Jan. 24, 1967 A. J. WALKER 3,300,566

ELECTRIC FURNACES

Filed Dec. 6, 1963 3 Sheets-Sheet 1

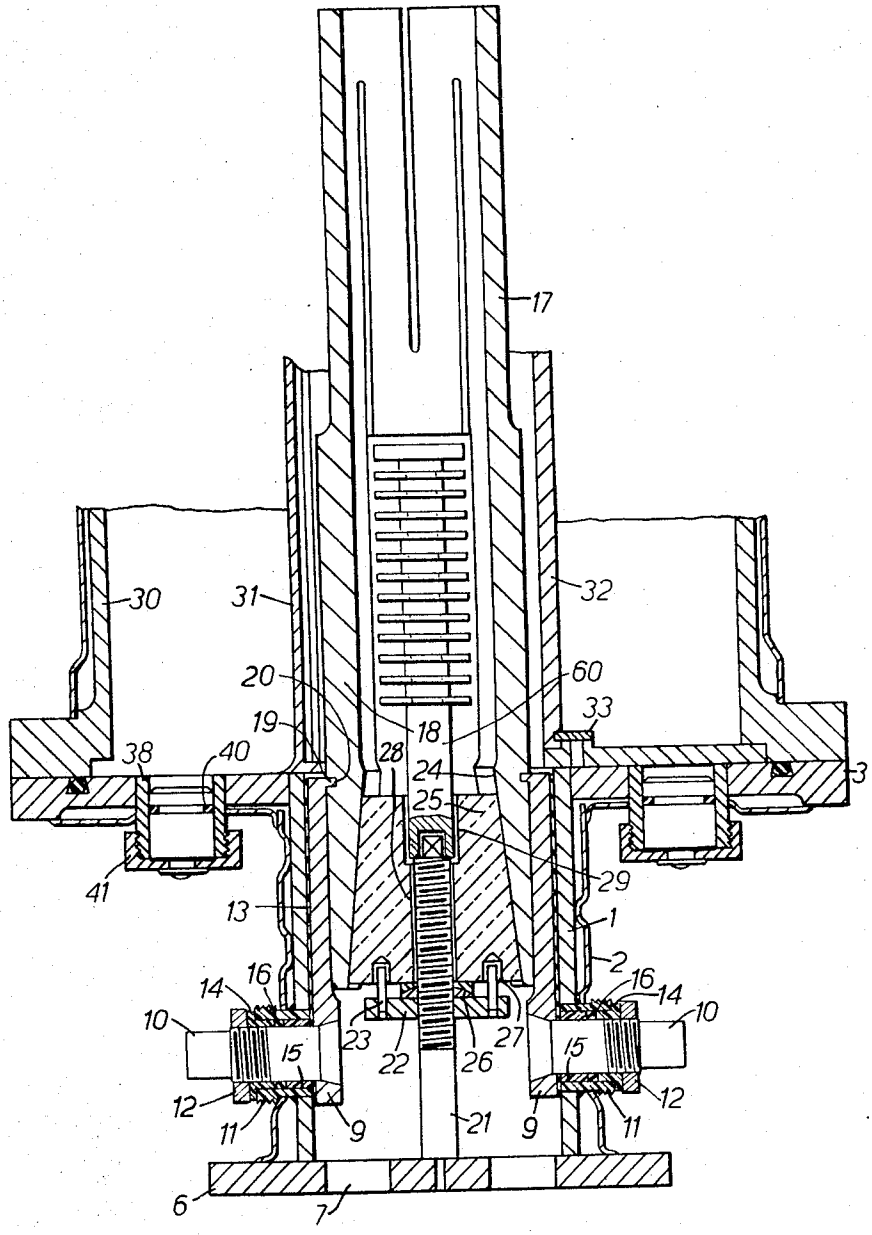


FIG. 1.

Jan. 24, 1967 A. J. WALKER 3,300,566

ELECTRIC FURNACES

Filed Dec. 6, 1963 3 Sheets-Sheet 2

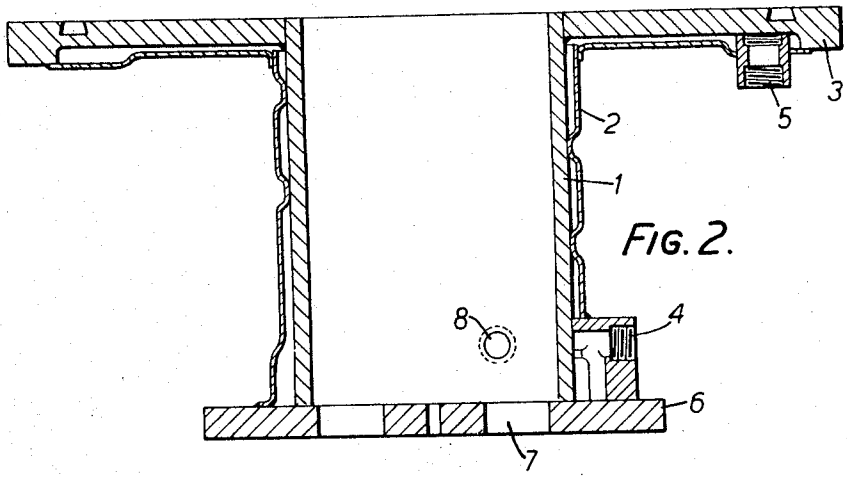


FIG. 2.

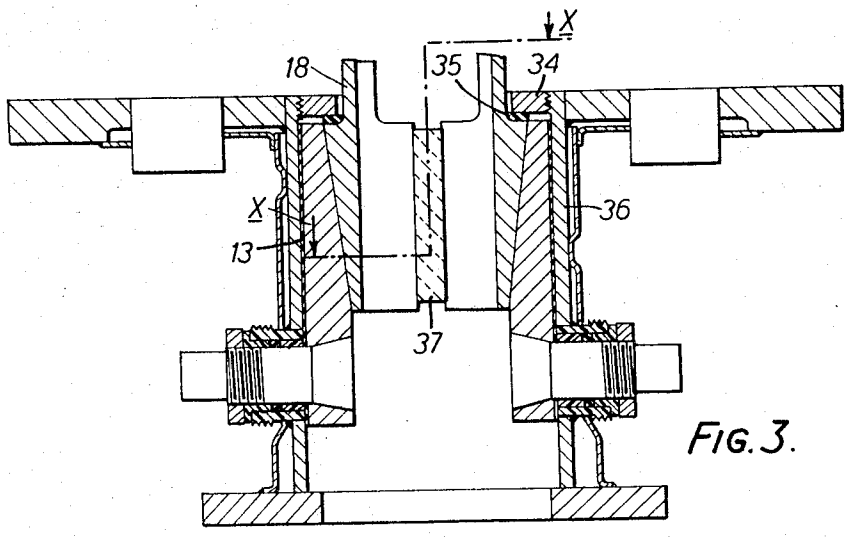


FIG. 3.

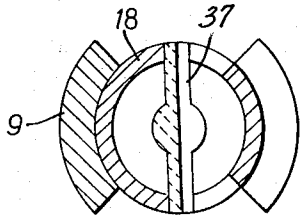


FIG. 4.

Jan. 24, 1967 A. J. WALKER 3,300,566

ELECTRIC FURNACES

Filed Dec. 6, 1963 3 Sheets-Sheet 3

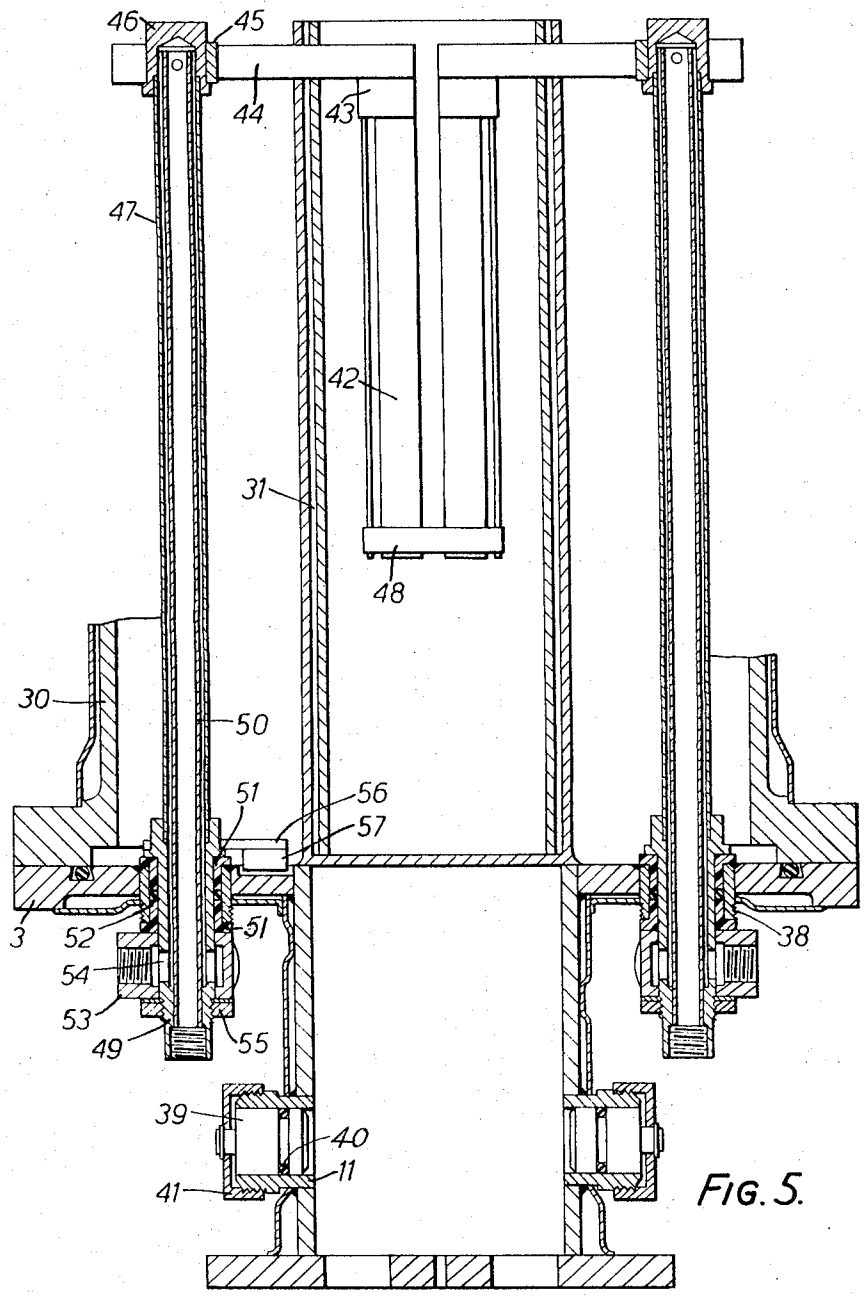


FIG. 5.

United States Patent Office

3,300,566

Patented Jan. 24, 1967

3,300,566

ELECTRIC FURNACES

Alan John Walker, Chatham, Kent, England, assignor to Spembly Limited

Filed Dec. 6, 1963, Ser. No. 328,586
Claims priority, application Great Britain, Dec. 8, 1962, 46,421/62
13 Claims. (Cl. 13—32)

This invention relates to an electric furnace, and is primarily concerned with the mounting of a resistance heating element and its current supply connections therein.

More particularly, the invention relates to a furnace having a tubular resistance heating element which is slotted to provide an extended path for the passage of heating current therealong, the element having a plurality of angularly spaced, axially extended arcuate portions which constitute supporting legs for the element.

It has an object of the invention to provide a mounting for the heating element which enables the element to be firmly mounted in good electrically conducting engagement with the current feeders which supply the element, and at the same time assures firm engagement between the current feeders and a cooling water jacket.

Accordingly, the invention provides an electric furnace comprising a tubular resistance heating element which is constructed to provide a lengthy path for the passage of heating current therealong, the element having at one end of plurality of angularly spaced, axially extended arcuate portions which constitute supporting legs for the element, a tubular water jacket, a plurality of current feeders of arcuate cross section each arranged longitudinally of the jacket to lie between the jacket and one of the said portions, the current feeders fitting closely on the one hand against the inner surface of the water jacket and being in heat conducting relationship therewith which electrically insulated therefrom, and on the other hand against the outer surface of the said portion, with which it is in electrically conducting relationship, and clamping means for pressing the said portions against the current feeders and the current feeders against the jacket in such a manner that uniform pressure is exerted over the respective contacting surfaces through which heat transfer and flow of current occur.

The invention will now be described by way of example with reference to the accompanying drawings which show the application of the invention to a furnace of the character described in my British patent specification No. 908,667.

In the drawings:

FIGURE 1 is a vertical section through the furnace;

FIGURE 2 is a vertical section through the water jacket;

FIGURE 3 is a vertical section of the lower part of the furnace showing a modification;

FIGURE 4 is a sectional plan on the line X—X of FIGURE 3;

FIGURE 5 is a vertical section through the furnace when a alternative heating element is employed.

The furnace includes a tubular water jacket, which comprises a relatively thick inner shell 1 and a thin outer shell 2, has its inner shell welded at its upper end in a central aperture in a furnace base plate 3. The outer shell is constructed to provide a spiral water path between the shells. The outer shell is extended at its upper end in a horizontal plane to enclose a water path between the extension and the underside of the base plate in the vicinity of the central aperture. A water inlet connection 4 is provided at the lower end of the jacket and an outlet connection 5 is provided in the extension. A plate 6

welded to the lower end of the jacket is provided with apertures 7 through which the furnace may be evacuated or supplied with an inert gas. An additional connection 8 may be provided to the interior of the duct formed by the jacket which can be fitted with a vacuum gauge or can provide an inert gas connection.

Copper bars 9 forming current feeders for the furnace heating element are secured in diametrically opposed positions to the inside wall of the water jacket by pins 10, passing through apertured bosses 11 in the wall of the jacket and threaded to receive nuts 12. The copper bars, which are in the form of quadrants cut longitudinally from a hollow cylinder, fit closely against the water jacket in heat conducting relationship therewith. They are insulated from the jacket by thin strips 13 of mica or other electrically insulating material. The pins 10 are insulated from the bosses 11 by means of insulating bushes 14, 15 between which is arranged an insulating ring 16 to form a gas or vacuum seal. Current supply connections are made to the ends of the pins protruding from the bosses.

The furnace heating element 17 which may be made of graphite, is in the form of a hollow cylinder slotted to provide a lengthy current path and provided at its lower end with integral, axially extended arcuate portions which constitute supporting legs 18 which extend circumferentially over diametrically opposed quadrants of the circumference of the cylinder. The external diameter over the legs 18 is equal to the internal diameter between the inner surfaces of the copper bars 9, so that the bars may fit closely against the legs in electrically conducting relationship therewith. The upper ends of the bars are provided with internal circumferential projections 19 and the legs 18 are provided with complementary circumferential recesses 20 so that the legs of the element can be inserted into the tubular water jacket in the circumferential spaces between the bars, and the element can then be rotated to align the legs and bars, axial movement of the element being prevented in this position by the projections engaging the recesses. This bayonet type joint allows for the ready fitting and removal of the element.

Loosely mounted in the center of the plate 6 at the lower end of the jacket is a jack comprising a screwed spindle 21 on which is threaded a lifting plate 22 provided with upstanding dowels 23. The spindle can be rotated by means of a key inserted through the heating element from its upper end to engage a square section portion on the upper end of the spindle.

The internal surfaces 24 of the lower ends of the supporting legs 18 of the heating element, are conical about the axis of the heating element and a refractory or ceramic plug 25 of complementary frusto-conical form is arranged on the lifting plate 22 of the jack. Washers 26 with interengaging spherical surfaces are arranged between the plate 22 and plug 25. The plug has recesses 27 which engage over the dowels 23, an axial hole 28 to allow passage of the spindle 21 of the jack, and a counterbored axial hole 29 to receive the end of the key for operating the jack. The plug is in the form of a frustrum of a cone parts of which are cut away axially to leave diametrically opposed conical quadrants alternating with diametrically opposed plane surfaces.

If the conical surfaces of the plug are aligned with the supporting legs 18 of the heating element and the copper bars 9 the jack may be operated to apply axial pressure to the legs 18, this pressure being transmitted through the conical sloping surfaces of the legs 18 in directions transverse to the axis of the element, so that the legs are clamped firmly against the copper bars 9, and the bars are clamped firmly against the wall of the water jacket.

In the furnaces described in my prior British patent specification 908,667, a pillar of refractory material is mounted in the center of the base plate and supports a cap of refractory material which forms the furnace hearth and is surrounded by the heating element. In the furnace of FIGURE 1 this pillar of refractory material (60) is formed at its lower end so as to fit the counterbored hole 29 in the plug 25, the end of the pillar being recessed so as to clear the projecting end of the spindle 21 of the jack.

The furnace is also provided with a water jacketed enclosure 30 in the form of an inverted pot removably mounted in a gas-tight manner on the base plate to enclose the heating element. The element may be further surrounded by radiation shields 31 or by a second pot 32. In the latter case the space between the pots is filled with lampblack. A ring 33 is provided to prevent upward movement of pot 32. These details are described in specification 908,667.

In the modification shown in FIGURES 3 and 4, the interior surfaces of the copper bars 9 and the exterior surfaces of the supporting legs 18 of the heating element are of complementary conical form. A ring nut 34 makes threaded engagement with the wall of the water jacket and is adapted to engage an insulating ring 35 arranged on shoulders 36 provided on the supporting legs 18 to exert axial pressure thereon. The supporting legs 18 extend circumferentially over quadrants of a circle at their upper portions but their lower portions which contact the copper bars 8 extend circumferentially to near semi-circles. This difference in cross-sections is shown clearly in FIGURE 4, in which view the water jacket is omitted.

A distance piece 37 of refractory material is arranged diametrally in the gap between the near semi-circular portions of the lower ends of the supporting legs 18 so as to prevent inward radial movement of the legs when the nut 34 is screwed down to apply axial pressure thereto. The top face of the distance piece is provided with a central axial recess corresponding to the counterbored hole 29, FIGURE 1, so that a pillar of refractory material can be mounted therein for supporting a refractory cap forming a furnace hearth.

In both of the above described forms of the invention, axial pressure is applied to a pair of mating conical surfaces to produce a wedging action which causes the supporting legs of the heating element to press radially outwardly into firm frictional and electrically conducting engagement with the current feeders; a uniform pressure is applied over the whole of the contacting surfaces between the heating element supporting legs and the copper current feed bars, and between these feed bars and the wall of the water jacket.

The furnace is specially designed so that the heating element and current feeders can be readily removed and replaced by an element and feeders of different form.

The furnace base plate 3 is provided with additional apertures in which are welded tubular bosses 38 which are of the same dimensions as the bosses 11 in the water jacket. These bosses are fitted with plugs 39 provided with circumferential recesses containing gas sealing rings 40. Each plug is attached at one end by means of a circlip to an internally threaded cap 41 adapted to be screwed on to the projecting end of one of the bosses which are suitably threaded externally.

When it is desired to use the alternative heating element, the heating elements 17, the copper feed bars 9, and the jack are removed from the furnace, and the gas-sealing plugs 39 are removed from the bosses 38 and fitted to the bosses 11 in the water jacket as shown in FIGURE 5 of the drawings. The alternative heating element shown in this figure comprises tungsten strips 42 arranged in parallel longitudinal spaced relationship. At the upper end of the element the ends of the strips are arranged between concentric arcuate tantalum strips 43 to which they are rivetted. The inner strip projects above

the top of the element and is rivetted or bolted to tantalum arms or straps 44 secured at their outer ends to split brass blocks 45 adapted to be clamped to brass caps 46 fitted to the upper ends of the current feeding tubes 47. At the lower end of the element, the tungsten strips 42 are secured between a circular tantalum ring 48 and arcuate tantalum strips (not shown) rivetted together.

The current feeding tubes 47 are mounted at their lower ends in tubular metal sleeves 49 which also carry open-ended tubes 50 arranged concentrically within the tubes 47 and spaced therefrom. The sleeves 49 are arranged in the tubular bosses 38. Opposed insulating bushes 51 abutting an insulating ring 52 adapted to form a gas seal are arranged in the bosses 38 around the sleeves 49. A metal banjo fitting 53 is arranged on the sleeve to supply cooling water through holes 54 in the wall of the sleeve to the space between the tubes 47, 50. By means of a nut 55 threaded on the sleeve the parts mounted thereon may be drawn together to effect water-tightness and firm mounting of the sleeve in the bosses 38. A plate 56 secured to the sleeve carries a button 57 of ceramic material adapted to engage a recess in the base plate 3 to prevent rotation of the sleeve.

When this alternative metal heating element is employed the radiation shields 31 are used to surround the element. Further, instead of the furnace hearth being supported on a refractory pillar the base of the inverted pot 30 forming the furnace enclosure is adapted so that the furnace charge can be introduced therethrough and suspended therefrom.

What is claimed is:

1. An electric furnace comprising a tubular resistance element subdivided to provide a path for the passage of heating current in excess of the length of the element, said element having at one end a plurality of angularly spaced axially extended apertured arcuate portions constituting supporting legs for the element, a tubular water jacket, a plurality of current feeders of arcuate cross section, each lying longitudinally of the jacket between the jacket and one of said leg portions closely adjacent thereto, insulation means interposed between an inner surface portion of the water jacket and the current feeders, whereby the current feeders are in heat-conducting relationship with said jacket but electrically insulated therefrom, and in electrically conducting relationship with the outer surface of said one leg portion of the heating element, and releasable clamping means operable to press said leg portions against the current feeders and the current feeders against the jacket in a manner such that a substantially uniform pressure is exerted over the respective surfaces through which heat transfer and the flow of current occur.

2. An electric furnace in accordance with claim 1, wherein each of the said arcuate portions of the element is formed with a surface which slopes relatives to the axis of the element, and the clamping means when operated applies axially directed pressure which is transmitted through the said sloping surfaces in directions transverse to the axis of the element.

3. A furnace in accordance with claim 2, wherein each said arcuate portion has a conically tapering internal surface, and the clamping means comprises a plug having a complementary conical surface mating with the said internal surfaces, the plug being axially movable, relative to the heating element to apply clamping pressure to the said arcuate portions.

4. A furnace in accordance with claim 3,, wherein the clamping means comprises a screw jack for moving the plug axially of the heating element, the said screw jack being rotatable by means of a key insertable through the interior of the heating element.

5. A furnace in accordance with claim 3, wherein the plug is recessed to receive the lower end of a refractory pillar carrying at its upper end a refractory cap forming the hearth of the furnace.

6. A furnace in accordance with claim 4, wherein a bayonet type joint is formed between the heating element and the current feeders, whereby the element may be readily removed.

7. A furnace in accordance with claim 1, wherein the exterior surfaces of the said arcuate portions of the heating element and the adjacent surfaces of the current feeders are of complementary conically tapering form, the element being axially movable, relative to the current feeders by the said clamping means, and a spacing means is provided for preventing the arcuate portions of the heating element from moving radially inwardly towards each other.

8. A furnace in accordance with claim 7 wherein the spacing means is recessed to receive the lower end of a refractory pillar carrying at its upper end a refractory cap forming the hearth of the furnace.

9. A furnace in accordance with claim 7, wherein the clamping means comprises a nut having threaded engagement with a fixed part of the furnace and bearing against an abutment on the element.

10. A furnace in accordance with claim 1, wherein the current feeders are removably secured to the wall of the jacket by means of pins adapted to be inserted into apertures in the wall of the jacket and to be connected to current supply leads externally of the jacket.

11. A furnace in accordance with claim 10 wherein the heating element is removable, and also comprising a base plate including apertures for receiving mounting means for an alternative form of heating element, and with plugs for sealing the said apertures, said plugs being alternatively insertable in the apertures in the wall of the jacket left by the removal of the said pins.

12. A furnace in accordance with claim 1, and comprising a base including an aperture, and wherein the said water jacket is secured in said aperture in the base and defines a duct through which the furnace can be evacuated or an inert gas introduced.

13. An electric furnace comprising a base, an annular water jacket at the base of the furnace, a plurality of current feeders shaped to fit closely against the inner surface of the water jacket, a heating element in the form of a hollow cylinder which is slotted to provide an extended path for the passage of heating current therealong, the element being formed integrally with a plurality of axially extending angularly spaced terminal portions of arcuate cross section, each having a surface which is conical about the axis of the element, the outer surface of each said portion fitting closely against the inner surface of one of said current feeders, clamping means engageable with the element and adapted to apply axially directed pressure thereto so as to create a wedging action against said conical surfaces, said wedging action causing said arcuate portions to press radially outwardly into firm frictional and electrically conducting engagement with said current feeders.

References Cited by the Examiner

UNITED STATES PATENTS

2,859,425	11/1958	Felton	339—270
2,964,389	12/1960	Bennett et al.	23—253
2,966,537	12/1960	Witucki et al.	13—22
2,971,039	2/1961	Western	13—25
3,012,090	12/1961	Robbins	174—52
3,129,314	4/1964	Hage et al.	338—238 X
3,160,693	12/1964	Palmer	13—22
3,213,177	10/1965	Diefendor	13—31

FOREIGN PATENTS

406,567	3/1934	Great Britain.

RICHARD M. WOOD, *Primary Examiner.*

ANTHONY BARTIS, *Examiner.*

V. Y. MAYEWSKY, *Assistant Examiner.*