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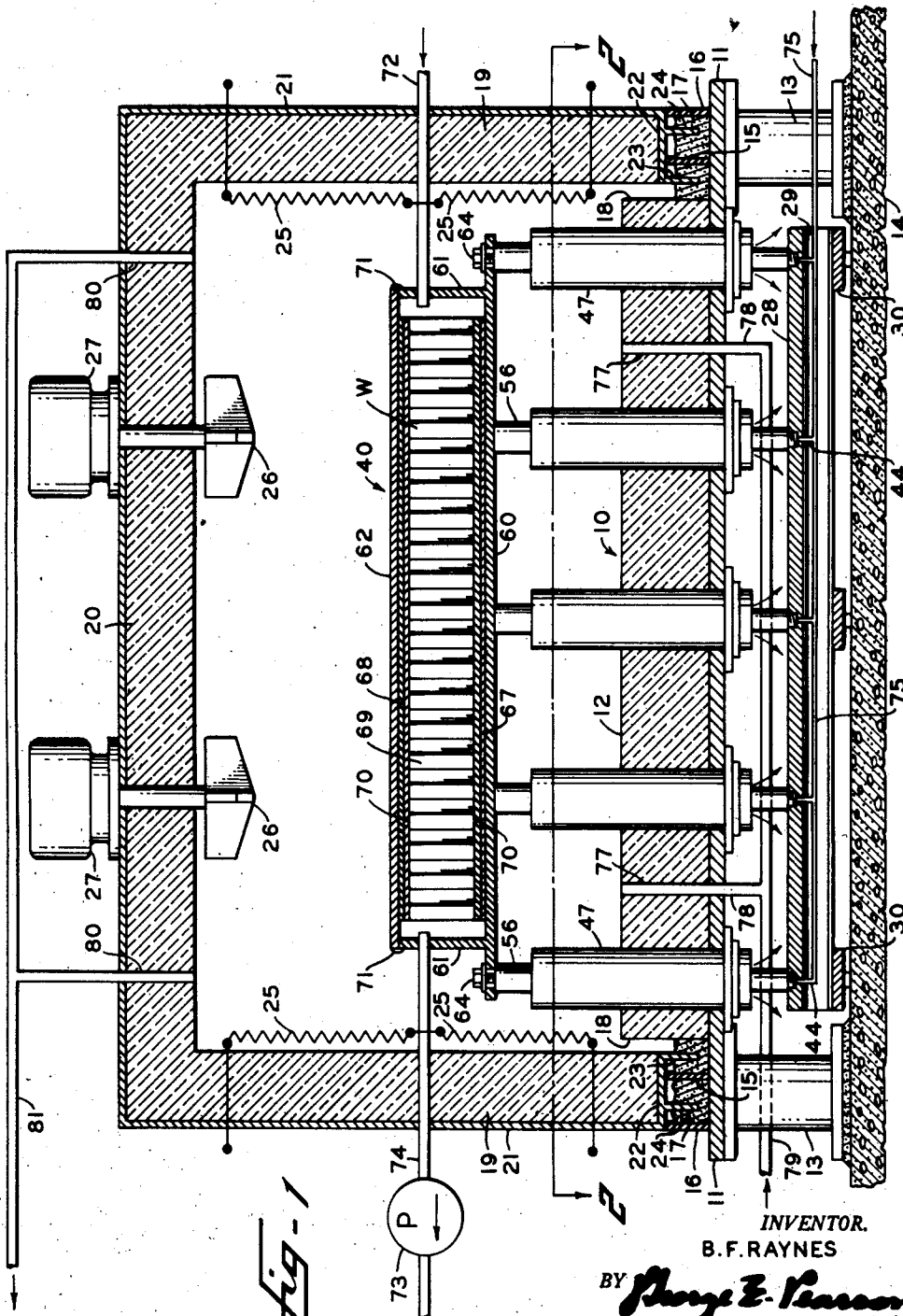
B. F. RAYNES

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BRAZING FURNACE FOR HONEYCOMB PANELS

Filed Aug. 25, 1958

3 Sheets-Sheet 1



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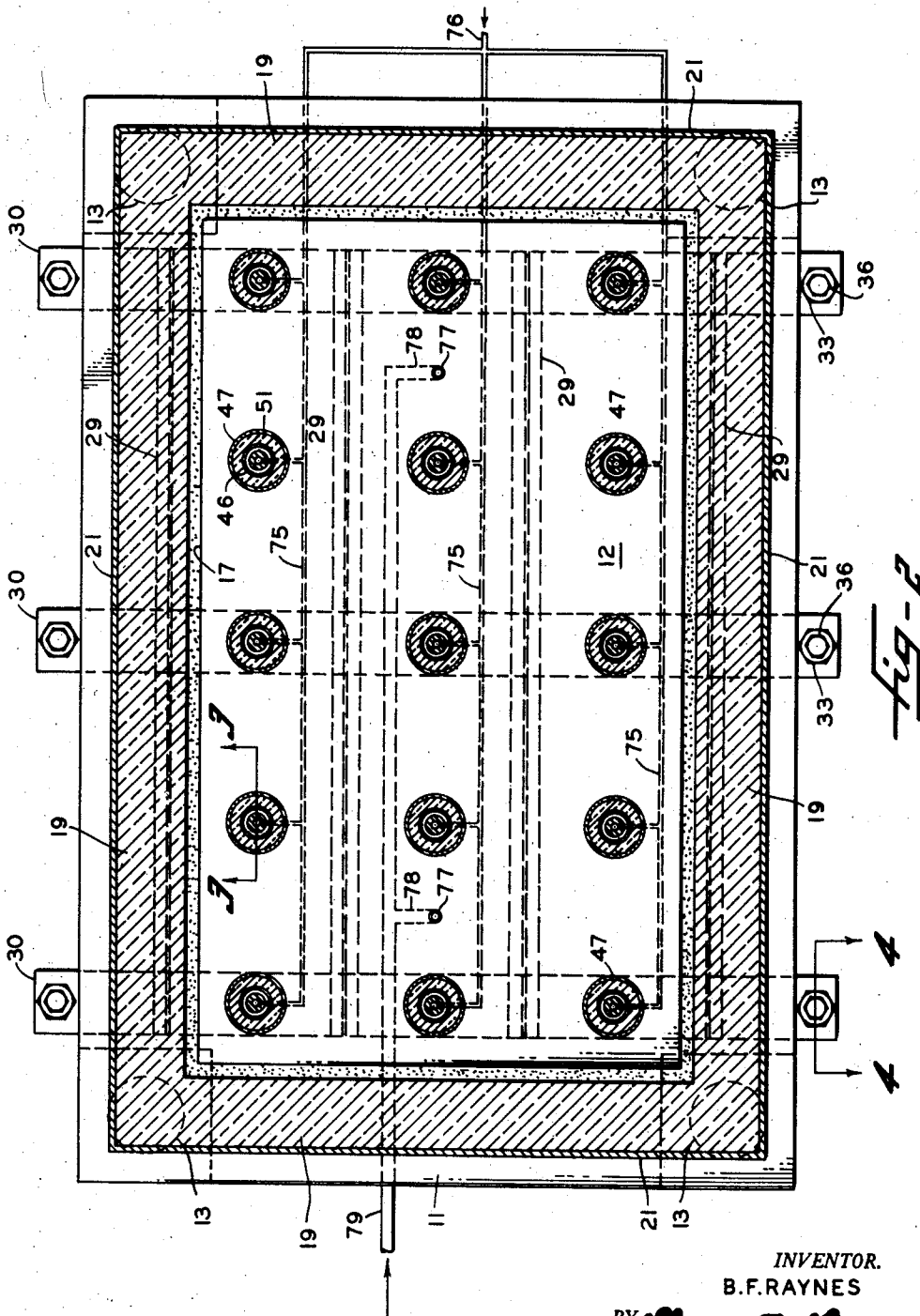
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BRAZING FURNACE FOR HONEYCOMB PANELS

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3 Sheets-Sheet 2



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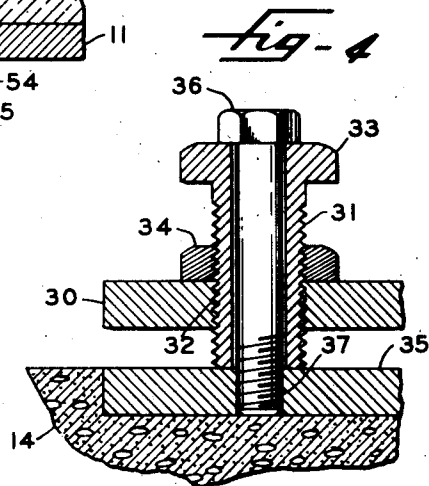
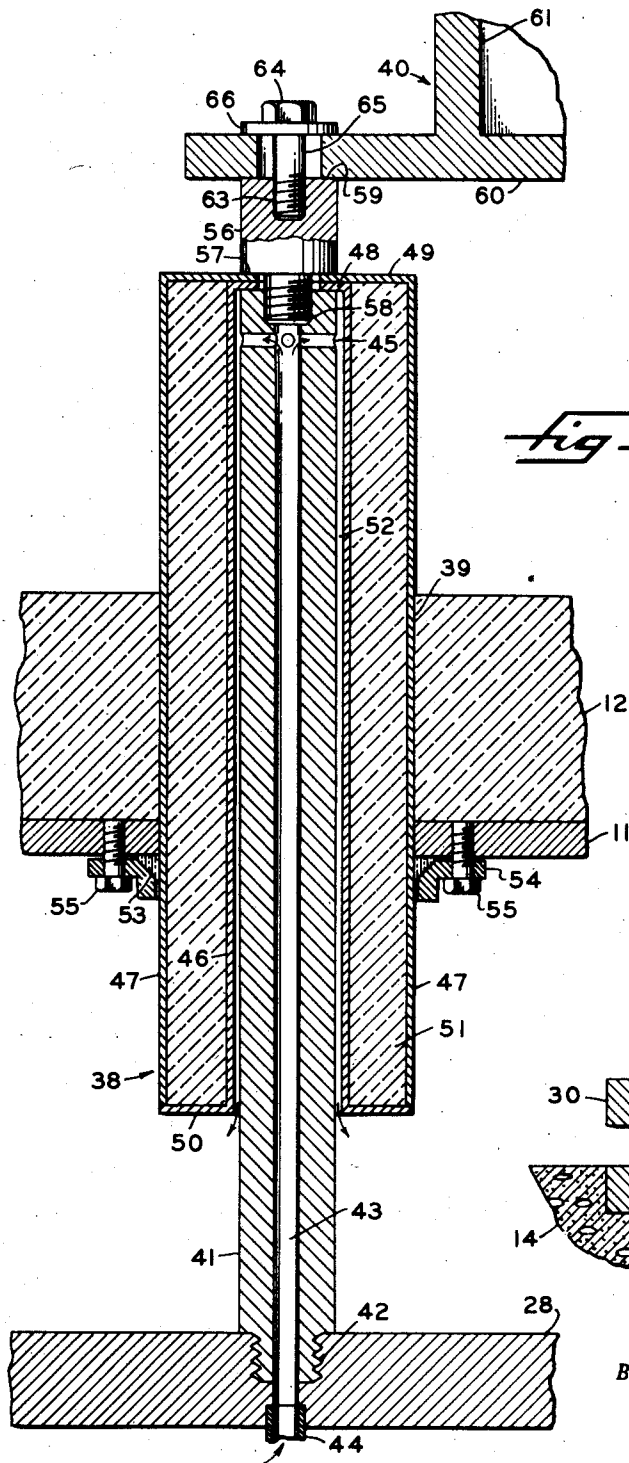
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BRAZING FURNACE FOR HONEYCOMB PANELS

Filed Aug. 25, 1958

3 Sheets-Sheet 3



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2,956,099

BRAZING FURNACE FOR HONEYCOMB PANELS

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8 Claims. (Cl. 13—20)

Metal panels have come into use as component parts of airplanes, each panel consisting of two thin metal plates or skins connected together by a core composed of a plurality of honeycomb cells whose opposite ends are brazed to the plates. It is usually required that one or both of the skins be flat or plane and it has been found practically impossible to have the skins flat after they are taken from the brazing furnace even if they were flat and plane when put into it to be brazed to the core.

Such panels have been put in metal brazing fixtures and the assembly then placed on the floor of the brazing furnace for support while brazing. Even if the furnace floor is level when it is laid, as the furnace heats up it is found that the floor warps as the temperature rises and the top of it no longer presents a flat, level support for the fixture. At brazing temperatures of 1700° to 1850° F. the metal of the fixture becomes less rigid and the bottom of the fixture bends somewhat to accommodate the non-planar top face of the furnace floor. As the fixture bends or warps, the core skins within it bend correspondingly with the result that the skins of the panel, after brazing, are no longer flat or planar.

It is a main object of my invention to provide a brazing furnace which overcomes the disadvantages above noted and which contains a plurality of spaced apart members arranged in a horizontal plane above the floor of the furnace for supporting the brazing fixture and contained workpiece.

A further object is to provide a plurality of spaced apart holes in the bottom wall of a furnace, a plurality of vertical workpiece supporting members passing through said holes and adjustable means disposed below the floor of the furnace for adjusting said supporting members to advance all the upper ends thereof into a common horizontal plane.

Another object is to provide sealing means associated with each of the aforesaid supporting members to prevent the escape of inert gas from within the furnace through the holes in its bottom wall.

Further objects will become apparent as a description of the furnace proceeds. For a better understanding of the invention reference is made to the accompanying drawings, in which:

Fig. 1 is a vertical sectional view of the furnace with some parts thereof shown schematically;

Fig. 2 is a horizontal section taken on line 2—2 of Fig. 1;

Fig. 3 is a vertical sectional view on line 3—3 of Fig. 2 showing one of the workpiece supports on an enlarged scale; and

Fig. 4 is a vertical section on an enlarged scale taken on line 4—4 of Fig. 2.

The electric furnace shown comprises a composite horizontal base 10 consisting of a large rectangular metal plate 11 and a thick wall or floor 12 composed of heat insulating material. Plate 11 is supported by a plurality of vertical columns 13 whose lower ends are anchored to a concrete floor 14. Two metal strips 15, 16 (see Fig.

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1) have their lower ends secured to the top of plate 11, these strips extending all around plate 11 near the edge thereof to provide a container to receive a body of silica sand 17 some of which also fills some of the space between strip 15 and the edge 18 of floor 12. The four sidewalls 19 and top wall 20 are integral and composed of blocks of heat insulating material which is attached to and encased in a thin metal housing 21. The lower end of housing 21 has an intumed flange 22 to which is attached two rectangular depending strips 23, 24 which extend into the sand 17. The top of the furnace including sidewalls 19 is removable and when lowered into the position shown in Fig. 1, its weight is taken by the two strips 15, 16 and the body of sand 17 serves to seal the interior of the furnace against the entrance of outside air. The furnace is heated by a plurality of electric heaters 25 mounted on the sidewalls 19. Preferably the hot gas within the furnace is circulated by a pair of fans 26 which are rotated by two electric motors 27.

Instead of supporting the workpiece W to be brazed on the furnace floor 12 in the usual manner, I provide a novel supporting means which comprises a thick metal plate 28 which is attached to the top flanges of four parallel I beams 29 whose lower flanges rest on three parallel bars 30 and are attached thereto by welding (not shown). Each bar 30 is supported at each end for vertical adjustment by a sleeve 31 (see Fig. 4) externally threaded to engage a threaded hole 32 in bar 30. The sleeve has a hexagon head 33 to receive a wrench and a lock nut 34 which presses against bar 30 to lock it in adjusted position. The bottom of each sleeve 31 rests on a thick metal plate 35 set in concrete floor 14. Each sleeve 31 has a bolt 36 extending therethrough, the lower end of the bolt being screwed into a threaded hole 37 in plate 35.

A plurality of similar supports 38 are attached to plate 28 and extend up through cylindrical holes 39 in plate 11 and floor 12 to support workpiece W and its holding fixture 40. Each support 38 comprises a metal rod 41 whose lower end is screwed into a threaded hole 42 in plate 28. Rod 41 has a central bore 43 which communicates with a pipe 44 supplying compressed air at a temperature of about 70° F. Near the top of rod 41, two or more small bores 45 convey the air from bore 43 through the rod for a purpose to be explained. Surrounding the major portion of rod 41 is a heat insulator comprising a pair of cylindrical tubes 46, 47 whose tops have intumed flanges 48, 49 which overlie the top of rod 41. The lower ends of tubes 46, 47 are connected by a flat ring 50 and the space between the tubes filled by a thick sleeve 51 composed of a heat insulating material which can be heated to 2200° F. without deterioration as, for example, fine quartz fibers matted together. Tube 46 is spaced a small distance from rod 41 thereby providing a narrow channel 52 down which the air leaving bores 45 travels to convey away the heat radiated inwardly by tube 46 which would otherwise raise the temperature of rod 41 and change its length. The joint between tube 47 and plate 11 is sealed by a circular gasket 53 pressed in place by a circular ring 54 held in position by bolts 55. A cylindrical plug 56 has its lower end cut away to provide a shoulder 57 which presses against flange 49 when the threaded lower end on the plug is screwed into a threaded hole 58 in the top of rod 41. By making all the rods 41 of the same length and all the plugs 56 of the same length, the flat top faces 59 of the plugs should lie in a horizontal plane when plate 28 has been leveled. If, due to manufacturing tolerances, the faces 59 of the plugs are not at the same level, a small amount may be ground off the upper ends of the plugs to make their faces 59 lie in the same plane within a tolerance of .001 inch.

The brazing fixture 40 illustrated comprises a rigid

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flat rectangular metal plate 60 which rests on the plug faces 59 and four box walls 61 which when a thin metal cover 62 is placed on and welded to the top of walls 61, forms a sealed container around the workpiece. To secure fixture 40 (see Fig. 3) to all the plugs 56 disposed under the edge of plate 60, each plug at its top is provided with a threaded hole to receive the threaded end 63 of a bolt 64 whose shank passes through a cylindrical bore 65 in plate 60. The bores 65 are of substantially larger diameter than the bolt shanks to permit sliding contact of the lower face of plate 60 with the plug faces 59 as fixture 40 expands and contracts under changes in temperature. A washer 66 larger in diameter than bore 65 is preferably interposed between the head of bolt 64 and the top face of plate 60 and plate 60 has sliding contact with the washer as the temperature within the furnace changes.

The workpiece illustrated comprises a pair of rectangular stainless steel sheets 67, 68 having a thickness of from .006 to .060 inch which are to be brazed to the ends of a stainless steel honeycomb core 69 whose cell walls are vertical. Sheets 70 of brazing alloy are interposed between core 69 and sheets 67, 68, the brazing alloy preferably having a composition of 85% silver and 15% manganese. After the panel components described have been placed inside the fixture (see Fig. 1) cover plate 62 is applied and its entire edge welded to box walls 61 as indicated at 71. Cover plate 62 is thin enough to bend under pressure and press down on steel sheet 68. Argon or other inert gas is supplied to the interior of the fixture by a pipe 72 from a source (not shown) and withdrawn by a pump 73 connected to outlet pipe 74. Pump 73 is operated at a speed which reduces the argon pressure in the fixture enough below the pressure in the furnace to cause cover 62 to apply a large downward pressure on the panel assembly during the brazing.

Compressed air is supplied to pipes 44 by three pipes 75 which are connected to a common supply pipe 76 which receives cool compressed air from a source not shown. In order to reduce the oxidation and rapid deterioration of the metal parts inside the furnace at high brazing temperatures, the air in the furnace may be purged by admitting argon or other inert gas. For this purpose a pair of openings 77 (Fig. 1) through the floor 12 are supplied with the inert gas by pipes 78 which are connected to a supply pipe 79 which is connected to a supply tank (not shown) of argon. The gas leaves the top of the furnace through openings 80 in the top wall to which outlet pipe 81 is connected. Pipe 81 may return the gas to the supply source thus preventing wastage of the argon.

With the top of the furnace removed by lifting it, the lock nuts 34 and bolts 36 are loosened then some or all of the sleeves 31 rotated to level plate 28 and bring the top faces 59 of all the plugs 56 into the same horizontal plane. During this adjustment some or all of the workpiece supports 38 are raised or lowered and tubes 47 have sliding contact with gaskets 53. Lock nuts 34 and bolts 36 are then tightened. Holding fixture 40 with its contained workpiece W is then placed on plugs 56 and secured thereto by bolts 64. Since panel sheets 67 and 68 are now level there is no tendency for the brazing alloy to run downhill when it melts and leave areas of these sheets unbrazed to core 69. The top of the furnace is now lowered into the position shown in Fig. 1 and pump 73 started to purge fixture 40 of air and reduce the pressure therein below that in the furnace. If a non-oxidizing atmosphere is required in the furnace, argon gas is supplied to pipe 79 and after the air is purged from the furnace, electrical current is supplied to heaters 25 to bring the temperature of fixture 40 and workpiece W up to 1815° F. The workpiece is kept at this temperature for a short time when

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the current is shut off and the workpiece allowed to cool in the furnace for a while until the brazing alloy has hardened. At temperatures above 1700° F. the metal of plate 60 tends to soften and warp but due to many areas of the plate being held against the plug faces 59 all of which are at the same level, the plate remains flat. The result is that the sheets 67 and 68 of the panel are kept flat and parallel before and after the brazing. If large portions of the supporting rods 41 were exposed to the furnace temperature, the rods would lengthen substantially as the temperature rises. This is prevented by the protective insulation 51 and the stream of coolant air passing up bore 43 and downward through channel 52. It is found that any changes in length of rods 41 due to variations in temperature are insignificant. I prefer to make the rods 41 and cylinders 46 of stainless steel and cylinders 47 and plugs 56 of Inconel, an alloy containing about 80 percent nickel, 13 percent chromium, 6 percent iron and balance of minor impurities. All the metal parts outside the furnace can be made of carbon steel.

The top of the furnace including sidewalls 19 can now be raised as a unit, the bolts 64 removed and the holding fixture 40 removed from the furnace and allowed to cool. Fixture cover 62 may now be removed and the finished honeycomb panel taken out of the fixture.

This invention may be embodied in other forms or carried out in other ways without departing from the spirit or essential characteristics thereof. The present embodiment of the invention is therefore to be considered as in all respects illustrative and not restrictive, the scope of the invention being indicated by the appended claims, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Having thus described my invention, what I claim as new and useful and desire to secure by Letters Patent is:

1. A furnace having side, top and bottom walls; a plurality of spaced apart vertical members extending through said bottom wall and whose upper ends lie in a substantially horizontal plane above the top of said bottom wall whereby the base of a workpiece holding fixture may be laid on the upper ends of said vertical members to be supported thereby; means for heating the interior of said furnace to a temperature exceeding 500° F; means for supporting said members externally of said furnace and independently thereof; and means for preventing elongation of said members in response to said heating of the furnace.

2. A furnace as claimed in claim 1, in which said vertical members are hollow and a coolant fluid circulates through the interiors of said vertical members.

3. A furnace having side, top and bottom walls; a plurality of spaced apart metallic members extending through said bottom wall and whose upper ends lie in a substantially horizontal plane above the top face of said bottom wall; means for supporting said members externally of said furnace and independently thereof; means for preventing elongation of said members in response to heating of said furnace; a workpiece holding fixture having a base in contact with the upper ends of said vertical members; securing means cooperating with said holding fixture and the upper portions of a plurality of said vertical members to retain said base in sliding contact with the upper ends of said vertical members as said holding fixture expands and contracts upon changes in temperature in the furnace; and means for heating the interior of said furnace to a temperature exceeding 500° F.

4. A furnace having side, top and bottom walls, said bottom wall being provided with a plurality of spaced apart vertical openings extending therethrough; a plurality of vertical members extending through said openings and whose upper ends lie in a substantially hori-

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zontal plane above the top face of said bottom wall whereby the base of a workpiece holding fixture may be laid on the upper ends of said vertical members to be supported thereby; means including tubes composed of heat insulating material and extended slidably through said openings and surrounding the major portions of said vertical members which are disposed within the furnace; means for supporting said members externally of said furnace and independently thereof; means including said tubes for preventing elongation of said members in response to heating of the furnace; and means for heating the interior of said furnace to a temperature exceeding 500° F.

5. A furnace having side, top and bottom walls, said bottom wall being provided with a plurality of spaced apart vertical openings extending therethrough; a plurality of vertical supports extending through said openings and whose upper ends lie in a horizontal plane above the top face of said bottom wall; means extended slidably through said openings and including a plurality of tubes of heat insulation material surrounding said supports and spaced therefrom; means for supporting said members externally of said furnace and independently thereof; a flange connecting the top of each tube to its support, each of said supports being provided with an interior opening extending from a level below the bottoms of said tubes and terminating under said flange in the space between said support and tube; means for conveying coolant fluid into the lower ends of each of said interior openings and outwardly through said space associated therewith; and means for heating the interior of said furnace to a temperature exceeding 500° F.

6. A furnace having side, top and bottom walls, said bottom wall being provided with a plurality of spaced apart vertical openings extending therethrough; a plate disposed below said bottom wall and openings; a plurality of vertical supports extending through said openings and having their lower ends attached to said plate;

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means for adjusting the inclination of said plate to position the tops of said supports in a substantially horizontal plane above the top face of said bottom wall; means slidably disposed within said openings and surrounding said supports for preventing elongation thereof in response to heating of the furnace; and means for heating the interior of said furnace to a temperature exceeding 500° F.

7. A furnace as claimed in claim 6, in which said vertical supports are of substantially the same length and the lower end of each support has screw threaded engagement with said plate.

8. A furnace having side, top and bottom walls, said bottom wall being provided with a plurality of spaced apart vertical openings extending therethrough; a plurality of vertical members extending through said openings and whose upper ends are exposed to support a workpiece holding fixture; means disposed below said bottom wall for supporting and adjusting said members vertically to advance the upper ends thereof into a substantially horizontal plane above said bottom wall; means extended slidably through said openings and including tubes composed of heat insulating material surrounding said members respectively; means for supplying the interior of said furnace with inert gas; sealing means carried by said bottom wall and in contact with said slidably extended means respectively to prevent leakage of said inert gas through said vertical openings; means including said tubes for preventing elongation of said members in response to heating of the furnace; and means for heating the interior of said furnace to a temperature exceeding 500° F.

References Cited in the file of this patent

UNITED STATES PATENTS

1,283,285	Pfanstiehl	Oct. 29, 1918
1,659,550	Steenstrup	Feb. 14, 1928
2,798,108	Poland	July 2, 1957