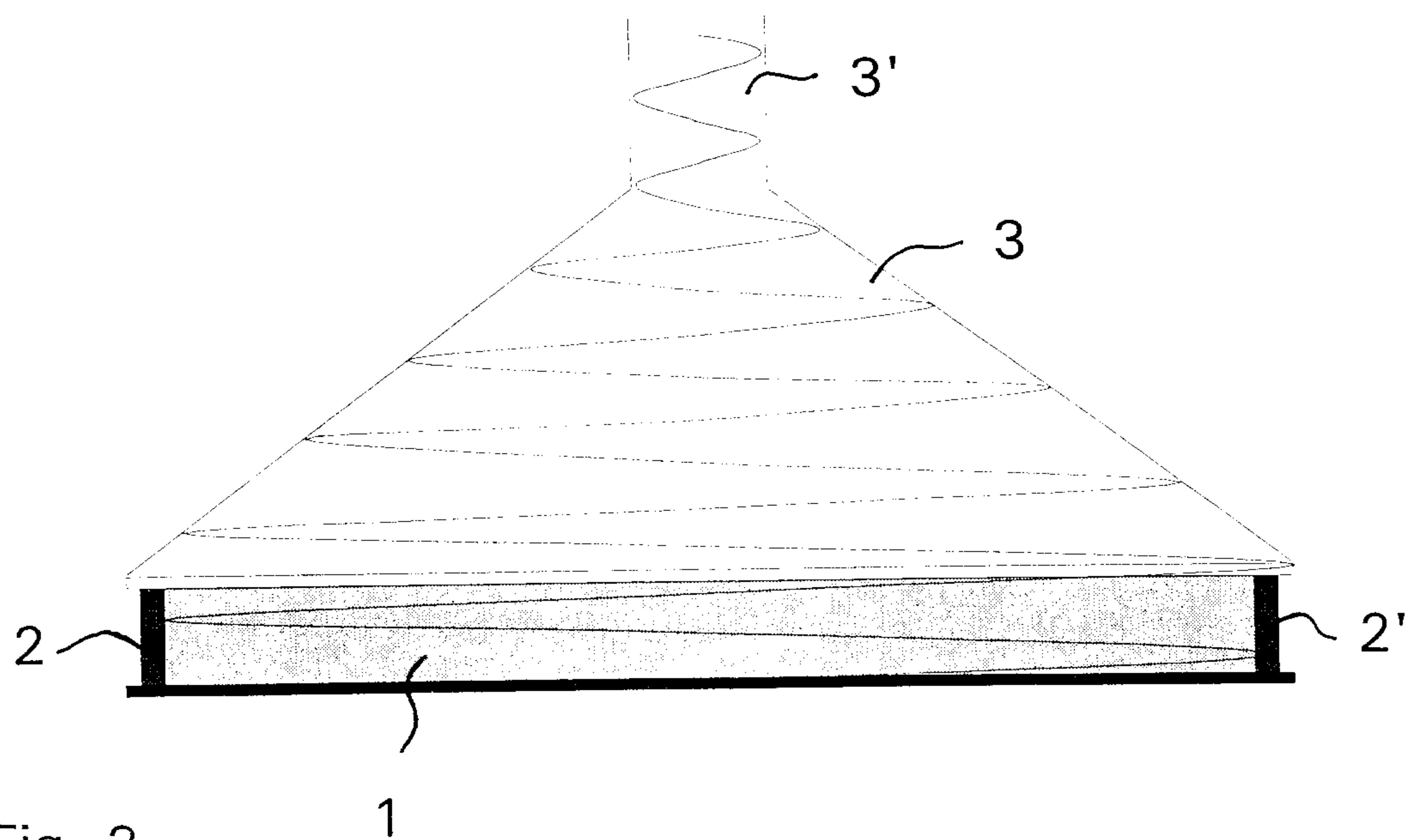


Fig. 2

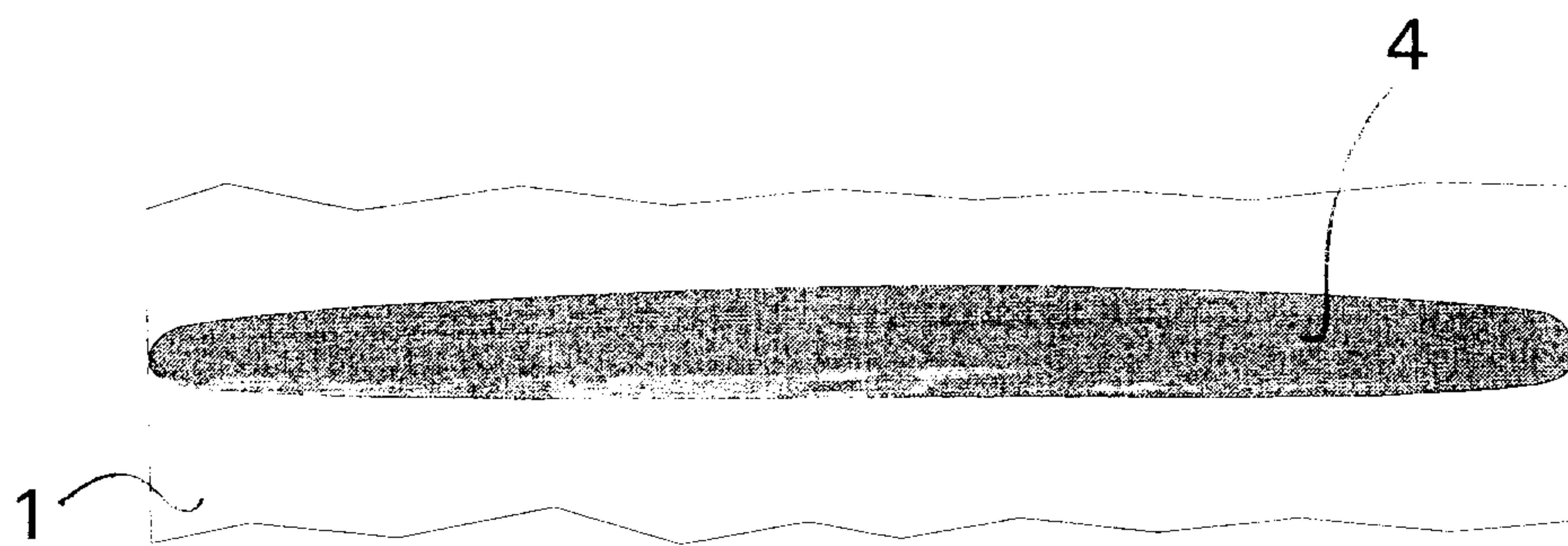


Fig. 3

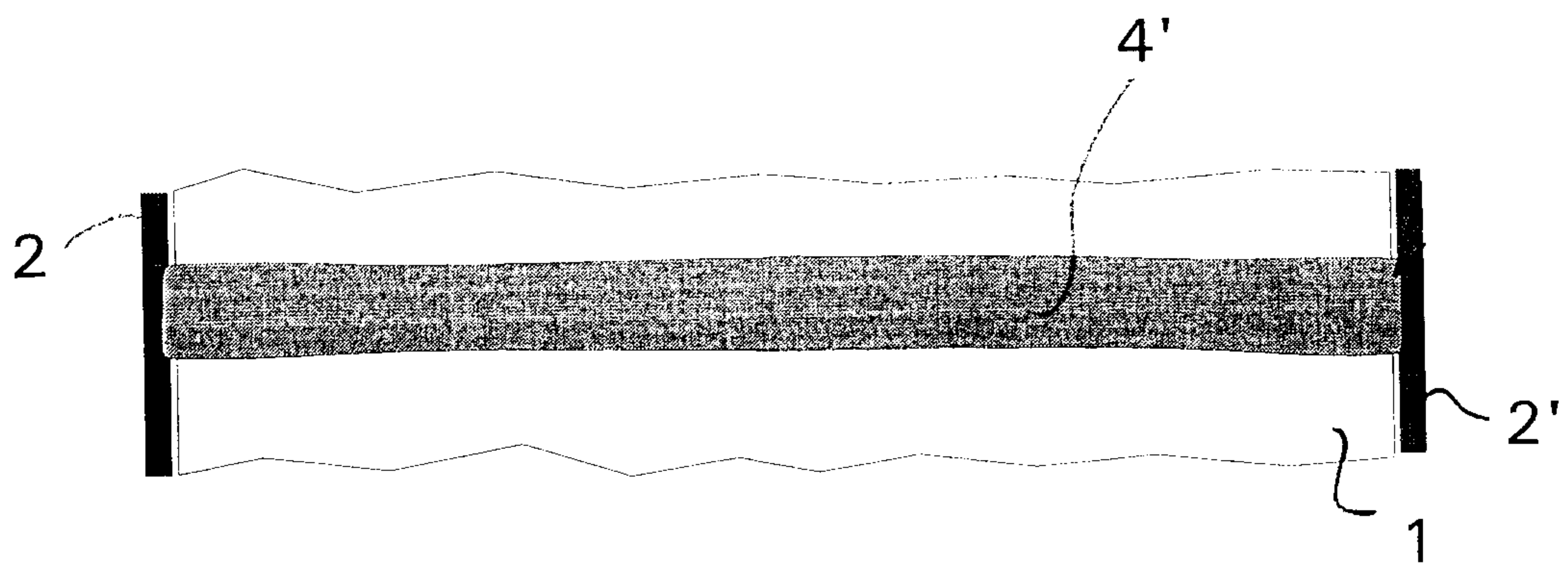


Fig. 4

