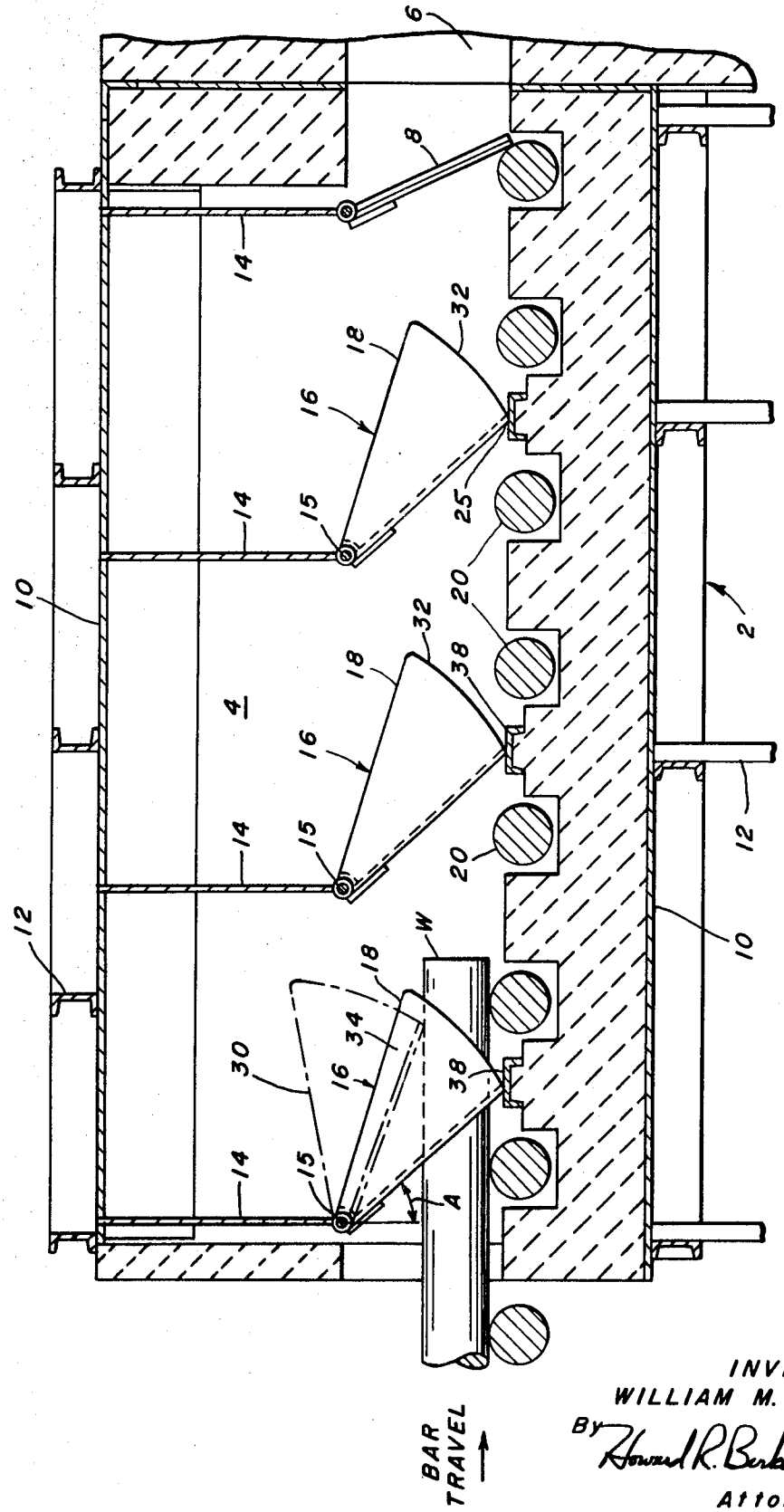
Sept. 20, 1971 W. M. BLOOM 3,606,288

FURNACE SEAL

Filed Feb. 2, 1970 3 Sheets-Sheet 1

FIG. 1.



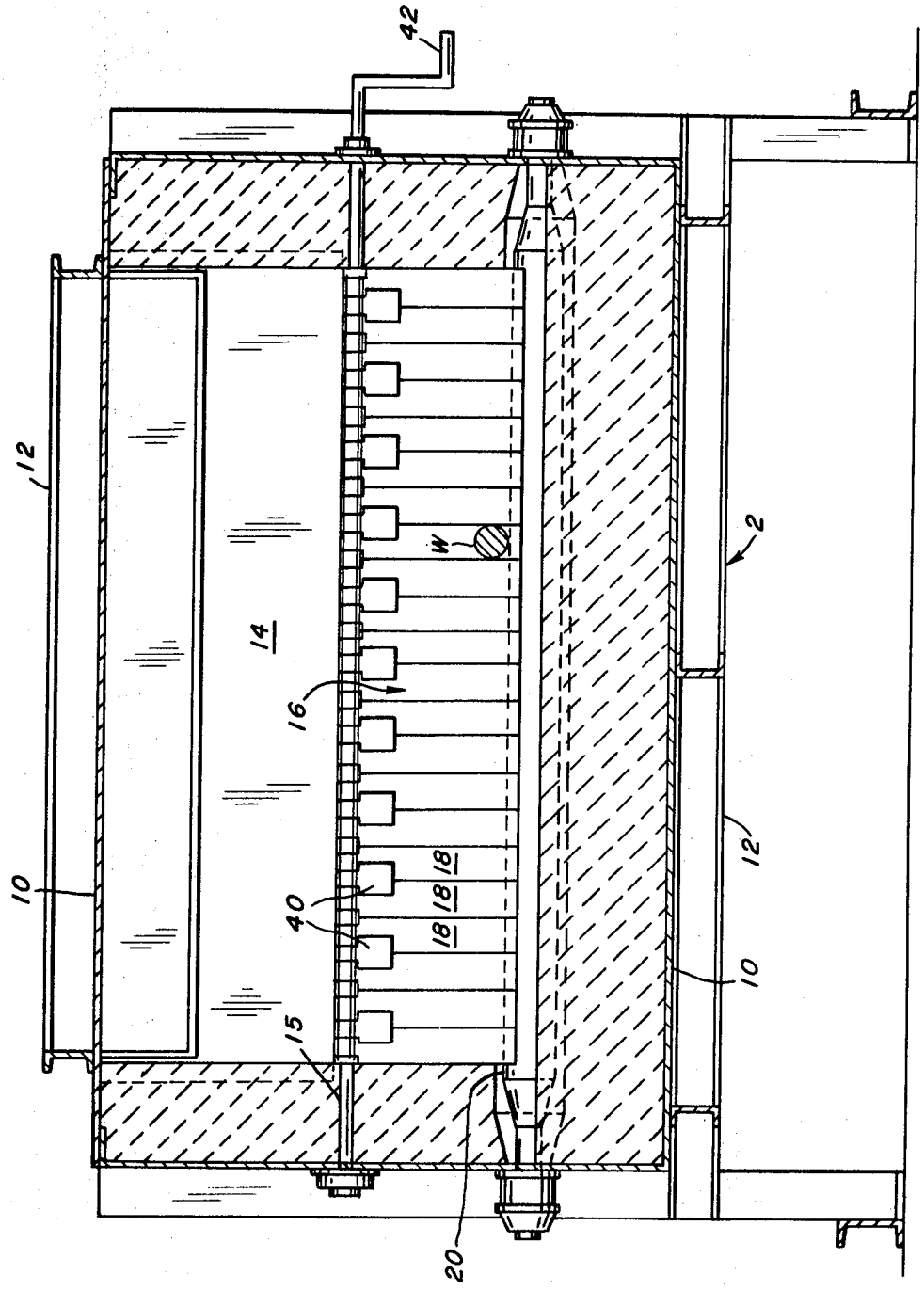
INVENTOR.
WILLIAM M. BLOOM
By Howard R. Berkenstock
Attorney

Sept. 20, 1971 W. M. BLOOM 3,606,288

FURNACE SEAL

Filed Feb. 2, 1970 3 Sheets-Sheet 2

FIG. 2.



INVENTOR.
WILLIAM M. BLOOM
By Howard R. Berkenstock Jr.
Attorney

Sept. 20, 1971 W. M. BLOOM 3,606,288

FURNACE SEAL

Filed Feb. 2, 1970 3 Sheets-Sheet 3

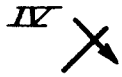


FIG. 3.

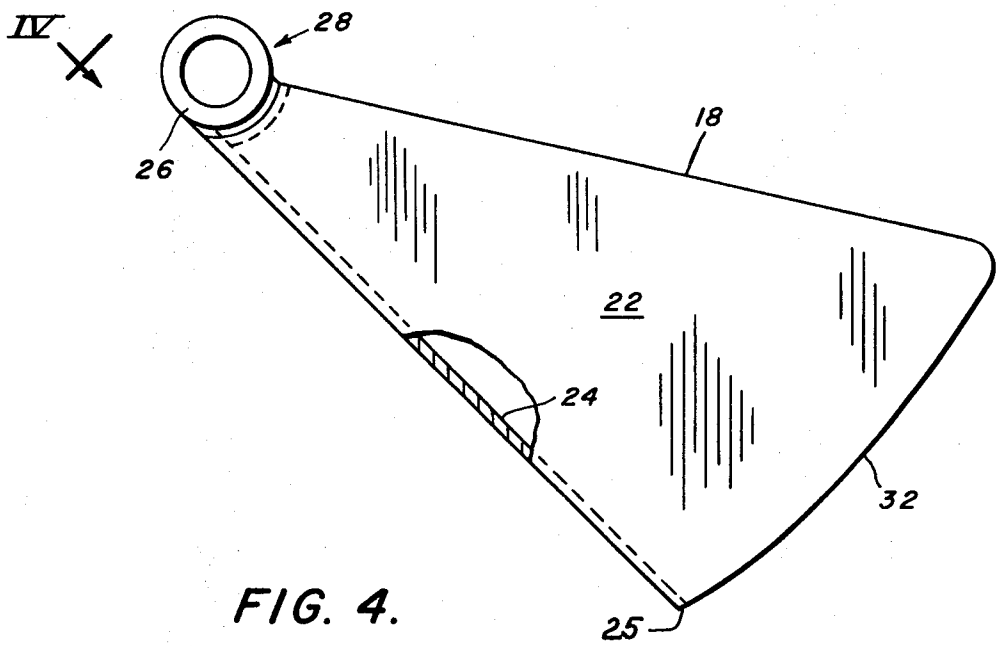
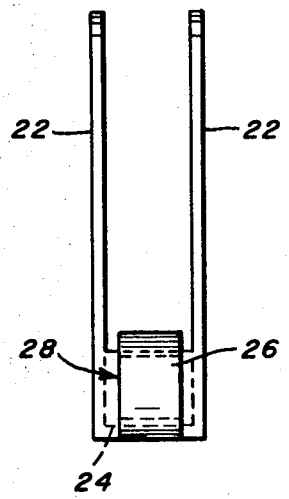


FIG. 4.



INVENTOR.
WILLIAM M. BLOOM
By Howard R. Berkowitz
Attorney

United States Patent Office 3,606,288
Patented Sept. 20, 1971

3,606,288

FURNACE SEAL

William M. Bloom, Pittsburgh, Pa., assignor to Allegheny Ludlum Steel Corporation, Pittsburgh, Pa.

Filed Feb. 2, 1970, Ser. No. 7,721
Int. Cl. C21d 1/00
U.S. Cl. 266—5R 10 Claims

ABSTRACT OF THE DISCLOSURE

A sealing system for a furnace, such as a continuous bar annealing furnace having a plurality of sealing elements supported across the opening to the furnace in a side-by-side relationship. Each element of the seal has two parallel planar sides in alignment with the direction of entry into the furnace. Material entering the furnace contacts one or more elements causing them to be displaced, permitting the material to enter the furnace. The dimension of the planar sides of each element in the direction of displacement is of such magnitude that the side of one element remains in a continually overlapping relationship with the side of an adjacent element when one of the elements is displaced by the material entering the furnace.

BACKGROUND OF THE INVENTION

The purpose of this invention is to provide an effective atmosphere seal at the entry or exit ends of a chamber, particularly one having an internal atmosphere different than that of the environment of the furnace, such as a continuous bar annealing furnace having a hydrogen atmosphere.

Continuous roller-hearth, atmosphere-type, tool steel bar annealing furnaces are designed to provide close temperature and atmosphere controls, so that as the temperature of charge material is increased or decreased within the furnace, the composition of the atmosphere may be changed to maintain an atmosphere neutral to the carbon content of the steel. In this manner the carbon content of the annealed bar after the annealing will be substantially equivalent to its carbon content before the anneal. Endothermic and exothermic gases are continuously admitted to the furnace at various predetermined points along its length in metallurgically prescribed quantities and ratios, to obtain the desired variation in atmosphere gas composition and temperature. Because it may be desirable to have a gas mixture injected into the furnace at a given point flow towards the exit end for one cycle and product and more towards the entry end for another product, means to bias the quantity of gas flowing out of one end of the furnace over the other end of the furnace is required.

The means to control the quantity of gas flow out of the furnace ends should be able to maintain a controlled atmosphere gas flow rate under varying environmental conditions such as when the conditions at the furnace ends vary, or the bar load passing through the furnace ends varies the cross-sectional area of the seal. Positive internal furnace pressure greater than environmental pressure is required in isolated atmosphere furnaces, such as at a sealing chamber to prevent infiltration of the environment atmosphere through the seals and into the furnace, causing a contamination of the atmosphere therein. This internal furnace pressure acting across the seals must also be great enough to overcome the external air impingement of the environmental disturbances in the vicinity of the furnace, such as the opening of building doors, etc. The effectiveness of the seals and the quantity of furnace atmosphere gas requirements to maintain a positive pressure within the furnace are dependent upon the seal's gas

flow resistance, determined by the cross-sectional flow area, the flow area shape for flow coefficient, and the length of flow path for frictional factors. An effective seal design should minimize gas leakage through the seals by providing sufficient flow resistance under all conditions of operation, to maintain a continuing, but minimized flow of atmosphere from the furnace to the environment outside. Thus, the seal should have sufficient flow resistance to make any influence of external environment atmosphere disturbance on the seals negligible, both when the seals are in the closed position as well as the open position as during the charging of the furnace.

Conventional seals used to restrict the flow of atmosphere gases from a continuous furnace consist of a plurality of sheet-like flapper baffles hung across the furnace opening width. Usually two or more rows of baffles are hung to increase the flow resistance to a workable level. These baffles are somewhat effective in reducing the size of the opening to the general shape of the load cross-section, but have a major deficiency in that side holes are opened up between an open or partially open flapper and an adjacent closed flapper when material passes through. This opening may vary from several to as much as 50 square inches for a 2-inch flap extending over a vertical opening of 12 inches or greater in area, dependent upon the dimension of seal height. This open area, or side hole, enables substantially large quantities of furnace atmosphere to escape, thereby requiring large quantities of atmosphere make-up cast to retain the desired furnace pressure. Further, due to the side holes the flow rate of atmosphere at the seals varies substantially with changes in the seal cross-section contour between the no load condition and the loaded condition thus, varying the internal bias furnace atmosphere points. The conventional baffle seals are also substantially influenced by abrupt changes in external environment atmosphere such that the flow rate of furnace atmosphere across the seal varies, affecting the atmosphere profile within the furnace. Disturbing the atmosphere profile within the furnace causes mixing and a more homogeneous mixture of gases in the different section. The quality of many annealing processes is directly dependent upon the attainment of a definite, tapered, reproducible furnace atmosphere composition along furnace length. Thus, the furnace atmosphere disturbances allowed by conventional seals materially affect the desired furnace atmosphere profile and quality of the anneal. The seals of my invention enable the establishment of a substantially continuous atmosphere gas flow rate across them to the external atmosphere which is relatively unaffected by the entrance or exiting of material or various external wind effects. Thus, the utilization of my seals permits the establishment of a stable, profiled atmosphere along the furnace length, enabling the production of a uniform, high quality anneal.

SUMMARY OF THE INVENTION

A seal for a chamber such as an isolated atmosphere furnace having a plurality of elements in a side-by-side relationship, each element having two substantially parallel sides and joined by a separator extending therebetween. The individual elements are supported across the opening to said chamber and adapted to be individually displaced by a workpiece entering therein. The dimensions of said parallel sides are of predetermined width such that adjacent sides of elements maintain a continually overlapping relationship when an element is displaced by an entering workpiece.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of the seals of my invention as embodied in a continuous bar annealing furnace shown in cross section.

FIG. 2 is a front elevation of the structure of FIG. 1.

FIG. 3 is a side elevation of a seal element of my invention.

FIG. 4 is a view looking in the direction of arrows IV—IV of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and FIGS. 1 and 2 in particular, reference numeral **2** indicates the entry portion of a furnace, such as a continuous bar annealing furnace, having an entry vestibule **4** separated from the furnace proper **6** by means such as a heat shield **8**. The entry vestibule **4** of the annealing furnace has a gas-tight envelope **10** supported by structure **12**. Conventionally, baffles **14** are suspended from the overhead portion of the vestibule, being usually an alloy sheet welded in a gas-tight manner to the overhead of envelope **10**. At these baffles **14**, supporting rods **15** extend across the vestibule **4**, carrying sealing curtains **16**, composed of individual sealing elements **18**, such as those of my invention and later described. Though three baffles **14**, rods **15**, and curtains **16** are illustrated, the number for any particular furnace vestibule may vary and will be determined by the various operating parameters, namely the temperatures, gases, and pressures involved therein. Vestibule **4** is further provided with rolls **20** supported by the furnace structure in a manner well known in the art for supporting and conveying a workpiece W such as a bar of steel to be annealed.

Referring now to FIGS. 3 and 4, seal element **18** has two parallel planar sides **22** which are separated and supported by partition **24**. In the preferred embodiment herein disclosed, partition **24** forms a third side which, when the element **18** is hung within the vestibule **4**, faces the approaching workpiece W. Element **18** is adapted with means **26** to mount the element on the rods **15**. In the preferred embodiment disclosed, the mounting means **26** is a sleeve **28** attached to both the sides **22** and partition **24**, forming a gas-tight jointure therewith which enables the element to be rotated as illustrated in FIG. 1 at **30** when workpiece W enters the vestibule **4**. Sides **22** of element **18** are further adapted to be triangular in shape and oriented such that their lateral dimension continually increases away from the mounting means **26** toward end **32**. The dimension of end **32** is predetermined to be greater than the vertical displacement of element **18** upon the entry of workpiece W, to insure a continually overlapping relationship of the adjacent sides **22**, as illustrated at **34** of FIG. 1. In the preferred embodiment element **18** is further adapted so that edge **32** presents a sloping aspect to the retreating workpiece passing the element **18**.

In this embodiment the seals of this invention are mounted in rows along the baffle **14** being suspended from the transverse rod **15** forming a series of articulating sealing baffle-like elements. The individual elements **18** swing upward to a position as at **30**, being displaced by the workpiece W passing into the furnace vestibule **4**, on rollers **20**. Elements **18** in the preferred embodiment are hung to form an angle A when closed, offset from the vertical plane in the direction of bar travel. Such an angle permits a tight closer of the element **18** of the edge **25** of side **24** against sealing means as plate **38**. The offset hanging of element **18** also prevents wedging or lock-up of the element against the bottom sealing means which might otherwise happen if the element were allowed to swing approximately to the vertical position upon passage of the workpiece W. The offset hanging of the element **18** also reduces the area above the element required for the full displacement of the element **18** upon the passage of a workpiece W. As may be seen in FIG. 1, sides **22** have sufficient lateral dimension to form a continuous overlapping relationship as at **34** between the closed and opened adjacent elements.

As previously discussed, the trailing edge **32** of each element in the preferred embodiment presents a sloping aspect to the passing workpiece W. By such structure, end **32** slides down to the end of the workpiece W as it moves past, thereby eliminating element **18** dropping to a closure and abrupt impact of the seal edge **32** against the sealing plate **38** upon closure. Additional advantage is gained from the overlapping relationship of the adjacent elements in that maintaining the overlap significantly, as illustrated at **34** increases the flow resistance to the atmosphere gases within the furnace and vestibule, thereby reducing the intensity from the gases to evacuate the chambers. In the preferred embodiment, the overlap measures 1½" for a clearance of 1/16" over a length of 18½" on side **22**. In the described embodiment these dimension parameters provide additional preferred advantage in that the gas flow between elements in the overlap area is turbulent as opposed to laminar according to Reynolds criterion. By causing the gas flow to go turbulent, additional gas flow resistance is developed across the seal area further enhancing the seal effectiveness and the stability of the tapered furnace atmosphere.

In preferred installations the sealing elements would be installed in curtains **16** at both the entry and discharge ends of vestibule **4** and furnace **6**, either singly or in multiple rows. Ideally, the lateral dimension of the individual element **18** formed by the distance between the sides **22** by partition **24** would be slightly larger than the width of the workpiece W passing into the furnace. The elements of the illustrated installation measure 2 inches and accommodate bars of slightly less width. Charge material may also be bundled to a width closely approaching an integral multiple of element width. In actual practice, the seals have worked effectively for coiled material displacing several seal elements upon entry into the furnaces.

In the embodiment disclosed, lift plates **40** affixed to shaft **15** and operable upon rotation of shaft **15** by crank **42**, are positioned against element **18** when in a closed position. Rotation of crank **42** and shaft **15** will lift all elements **18**, thus raising the curtain **16** and presenting up to a full opening to furnace vestibule **4** for those instances where decreased gas flow resistance or access is desired. In the preferred embodiment disclosed, rod **15** is hollow and water cooled to maintain the shaft strength at the elevated temperatures encountered within the vestibule **4**.

I claim:

1. Apparatus for sealing an opening in a closed atmosphere chamber comprising: a plurality of individual elements having two parallel planar sides; a separator disposed between said planar sides joined thereto and having a dimension along said jointures at least as large as one dimension of said opening; mounting means adapting said elements for displacement in the direction of said two planar sides, said two sides having a dimension in the direction of displacement at least as large as said displacement and said individual elements being mounted in a side-by-side relationship having a planar side of one in juxtaposed relationship with the planar side of an adjacent element whereby said juxtaposed planar sides of adjacent elements maintain a continually overlapping relationship when one of said elements is displaced.

2. Apparatus according to claim **1** wherein any atmosphere flow exiting said chamber between adjacent elements is turbulent flow.

3. Apparatus according to claim **2** wherein the chamber is an annealing furnace and said mounting means adapting said elements for displacement in the direction of said planar sides includes pivotal mounting means whereby said displacement is rotational about said pivotal mounting means in the direction of said planar sides.

4. Apparatus according to claim **3** wherein said planar sides are substantially triangular in shape with said pivotal mounting means disposed at one corner of said triangle.

5. Apparatus according to claim **4** wherein said separator is joined to said pivotal mounting means forming

a gas-tight juncture therewith and extends between the said planar sides along a corresponding edge of said triangular sides forming a gas-tight juncture therewith.

6. Apparatus according to claim 5 wherein said individual elements are adapted to be displaced by a workpiece progressing through said furnace.

7. An apparatus according to claim 6 wherein the width of an individual element is larger than the width of the workpiece progressing through said furnace whereby said workpiece when aligned with said individual elements will displace only one element per row.

8. Apparatus according to claim 7 wherein said individual elements are adapted with means displacing all elements upon actuation of said means.

9. Apparatus according to claim 8 wherein said elements are disposed in a plurality of rows.

10. Apparatus according to claim 8 wherein the distance between the first and last of said plurality of rows is greater than the length of the workpiece progressing through said furnace.

References Cited

UNITED STATES PATENTS

2,233,474	3/1941	Dreffein	266—5R
3,105,863	10/1963	Holcroft et al.	266—5R
3,130,250	4/1964	Mescher	266—5R

GERALD A. DOST, Primary Examiner

U.S. Cl. X.R.

266—5A