United States Patent [19]

Kreider et al.

[11] **4,212,633**

[45] **Jul. 15, 1980**

[54] **VACUUM ELECTRIC FURNACE**

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[73] Assignee: **Abar Corporation,** Feasterville, Pa.

[21] Appl. No.: **961,298**

[22] Filed: **Nov. 16, 1978**

[51] **Int. Cl.**[2] **F27B 9/14**

[52] **U.S. Cl.** ..... **432/122;** 432/123; 432/194; 432/234; 432/249; 13/31 R

[58] **Field of Search** 432/122, 123, 126, 127, 432/194, 233, 234, 226, 249, 253, 243, 244; 13/31, 32; 198/600, 633, 774

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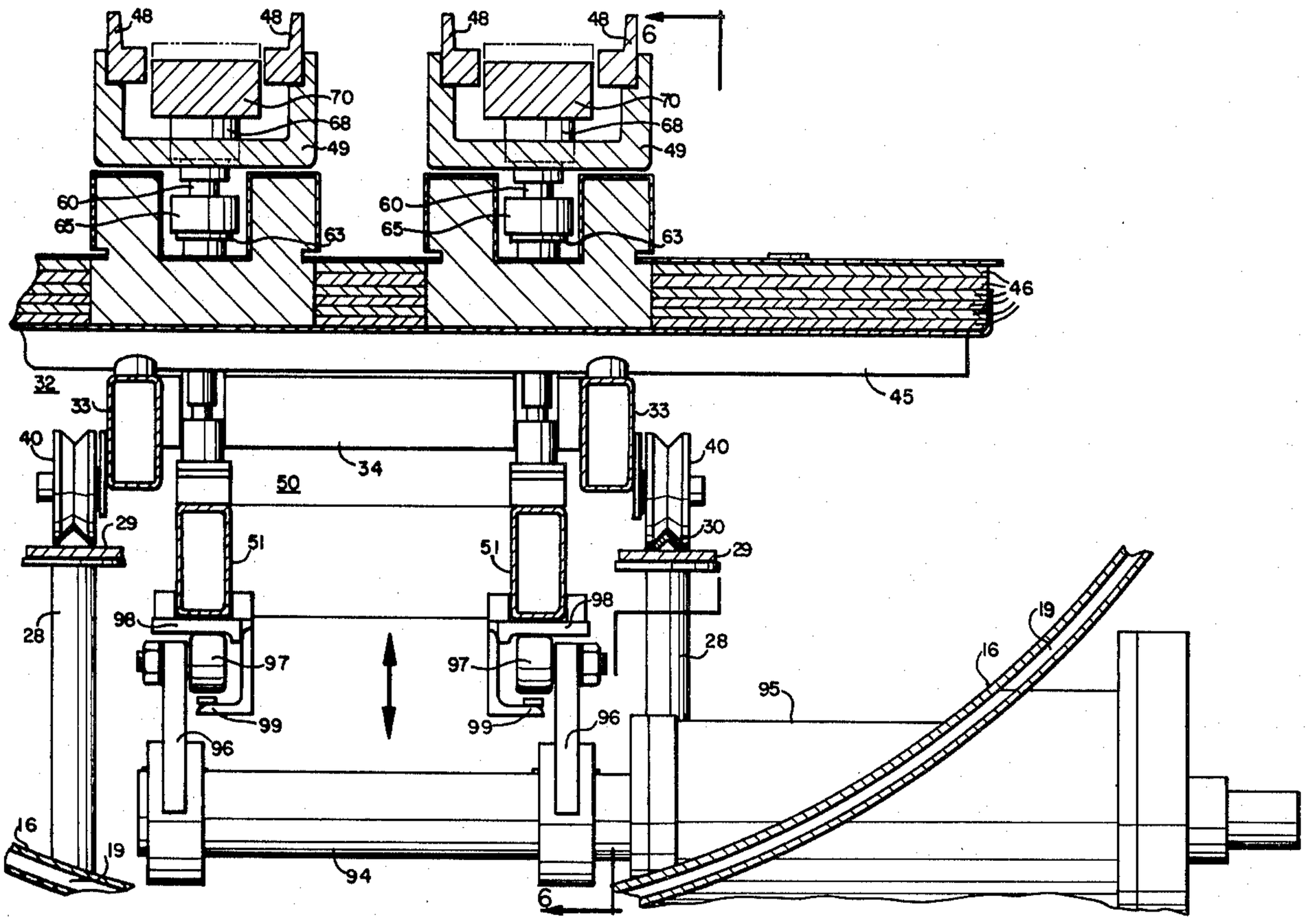
Primary Examiner—Henry C. Yuen
Attorney, Agent, or Firm—Zachary T. Wobensmith, 2nd; Zachary T. Wobensmith, III

[57] **ABSTRACT**

A vacuum electric furnace is disclosed for operation with a hostile environment therein which may be above the melting temperature of most metals, other than refractory metals, with apparatus in the furnace for advancing the work, the advancing apparatus being a walking beam with provisions for protecting the exposed portions of the walking beam by the use of graphite and with work supporting buttons of molybdenum to prevent the work from reacting with the graphite at high temperatures, and with separation and shielding of portions of the walking beam from the hot zone and with liquid cooling of the shielded portions.

13 Claims, 9 Drawing Figures



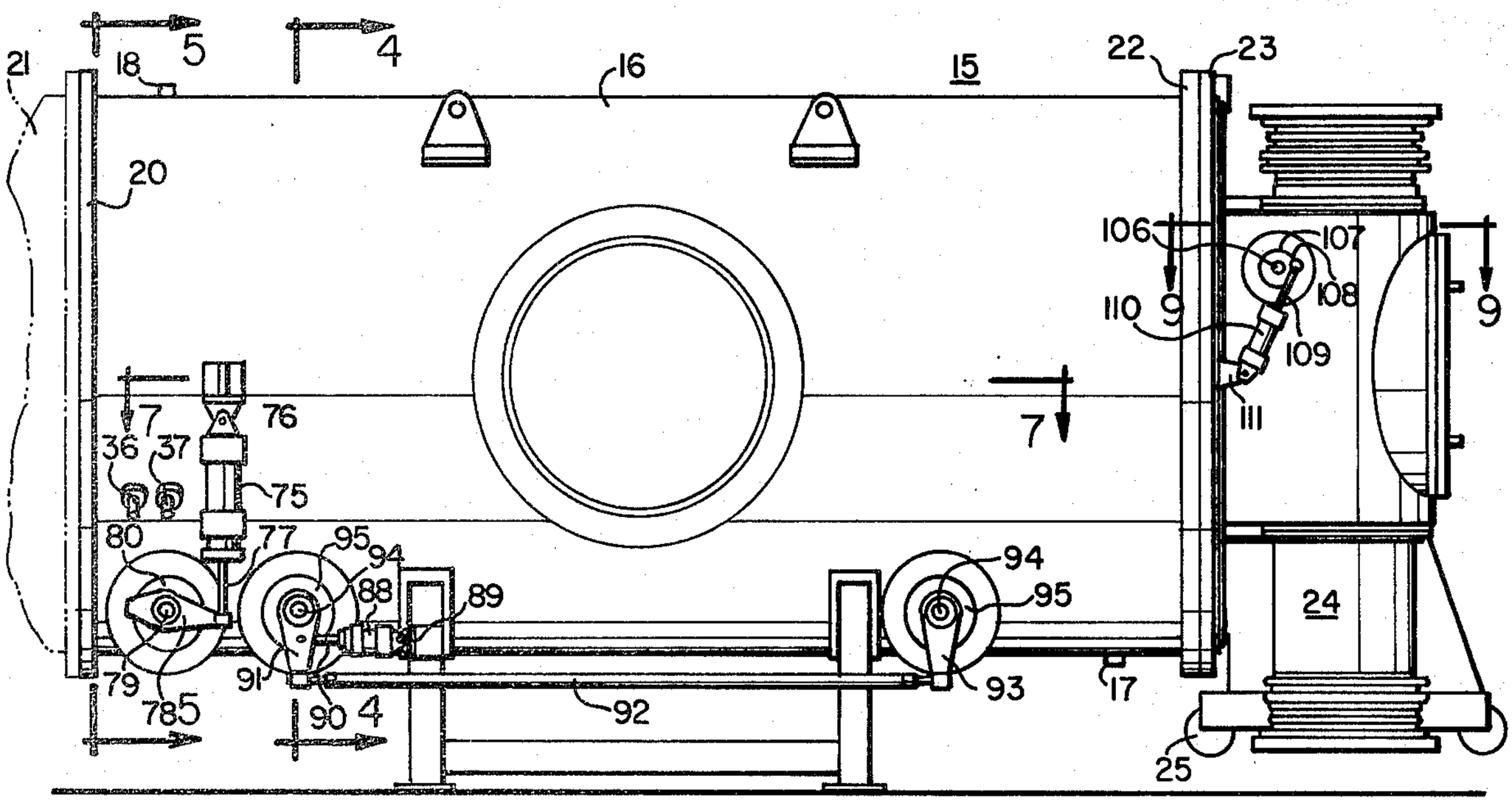


FIG. 1

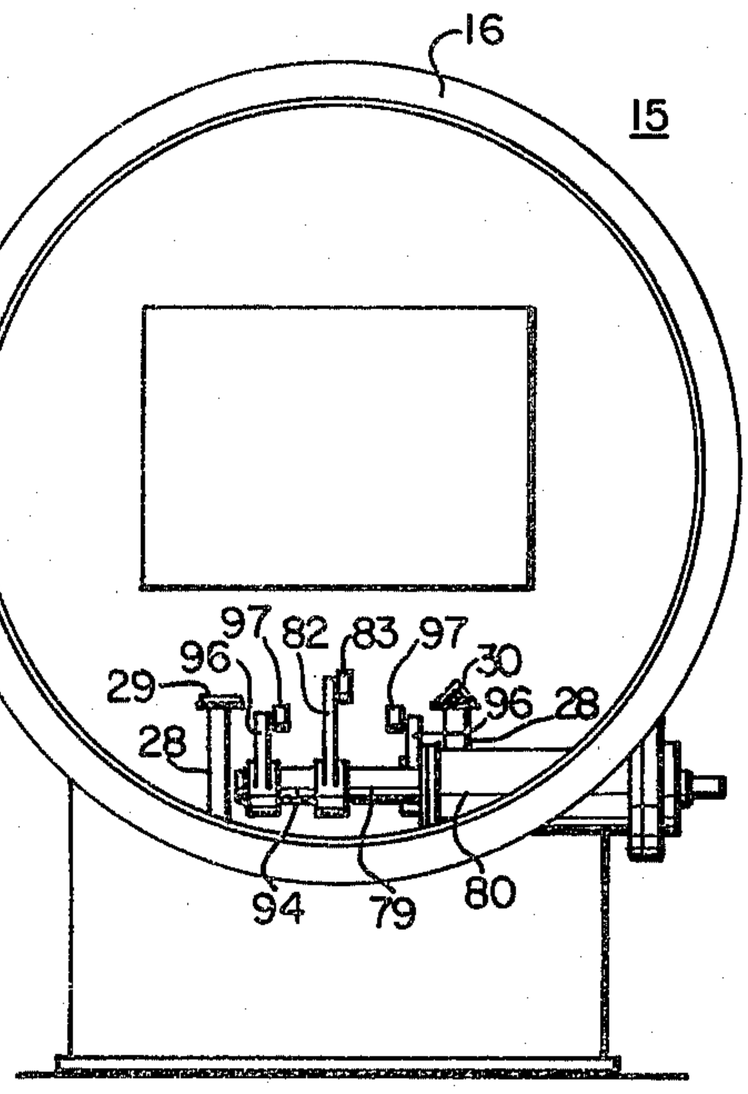


FIG. 2

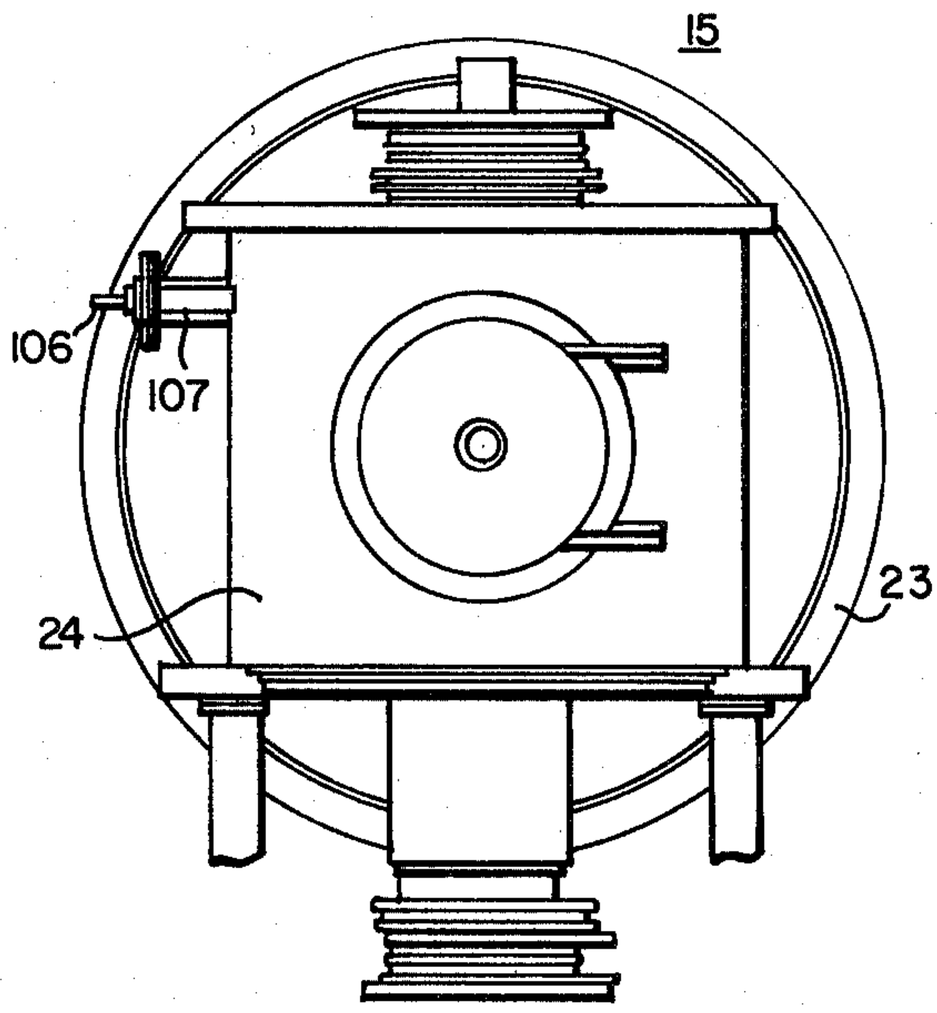


FIG. 3

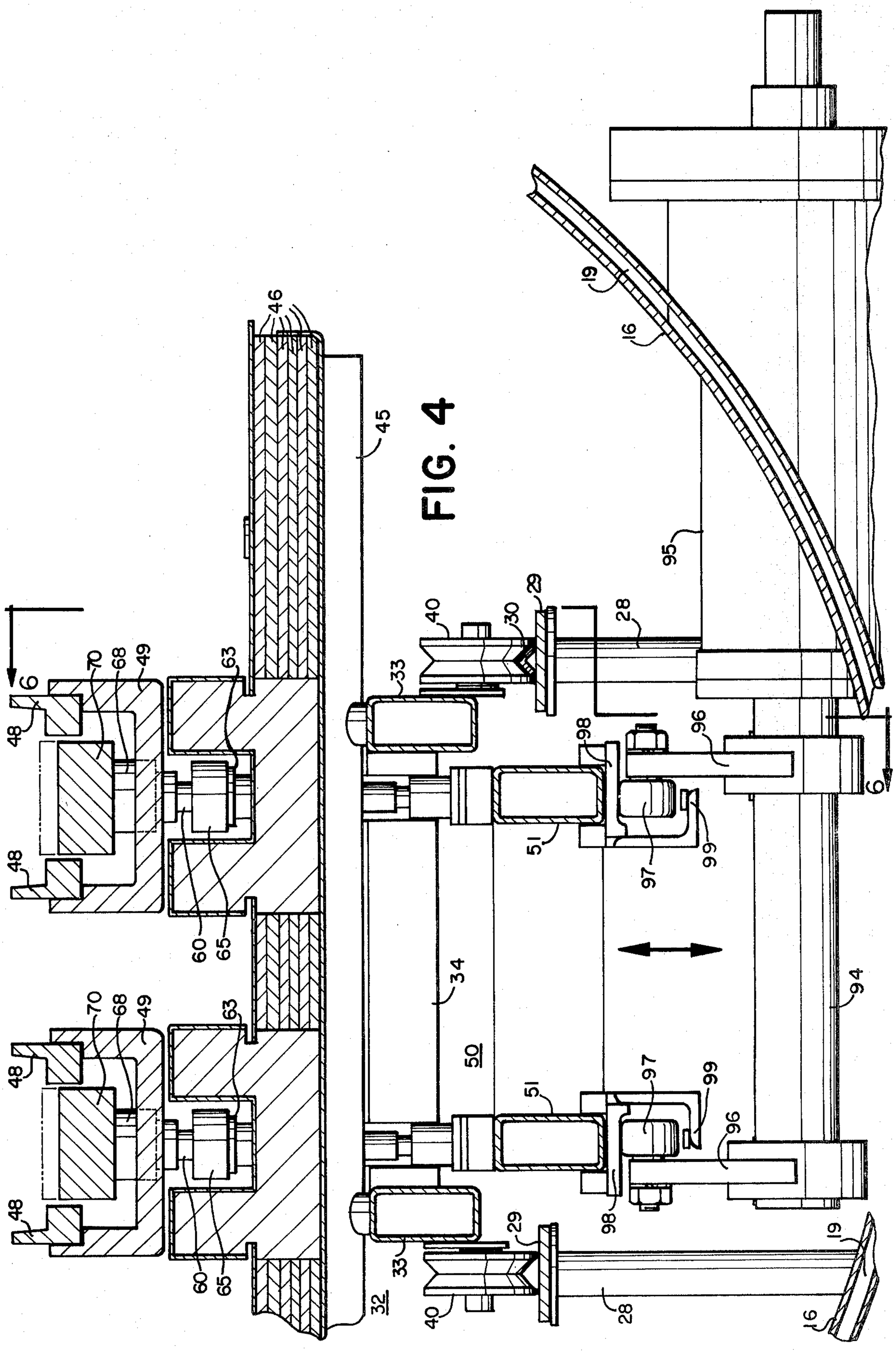

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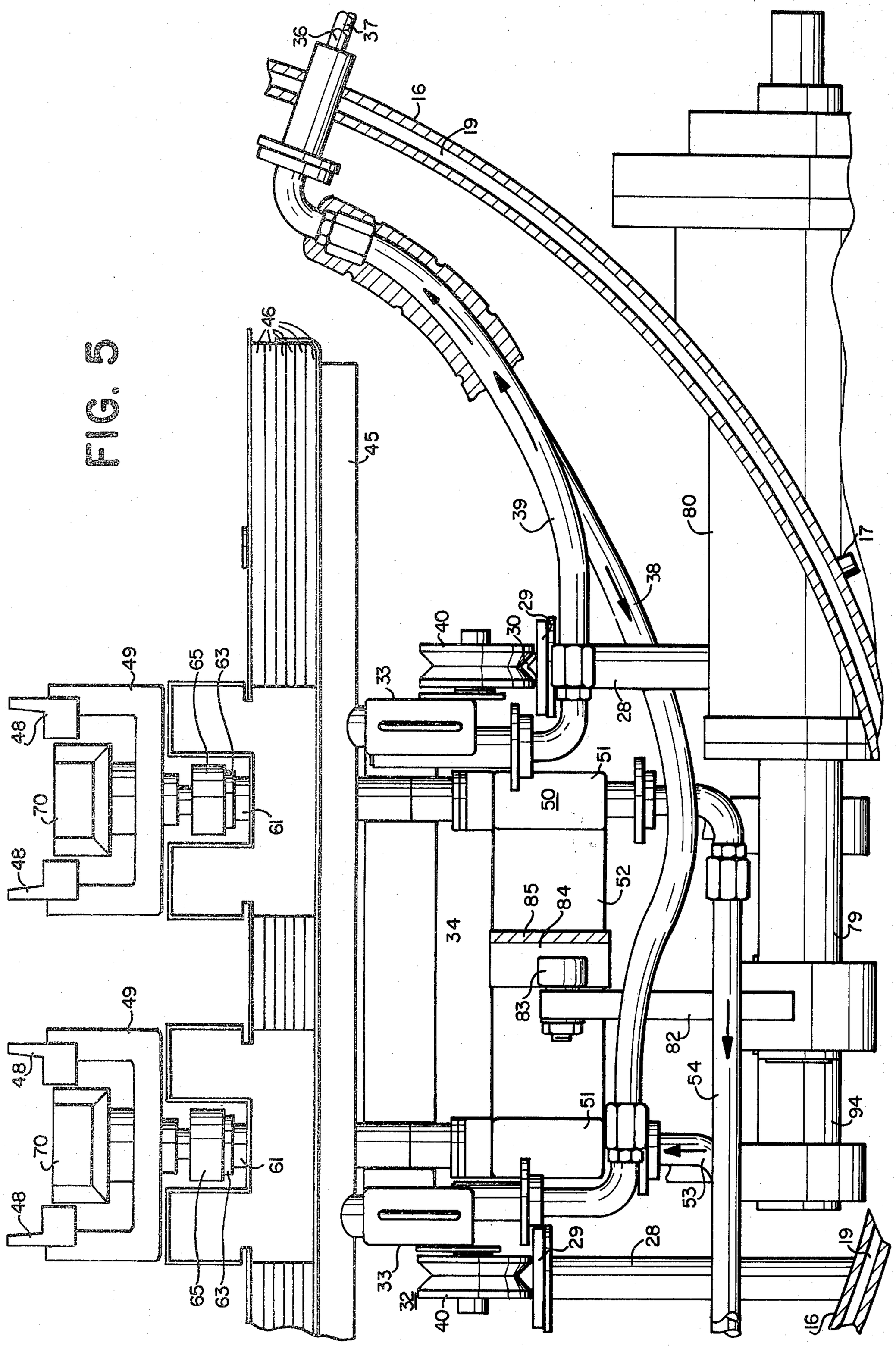
FIG. 4

FIG. 5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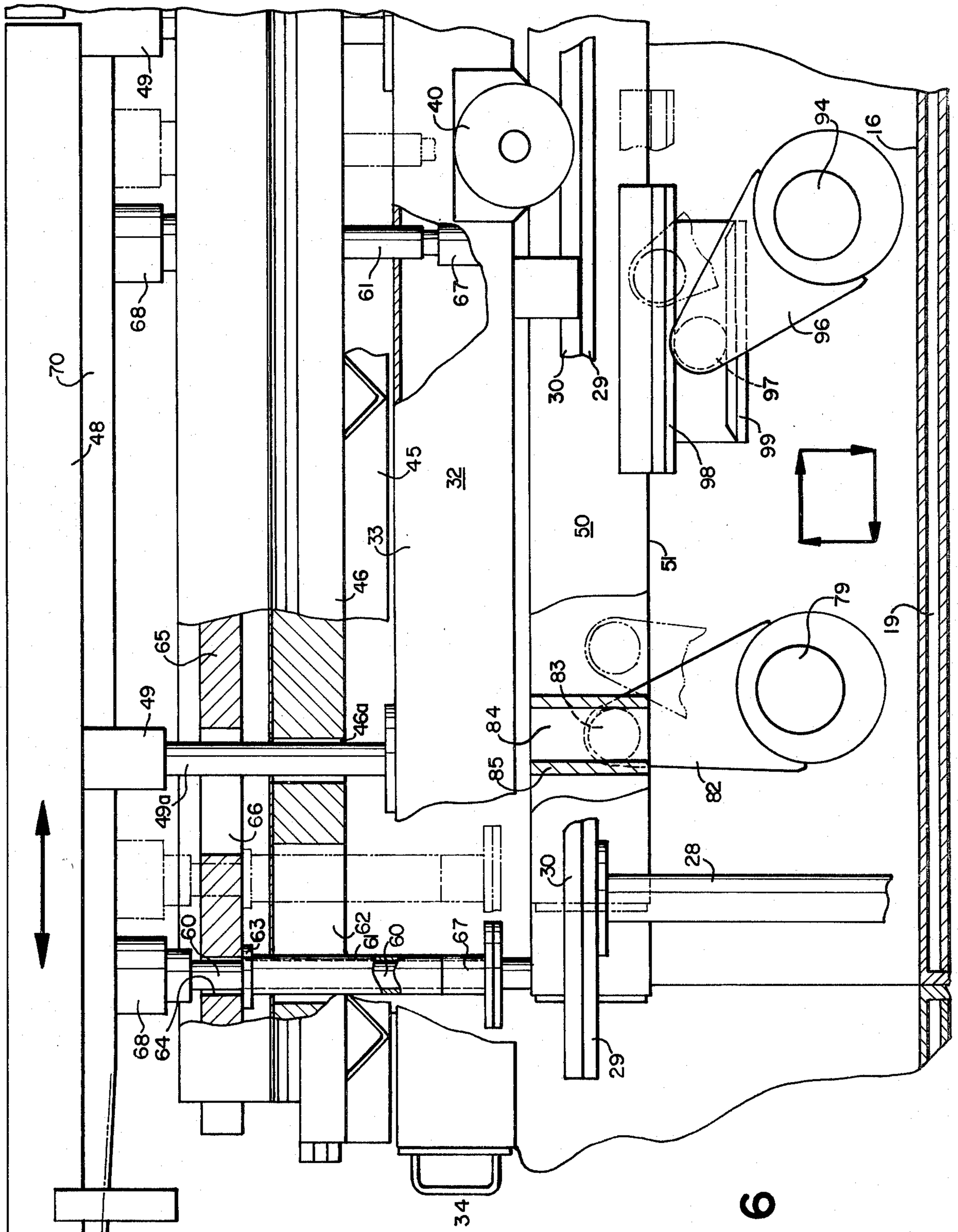
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FIG. 6

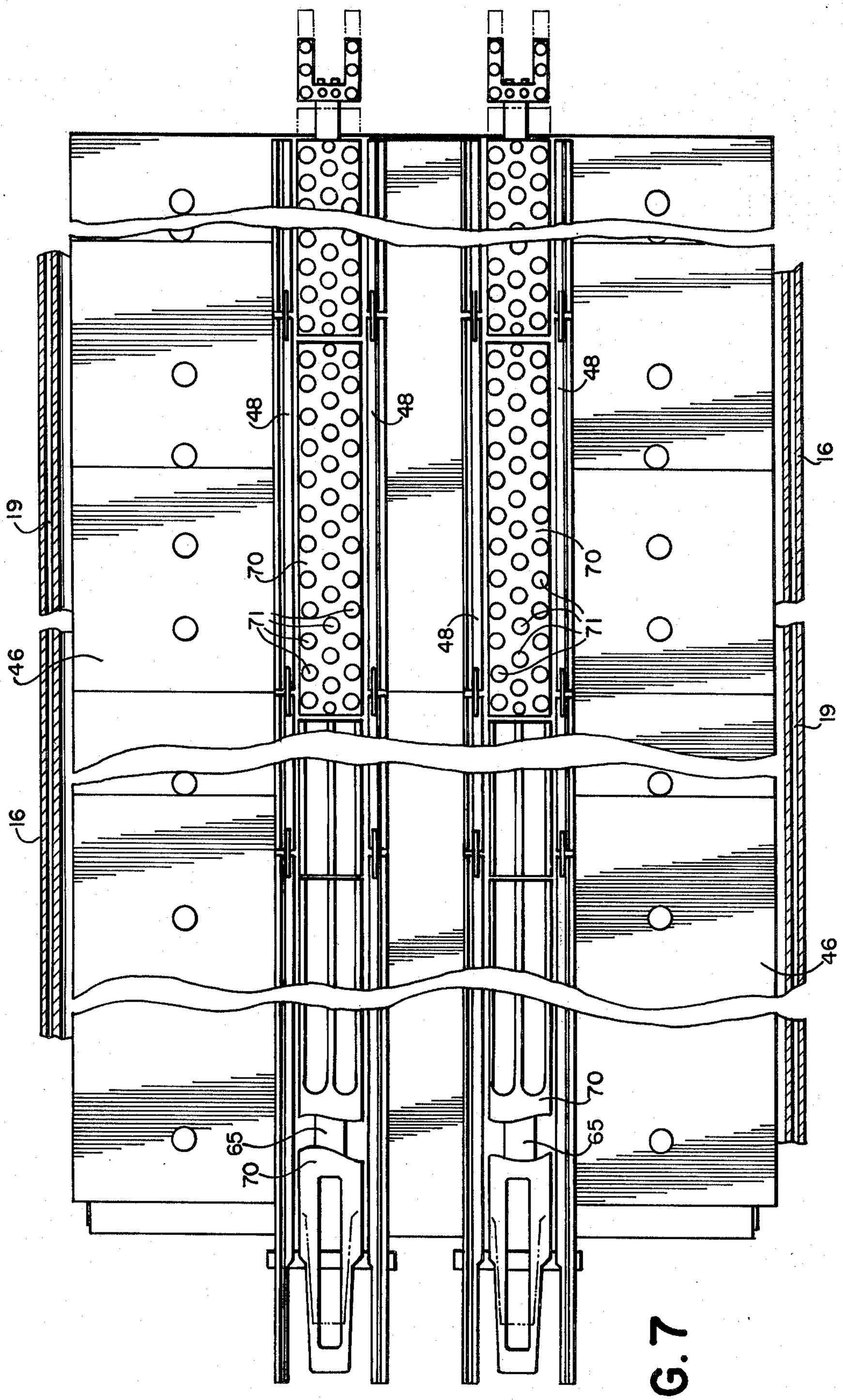

FIG. 7

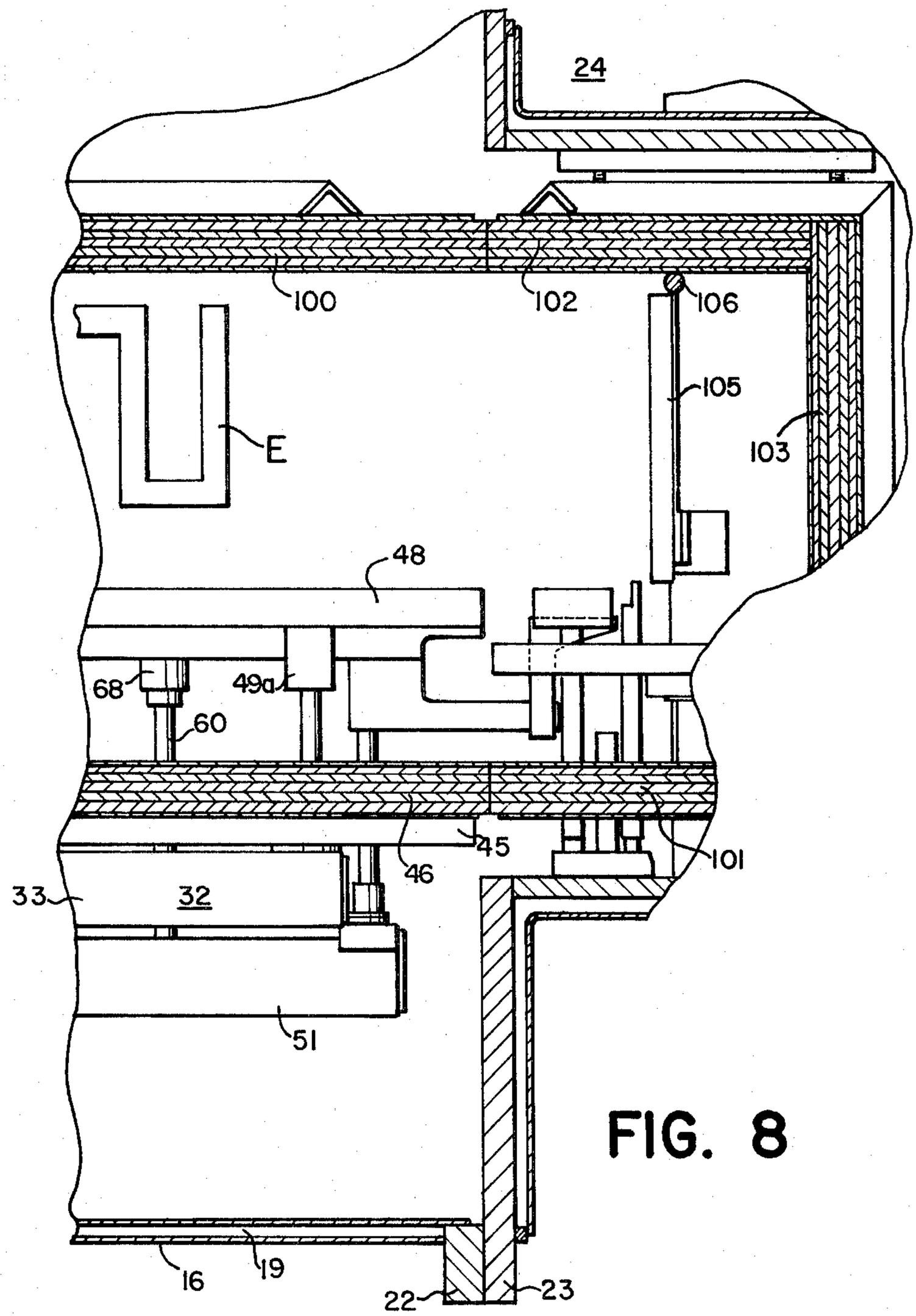

FIG. 8

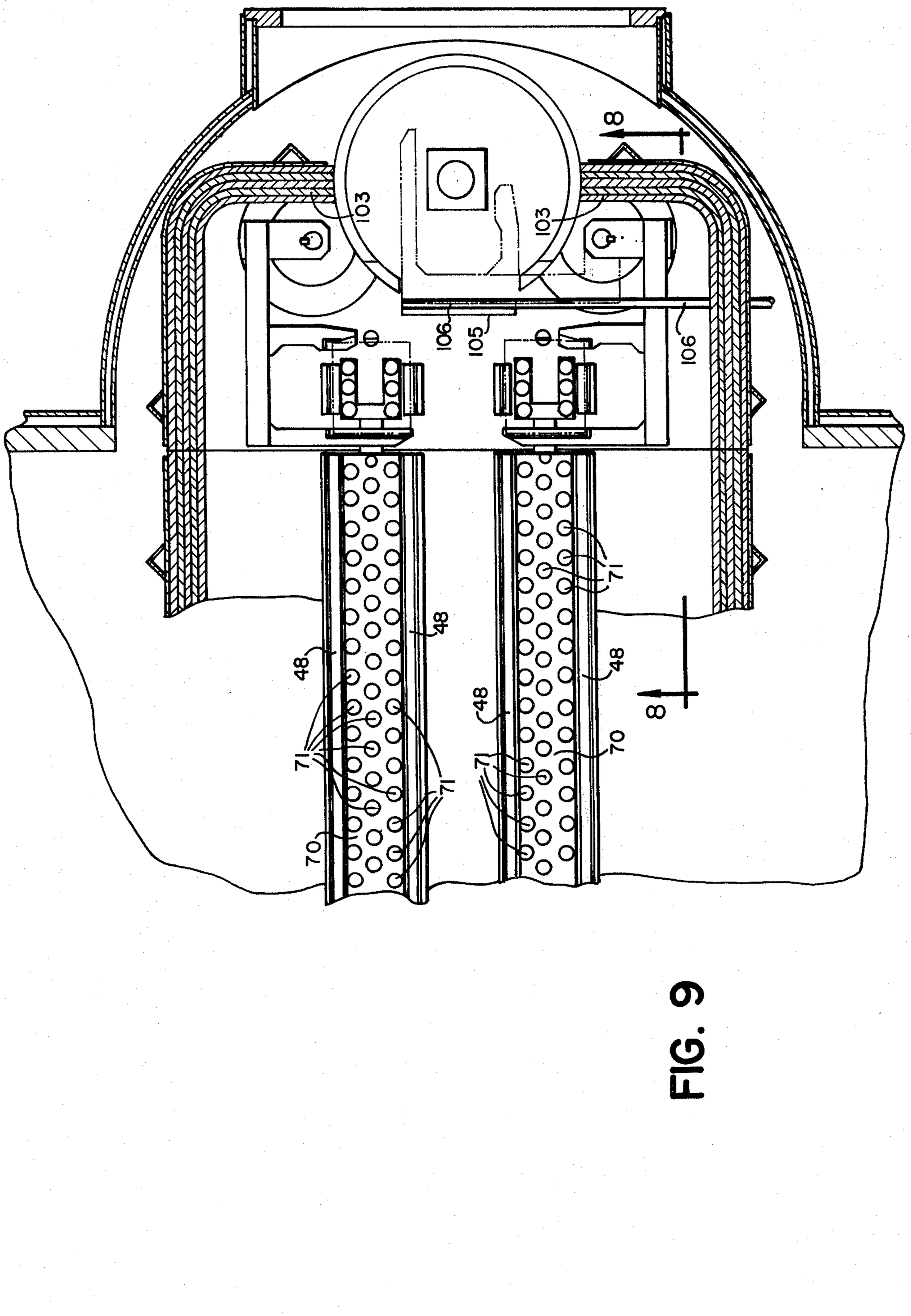

FIG. 9

VACUUM ELECTRIC FURNACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to vacuum electric furnaces and more particularly to apparatus for advancing the work pieces in the furnace.

2. Description of the Prior Art

Various provisions have heretofore been made for advancing work pieces within a vacuum electric furnace.

It has heretofore been proposed, for use in furnaces, to employ conveying apparatus of the walking beam type having the beams thereof exposed within the furnace made of refractory material and with provisions for cooling. The structures heretofore provided for that purpose were, however, unsuited for vacuum electric furnaces operating at temperatures in excess of 2200° F. and were not adequately resistant if such temperatures were employed and were subject to dimensional instability. An example of such walking beams is illustrated at pages 270 to 273, inclusive, of Industrial Furnaces, 4th Edition, Vol II, by W. Trinks and M. H. Mawhinney, published 1967, by John Wiley and Sons, Inc., New York, N.Y.

The work pieces may be in a hostile environment with temperatures at levels at which most metals, other than refractory metals, are unstable thereby rendering the work piece advancing structure dimensionally unstable.

SUMMARY OF THE INVENTION

In accordance with the invention, apparatus is provided for use in vacuum electric furnaces having a hostile environment for advancing work pieces in the furnace and more specifically a walking beam construction in which the exposed parts are of a material such as graphite or graphite with molybdenum buttons which withstand the hostile environment, have dimensional stability and which prevent interaction between the work piece and the graphite, the remaining parts of the walking beam within the furnace being shielded from the hot zones with liquid cooling of the primary supporting structure.

It is the principal object of the invention to provide conveying or advancing apparatus for use in a vacuum electric furnace having a hostile environment therein and which is resistant to the hostile environment with freedom from interaction between the work pieces and conveying apparatus.

It is a further object of the invention to provide, in apparatus of the character aforesaid, for protective features to avoid rapid disintegration of the conveying apparatus.

It is a further object of the invention to provide, in apparatus of the character aforesaid, high temperature resistant components exposed in the furnace, and for shielding and protecting less resistant portions of the apparatus.

It is a further object of the invention to provide, in apparatus of the character aforesaid, for simple but effective cooling of portions of the equipment which are not resistant to the high temperatures in the furnace.

It is a further object of the invention to provide, in apparatus of the character aforesaid, a controlled step by step advance of the work pieces so that their location within the furnace will be known.

Other objects and advantageous features of the invention will be apparent from the description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The nature and characteristic features of the invention will be more readily understood from the following description taken in connection with the accompanying drawings forming part hereof in which:

FIG. 1 is a view in side elevation of a furnace with advancing apparatus in accordance with the invention;

FIG. 2 is an end elevational view of the furnace of FIG. 1 as seen from the left;

FIG. 3 is an end elevational view of the furnace of FIG. 1 as seen from the right;

FIG. 4 is a fragmentary transverse vertical sectional view, enlarged, taken approximately on the line 4—4 of FIG. 1;

FIG. 5 is a fragmentary vertical sectional view, enlarged, taken approximately on the line 5—5 of FIG. 1;

FIG. 6 is a fragmentary longitudinal, sectional view taken approximately on the line 6—6 of FIG. 4 with parts being broken away to show details of construction;

FIG. 7 is a fragmentary horizontal sectional view taken approximately on the line 7—7 of FIG. 1 but with the furnace wall omitted;

FIG. 8 is a fragmentary vertical sectional view taken approximately on the line 8—8 of FIG. 9;

FIG. 9 is a fragmentary horizontal sectional view, enlarged, taken approximately on the line 9—9 of FIG. 1;

It should, of course, be understood that the description and drawings herein are illustrative merely and that various modifications and changes can be made in the structure disclosed without departing from the spirit of the invention.

Like numerals refer to like parts throughout the several views.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now more particularly to the drawings a furnace 15 is shown having an outer water jacketed tank 16 with a cooling liquid inlet connection at 17 and a liquid discharge connection at 18, communicating with a cooling liquid circulating space 19.

The tank 16 has an end flange 20 for connection of suitable loading or charging mechanism 21 not shown in detail but which can be that shown in our companion application Ser. No. 955,601, filed Oct. 26, 1978.

The tank 16 has an end flange 22 for connection of a flange 23 of unloading mechanism 24 for the work pieces. The unloading mechanism 24 is preferably supported on wheels 25 for removal, upon disconnecting of the flange 23 from the flange 22 for access to the interior of the furnace 15 for inspection and maintainance.

Heating elements shown generally at E in FIG. 8 are provided throughout the heated zone.

Within the furnace 15, a plurality of upright posts 28 are provided, extending upwardly from the tank 16 which on one side support longitudinally extending support plates 29 and which on the other side have inverted V-shaped rails 30.

A stationary frame 32, as shown in FIG. 5, is provided having hollow elongated longitudinal box beams 33 with hollow cross beams 34 with their interiors in

communication with the interiors of the beams **33** for cooling liquid circulation. Cooling liquid for this purpose is supplied through an inlet connection **36** and discharged through a delivery connection **37**, flexible detachable connector hoses **38** and **39** being utilized.

The frame **32** is supported at each end on wheels **40** on the tracks **29** and **30** to permit retraction of the frame **32** for inspection and maintenance if desired.

The frame **32** supports the insulation frame which carries a plurality of layers of furnace insulation **46** with spaced stationary longitudinally extending work piece supports **48** having transverse connectors **49** at spaced intervals therealong. The work piece supports **48** and connectors **49** can be of any suitable material which is resistant to the temperatures encountered in the furnace, and has high temperature stability, graphite and high temperature ceramics being suitable materials.

The connectors **49** are supported on pins **49***a* extending upwardly from the stationary frame **32** through openings **46***a* in the insulation **46**.

Between and below the longitudinal side box beams **33**, and on each side, movable frame **50** is provided having longitudinal hollow side box beams **51** and hollow cross beams **52** with their interiors in communication with the interiors of the beams **51** for cooling liquid circulation. Cooling liquid for this purpose is supplied through a supply hose **53** and discharged through a return hose **54**.

The movable frame **50** has a plurality of supporting pins **60**, preferably of graphite, extending upwardly therefrom and with surrounding sleeves **61**, preferably also of graphite extending upwardly through elongated slots **62** in the insulation **46**. The sleeves **61** have washers **63**, preferably also of graphite, at their upper ends with the pins **60** extending thereabove. The pins **60** extend through an opening **64** in a longitudinally reciprocable shield **65** of fibrous graphite insulation. The shield **65** has an elongated slot **66** for movement relative to the support pins **49***a*.

The pins **60**, at their lower ends, are carried in steel sockets **67** carried on the frame **50**.

The pins **60**, at their upper ends extend into sockets **68**, preferably of graphite, connected to elongated platforms **70**, preferably of graphite or high temperature ceramics, which have on their upper faces a plurality of molybdenum buttons **71** for engagement with the work pieces. The platforms **70** are of such length as to reduce the cumulative effect of thermal expansion.

In order to move the platforms **70** in a path to advance the work along the fixed supports **48**, the platforms **70** are moved in a path which is preferably substantially rectangular with an upward movement for elevation of the platforms **70** above the supports **48**, a forward movement in an elevated position, a downward movement for retraction of the platforms **70** below the supports **48**, and a return movement in a lowered position for repetition of the movements just referred to.

For this purpose, a pressure fluid cylinder **75** is provided, pivotally carried on a bracket **76** on the exterior of the tank **16** with a piston (not shown) operating a piston rod **77** to actuate a rocker arm **78** which is connected to a shaft **79** extending through a seal **80**.

The shaft **79** has a rocker arm **82** secured thereto for moving an actuator roller **83** which engages in a vertical slot **84** in brackets **85** secured to beams **52** for horizontal movement of the frame **50** and the platforms **70** carried thereby.

For this purpose, also, a pressure fluid cylinder **88** is provided, pivotally carried on a bracket **89** on the exterior of the tank **16** with a piston (not shown) operating a piston rod **90** pivotally connected to a rocker arm **91**. The rocker arm **91** is connected by a rod **92** pivotally connected thereto and to a rocker arm **93**. The rocker arms **91** and **93** are connected to shafts **94** extending through seals **95**.

Each shaft **94** has a rocker arm **96** secured thereto for moving an actuating roller **97** which engages a horizontal plate **98** on the undersides of the beams **51** for an elevating action and which can engage a lower horizontal plate **99** for positive draw down if required and thereby effect vertical movement of the frame **50** and the platforms **70** carried thereby. The combined action of the rollers **83** and **97** provides the desired cyclic movement of the platforms **70** in the path previously described.

In spaced relation above the supports **48**, insulation **100**, similar to the insulation **46** may be provided.

The unloading apparatus **24** which receives the work pieces advanced along the supports **48** forms no part of the present invention but to reduce the internal circulation and undesired heat transfer within the tank **16** may include lower insulation **101**, aligned with the insulation **46**, upper insulation **102**, aligned with the insulation **100**, and vertical end insulation **103**. Within the space enclosed by the insulation **101**, **102**, **103** a radiation blocking door **105** pivotally carried by a shaft **106** may be provided. The shaft **106** extends through a seal **107** for actuation by an arm **108** having a piston rod **109** connected thereto from a piston (not shown) in a cylinder **110** pivotally mounted on a bracket **111** on the flange **23**.

The mode of operation will now be pointed out.

Work pieces introduced by the charging mechanism **21** are supported by the work piece supports **48**.

Actuation of the piston rod **90** by application of fluid pressure in the cylinder **88** is effective through the shafts **94**, to the rocker arms **96** and the engagement of the actuating rollers **97** on the plates **98** to raise the movable frame **50** and the platform **70** to raise work pieces from the longitudinal supports **48** and while so raised actuation of the piston rod **77** is effective through the rocker arm **78**, shaft **79**, rocker arm **82** and actuating roller **83** in the slot **84** to move the elevated platform to advance the work pieces to a new location above the supports **48**. At the end of the horizontal advance, the platform **70** is lowered by the release of pressure fluid from the cylinder **88** which is effective on the shaft **94**, the rocker arm **96** and the actuating roller **97**, and the lower plate **99**.

When the platform **70** reaches its lower position it is returned to its original position, ready for elevation as desired, by the action of the cylinder **75**, through the piston rod **77**, rocker arm **78**, shaft **79**, rocker arm **82** and roller **83** in the slot **84**.

When the furnace is in use cooling of the stationary frame **32** and the movable frame **50** is effected as previously pointed out. Overheating of the frames **50** and **32** is prevented in part by the shielding action of the insulation **46** and further prevented by the shielding action of the shield **65** which by its movement cuts off line of sight transmission of radiant heat through slots **62**.

The parts of the advancing mechanism above and immediately below the insulation **46** and the shield **65**, including the longitudinal work supports **48** and the supporting structure therefor, including the pins **49***a*,

and the connectors **49** are of materials which are not affected adversely by the very high temperatures in the furnace.

The platforms **70**, and their supporting structure above and immediately below the platforms **70** including the pins **60**, the sleeves **61**, the washers **63** and the sockets **68** are also of materials which are not adversely affected by the high temperatures in the furnace.

The sleeves **61** may also be easily replaced if desired.

The use of the molybdenum buttons **71** on the top of the platforms **70** and in supporting relation to the work pieces also prevents any interaction between the work pieces and the graphite of the platforms **70**.

We claim:

1. Apparatus for the support of work pieces in a vacuum electric furnace which comprises, within the furnace tank:

heating elements within the upper part of said tank to provide a heated zone,

fixedly mounted spaced parallel work supporting rails of a material resistant to the temperatures in said heated zone,

a stationary frame disposed below said rails,

supporting members for said rails extending upwardly from said stationary frame,

shielding members interposed between said rails and said stationary frame for preventing radiant heat transmission from said heated zone to said stationary frame,

means for cooling said stationary frame,

means for advancing work pieces along said rails,

said last means comprising

work piece supports movable to positions above and below said rails and longitudinally with respect thereto for elevating work pieces above said rails for advancing movement with respect to said rails, and

a second frame movable with respect to said stationary frame for positioning said work piece supports and having supporting pins for said work piece supports extending upwardly therefrom,

said shielding members preventing radiant heat transfer to said movable frame,

said shielding members include a fixed shield through which supporting members extend, and

a movable shield having openings therethrough for said supporting members,

said fixed shield being in shielding relation to said openings, and

means for cooling said movable frame.

2. Apparatus as defined in claim **1** in which

said shielding members include a fixed shield having openings therethrough for supporting pins interposed between said movable frame and said movable work piece supports, and

a movable shield in shielding relation to said openings.

3. Apparatus as defined in claim **1** in which

said interposed supporting pins are of a material resistant to the temperature of the heated zone of the furnace.

4. Apparatus as defined in claim **3** in which

said interposed supporting pins have sleeves in surrounding relation thereto,

said sleeves have washers supported thereby, and

one of said shielding members is supported by one of said washers.

5. Apparatus as defined in claim **1** in which said work supporting rails are of graphite.

6. Apparatus as defined in claim **1** in which said movable work piece supports are of graphite.

7. Apparatus as defined in claim **5** in which said movable work piece supports comprise platforms with inserts on their upper faces for work piece contact.

8. Apparatus as defined in claim **6** in which said inserts are of molybdenum.

9. Apparatus as defined in claim **1** in which

said stationary frame is supported on longitudinal supporting rails for retraction along said rails.

10. Apparatus as defined in claim **1** in which

one of said shielding members is a fixed shield and another of said shielding members is a movable shield, and

said movable shield is of fibrous graphite insulation.

11. Apparatus as defined in claim **10** in which

said movable shield is supported for movement with said movable frame.

12. Apparatus as defined in claim **1** in which

actuating members are provided for said movable frame for elevating said frame, advancing the elevated frame, lowering the frame, and returning the frame to its initial position.

13. Apparatus as defined in claim **1** in which

actuating members are provided for elevating said movable work piece supports above said rails, advancing said elevated supports along the rails, lowering said supports below said rails, and returning said supports to their initial positions below said rails.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 4,212,633 Dated July 15, 1980

Inventor(s) Benjamin A. Kreider and William J. Metalsky

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6,

Line 4, after "for" insert - said - .

Signed and Sealed this

Seventh Day of *October 1980*

[SEAL]

Attest:

Attesting Officer

SIDNEY A. DIAMOND

Commissioner of Patents and Trademarks