(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 131 324**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **84200916.9**

(22) Date of filing: **25.06.84**

(51) Int. Cl.⁴: **F 24 C 15/02**

(30) Priority: **30.06.83 IT 2186683**

(43) Date of publication of application:
16.01.85 Bulletin 85/3

(84) Designated Contracting States:
DE FR GB IT SE

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(84) Designated Contracting States:
DE FR GB SE

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(54) A method of manufacturing doors for domestic ovens combining microwave and electrical resistance heating.

(57) A method of manufacturing doors for domestic ovens combining microwave and electrical resistance heating. An inner backing door (5) comprising an outer side wall (6) having a plurality of transversal slots (7), a stiffening frame (11), and an outer backing door (16) comprising a supporting side wall (26) are pressed from sheet steel. A flat metal sheet is punched and pressed to form a perforated microwave shield (14). The stiffening frame (11) is welded to the inner backing door (5) to form a sub-assembly. The sub-assembly (5, 11) and the outer backing door (16) are selectively enamelled so that each comprises a zone (12, 17) free from enamel, and are heated to a temperature exceeding 700°C. A gasket (13), a first glass pane (12A) and the shield (14) are placed on the sub-assembly (5, 11) to which the outer door (16) is fastened so that the shield (14) is clamped between the non-enamelled zones (12, 17). A second glass pane (28) is placed on the outer backing door (16) and fastened to the supporting side wall (26).

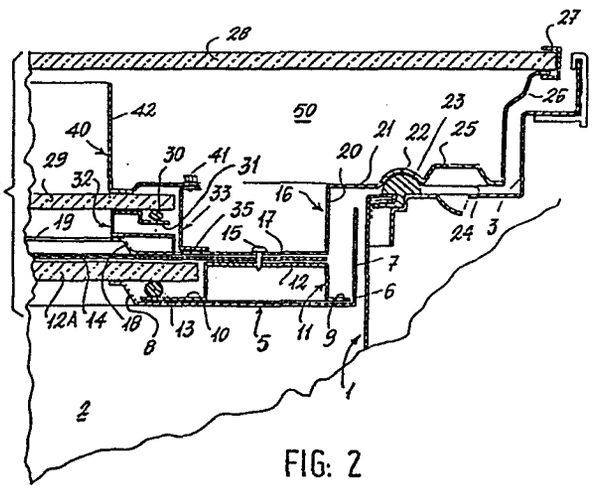

FIG. 2

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A method of manufacturing doors for domestic ovens combining microwave and electrical resistance heating.

This invention relates to a method of manufacturing doors for domestic ovens which cook or heat food by using a combination of microwave and conventional electrical resistance heating elements. The electrical resistance heating elements may also be used for the thermal destruction at about 500°C (pyrolysis) of the food residues present in the chamber of the oven, which is then referred to as a "pyrolytic oven".

The cooking or heating of foods in microwave ovens is well known. The temperature attained in the cooking chamber of such ovens generally does not exceed 100°C so that their doors, either by choice of materials or by arrangement and construction of component parts, are designed only to withstand such a temperature and prevent microwave leakage. Doors intended for this known type of oven using only microwave energy are described for example in U.S. Patents Nos. 3,767,884 and 4,146,768. The first of these patents describes a door construction comprising a perforated shield of large thickness which is provided with a side wall having a plurality of transverse slots, and gaskets of thermoplastic material such as polystyrene or polypropylene which are unable to withstand temperatures of 250°C or more, as exist in ovens which use the combined microwave and electrical resistance heating. At such temperatures, perforated shields of large thickness exert considerable stresses on the gaskets and on the casing and undergo substantial deformation, which can cause fracture of the glass panes provided in the door to allow visual observation of the cooking chamber. The door construction according to the second of these patents, although comprising a flat perforated shield of small thickness, which may be even less than 1 mm, also comprises two glass panes which adhere to the opposite sides of the perforated shield. There are therefore no air chambers, which are known to constitute the best barrier to heat transmission. This door construction further comprises an outer frame moulded in one piece of aluminium or zinc which makes a direct contact with an inner frame shaped as a metal profile. A path of high thermal conductivity is therefore created and, as a consequence, the outer frame can reach a temperature which is dangerous to the user and not very different

from that inside the oven cooking chamber. This known door construction is therefore unsuitable for use in an oven operating at high temperatures. U.S. Patent No. 4,206,338 describes a self-contained window unit comprising three glass panes and a microwave shield which is adapted to be assembled into the door of microwave ovens, which also comprise resistance heaters for the automatic cleaning of the cooking chamber by pyrolysis, and which are therefore able to operate at high temperature. However, the patent in question does not describe how the rest of the door is constructed in order to prevent the electromagnetic waves dispersing to the outside along the door contour . Known industrial embodiments of this patent clearly show that the door has to be even more complicated and has to have a considerable thickness, to an extent which reduces the useful capacity of the oven when the oven has the overall dimensions (length and depth not exceeding 60 cm) provided under ISO standards.

An object of the present invention is to provide a relatively simple and inexpensive method of manufacturing a door for combined microwave and resistance heating which will form an effective barrier to both microwaves and heat.

In accordance with the invention there is provided a method of manufacturing a door for a domestic oven of the type combining microwave and electrical resistance heating, the door including at least one pair of glass panes in spaced parallel relation, an electrically conductive perforated metal shield, and door frame means for supporting the glass panes and the shield and for providing a microwave energy seal along the periphery of the door, characterized in that the method comprises the following steps:

a) pressing from sheet steel
   - an inner backing door defining a central viewing aperture and comprising an outer side wall having a plurality of transversal slots,
   - a stiffening frame,
   - an outer backing door defining a central viewing aperture and comprising a supporting side wall in a peripheral position and a step in an intermediate position;

b) punching and pressing a flat metal sheet to form a shield having a plurality of perforations in a central portion;

c) forming a sub-assembly by welding the stiffening frame to the inner backing door in a position between the central viewing aperture and

the outer side wall such that the outer side wall and the stiffening frame define a peripheral channel;

d) selectively enamelling the sub-assembly in a manner such that at least a peripheral zone of the stiffening frame remains free from enamel;

e) selectively enamelling the outer backing door in a manner such that at least an inner zone is free from enamel;

f) heating the sub-assembly and the outer backing door to a temperature exceeding 700°C so that the enamel is fired;

g) putting a first gasket, a first glass pane, the perforated shield and the outer backing door in the order named on the sub-assembly and fastening the outer backing door to the sub-assembly at their non-enamelled zones so that the periphery of the perforated shield is clamped between the non-enamelled zones; and

h) putting a second glass pane on the outer backing door and fastening the second glass pane to the periphery of the supporting side wall of the outer backing door.

The above and further features of the invention will be more fully appreciated from the following description of a preferred embodiment, given by way of non-limiting example, when considered in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective exploded view of the door manufactured in accordance with the invention; and

Fig. 2 is a partial cross-sectional view of the door of Fig. 1 taken along one side, when the door is mounted in an oven which is also shown in partial cross-sectional view. In Fig. 2 reference numeral 1 designates an oven structure, which defines an oven cooking chamber 2 with an access aperture 3. The access aperture 3 can be closed by a door 4 connected by any known hinges to the oven structure 1 so that the door 4 can be rotated by the user. The oven structure 1 does not form part of the invention and will not be further described.

The door 4 comprises an inner annular backing door 5 which is pressed from sheet steel and comprises along its outer periphery a continuous side wall 6 having a plurality of transverse parallel slots 7. The inner backing door 5 defines a central aperture by means of an edge 8 formed by an inclined portion and a terminal portion parallel to the flat surface forming the major part of this inner backing door 5.

An annular stiffening frame 11 is also pressed from sheet steel and welded along its two longitudinal flanges 9, 10 to the front

side of the inner backing door 5. The stiffening frame 11 comprises an intermediate channel-shaped portion 12 which faces the inner backing door 5. The sub-assembly 5, 11 thus formed is enamelled by known methods, and the enamel is fired in a furnace at a temperature exceeding 700°C. By previous masking, the enamel is prevented from coating the outer face of the intermediate portion 12 of the stiffening frame 11. A first glass pane 12A is placed on the edge 8 after interposing a gasket 13 of heat-resistant material (for example fibreglass) which is elastically yieldable and extends along the entire periphery of the pane 12A.

A microwave shield 14 in the shape of a perforated thin flat metal sheet, for example of stainless steel or aluminium, and formed by punching and pressing is placed on glass pane 12A. By means of a series of self-tapping screws 15, an outer backing door 16 is fastened to the stiffening frame 11 along its intermediate channel-shaped portion 12 so as to clamp the shield 14 along its periphery. The outer backing door 16 is also pressed from sheet steel so as to comprise a intermediate step 20 and it then enamelled, the enamel being fired as set out in the foregoing. The enamel is applied selectively so that the most inner portion 17 remains free from enamel in that zone which is opposite the base wall of the channel-shaped portion 12 and thereby the peripheral edge of the shield 14 becomes clamped between two electrically conductive surfaces. The outer backing door 16 is fastened to the sub-assembly comprising the inner backing door 5 and the annular stiffening frame 11 in a manner such that the step 20 is spaced apart from the slotted side wall 6. The inner side wall of the peripheral channel defined by the annular stiffening frame 11 and the outer side wall 6 is thus prolonged by the step 20 so as to constitute an effective seal for preventing microwave energy leakage from the oven cooking chamber 2 to the surrounding environment.

By means of an inclined edge 18, the outer backing door 16 defines a central viewing aperture 19 which is practically coaxial and equal to that of the inner backing door 5. The first glass pane 12A is locked in position between the inner and outer backing doors 5, 16 by the shield 14.

Outwards from the step 20, the outer backing door 16 comprises a flat portion 21 which is parallel to the portion 17 and is followed by a groove 22. In the closed position of the door 4, the groove 22 presses against the soft part of a heat-resistant seal gasket 23 which is

connected to the oven structure 1 in a position corresponding with the aperture 3 of the cooking chamber 2. The groove 22 is followed by a flat portion 24 comprising bored indentations 25 which allow the fixing of conventional hinges (not shown) for connecting the door 4 is connected to the oven structure 1. The outer backing door 16 terminates in a profiled side wall 26 having a bent end for supporting a second glass pane 28. This glass pane 28 is locked in position by conventional removable fasteners such as, for example a surrounding profiled section 27 which clamps the edge of the pane 28 against the bent end of the side wall 26.

In the case of a pyrolytic oven, heat loss from the inside to the outside of the oven is minimized by further providing the door 4 with a third glass pane 29 disposed between the two panes already described (12A, 28) and resting along its entire periphery on a gasket 30 of heat-resistant material placed on a depressed edge 31 of a metal channel bar frame 32 which is elastically yieldable and rests on the inner edge 18 of the outer backing door 16.

A metal channel bar section 33, acting as spacer, is welded along its flange 35 to the front side of the outer backing door 16. An angle bar frame 40 pressed from sheet metal is fastened to the channel bar section 33 by means of screws 41 so as to lock the intermediate glass pane 29 in position.

The frontally projecting side wall 42 of angle bar frame 40 terminates very close to the outer glass pane 28 and defines a central viewing port, which is practically coaxial and equal to the viewing apertures of the inner and outer backing doors 5, 16 and which also defines an annular chamber 50, into which heat insulating material such as rock wool is inserted.

The invention also covers a modification of the door 4 described in the foregoing which is suitable for a domestic oven employing microwave and resistance heating, but in which the latter is used only for cooking or heating food. In this case, the maximum temperature which can exist in the oven cooking chamber 2 is 300^{o}C, so that the oven door 4 need only offer reduced resistance to heat loss. Those parts of the door 4 described which are therefore not used are: the intermediate glass pane 29, the metal channel bar frame 32 and the gasket 30. The spacer section 33 and the metal angle bar frame 40 will then be of conveniently modified depth and the gaskets 13, 23 can be of neoprene rubber. As will be evident,

the constructional differences between the two door embodiments described are very limited in scope. It is therefore a basic feature of the present invention that the constituent elements, of the door 4 are optimally standardized, irrespective the type of oven for which the door 4 is intended.

1. A method of manufacturing a door for a domestic oven of the type combining microwave and electrical resistance heating, the door including at least one pair of glass panes in spaced parallel relation, an electrically conductive perforated metal shield, and door frame means for supporting the glass panes and the shield and for providing a microwave energy seal along the periphery of the door, characterized in that the method comprises the following steps:

a) pressing from sheet steel
- an inner backing door (5) defining a central viewing aperture and comprising an outer side wall (6) having a plurality of transversal slots (7),
- a stiffening frame (11),
- an outer backing door (16) defining a central viewing aperture (19) and comprising a supporting side wall (26) in a peripheral position and a step (20) in an intermediate position;

b) punching and pressing a flat metal sheet to form a shield (14) having a plurality of perforations in a central portion;

c) forming a sub-assembly (5, 11) by welding the stiffening frame (11) to the inner backing door (5) in a position between the central viewing aperture and the outer side wall (6) such that the outer side wall (6) and the stiffening frame (11) define a peripheral channel;

d) selectively enamelling the sub-assembly (5, 11) in a manner such that at least a peripheral zone (12) of the stiffening frame (11) remains free from enamel;

e) selectively enamelling the outer backing door (16) in a manner such that at least an inner zone (17) is free from enamel;

f) heating the sub-assembly (5, 11) and the outer backing door (16) to a temperature exceeding 700^{o}C so that the enamel is fired;

g) putting a first gasket (13), a first glass pane (12A), the perforated shield (14) and the outer backing door (16) in the order named on the sub-assembly (5, 11) and fastening the outer backing door (16) to the sub-assembly (5, 11) at their non-enamelled zones (12, 17) so that the periphery of the perforated shield (14) is clamped between the

non-enamelled zones (12, 17); and

h) putting a second glass pane (28) on the outer backing door (16) and fastening the second glass pane (28) to the periphery of the supporting side wall (26) of the outer backing door (16).

2. A method as claimed in claim 1, characterized in that it comprises the further step of pressing the step (20) of the outer backing door (16) in such an intermediate position that the step (20) of the outer backing door (16) fastened to the sub-assembly (5, 11) forms a prolongation of the inner side wall of the peripheral channel defined by the stiffening frame (11) and the outer side wall (6).

3. A method as claimed in claim 1, characterized in that it comprises the further steps of pressing from sheet metal an angle bar frame (40) comprising an inner side wall (42) defining a central viewing port; welding a channel bar metal frame (33) to the outer backing door (16) in a position adjacent to the central viewing aperture; removably fastening the angle bar frame (40) to the channel bar frame (33) before the second glass pane (28) is placed on and fastened to the outer backing door (16).

4. A method as claimed in claim 3, characterized in that it comprises the further steps of putting an elastically yieldable channel bar metal frame (32), a second gasket (30) and a third glass pane (29) in the order named on the outer backing door (16) in a position inside the welded channel bar frame (33); and thereafter fastening the angle bar frame (40) to the welded channel bar frame (33) so that the third glass pane (29) is locked in position.

5. A method as claimed in claim 4, characterized in that it comprises the further step of inserting thermally insulating material in an annular chamber (50) defined by the angle bar frame (40), the outer backing door (16) and the second glass pane (28) before the second glass pane (28) is placed on and fastened to the outer backing door (16).

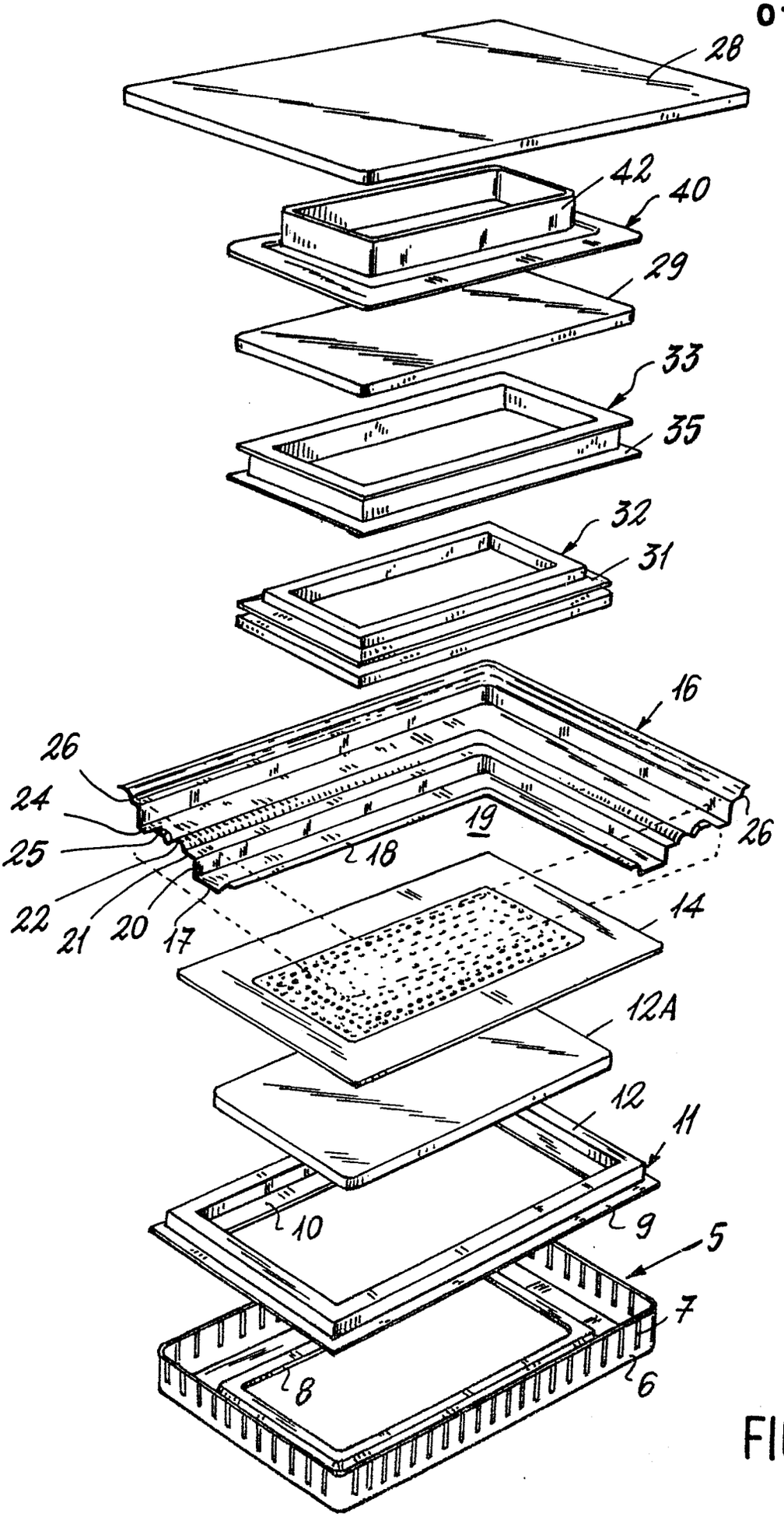
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FIG. 1

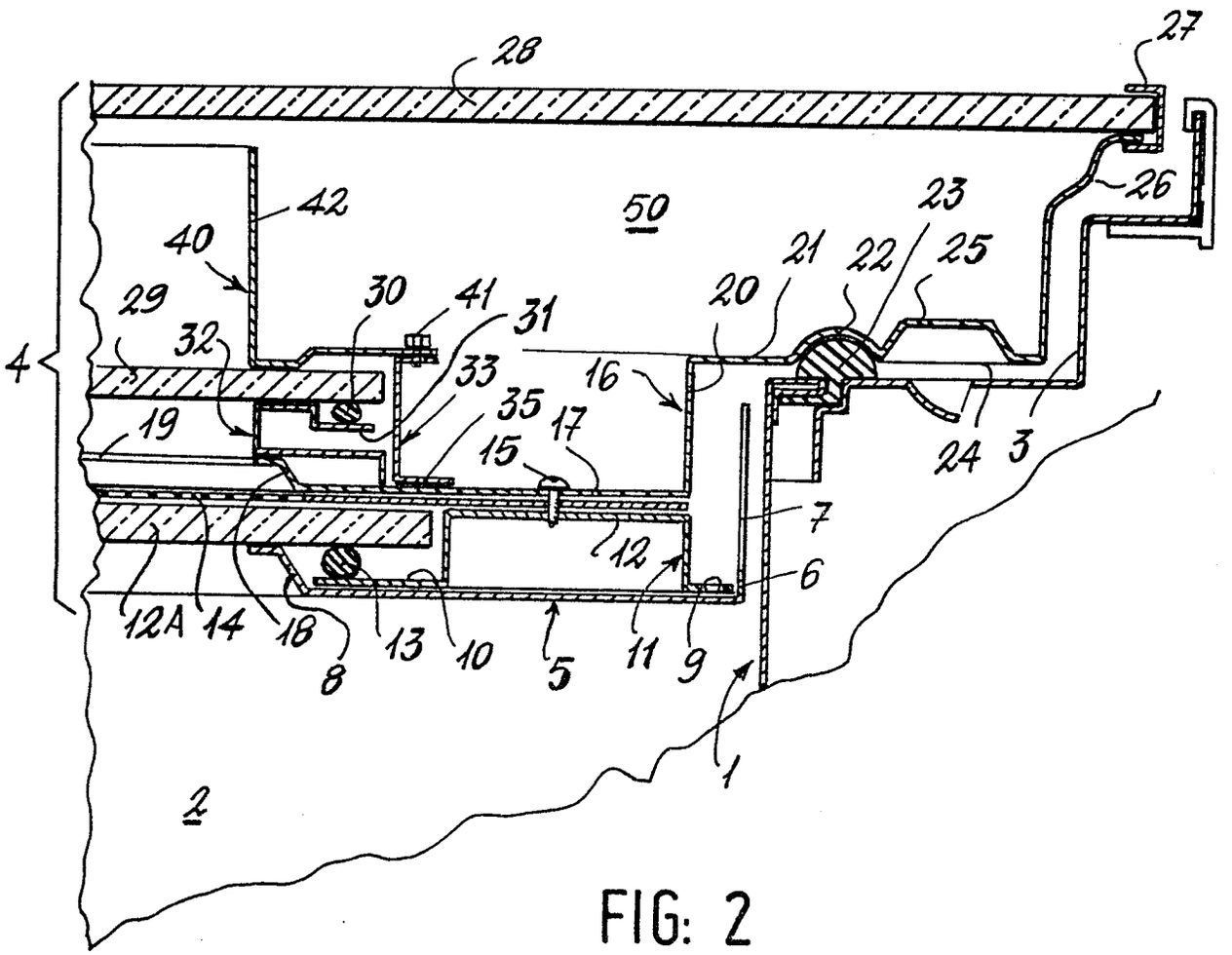
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FIG: 2