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Krieder et al.

[11] **3,879,165**

[45] **Apr. 22, 1975**

[54] **VACUUM ELECTRIC FURNACES**

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[52] **U.S. Cl.** **432/121;** 13/31; 432/204

[51] **Int. Cl.** **F27b 9/14**

[58] **Field of Search** 432/121, 203, 205, 204; 13/31

[56] **References Cited**

UNITED STATES PATENTS

1,112,454	10/1914	Joseph	432/203
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[57] **ABSTRACT**

A vacuum electric furnace is described having interiorly disposed structure for supporting and advancing work pieces within the furnace including track rails and their supports and carriers supported by and pendant from the track rails with freedom from adverse effects due to thermal expansion and contraction over wide temperature differential, the drive for the carriers and the carriers avoiding undesired stressing attendant upon temperature changes, the rails and the carriers being disposed within the hot zone of the furnace to prevent collection thereon of contaminants.

14 Claims, 10 Drawing Figures

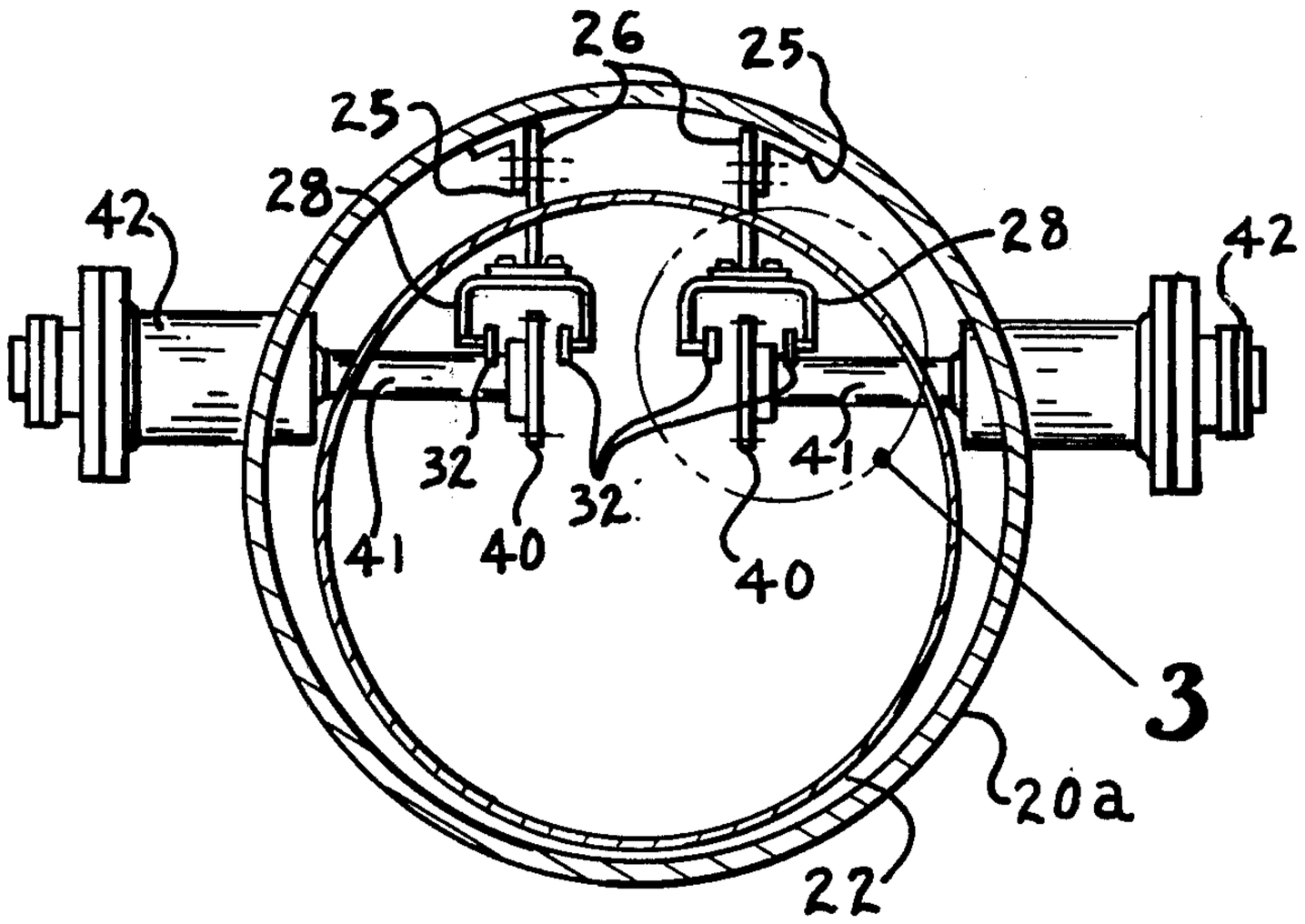


Fig. 2.

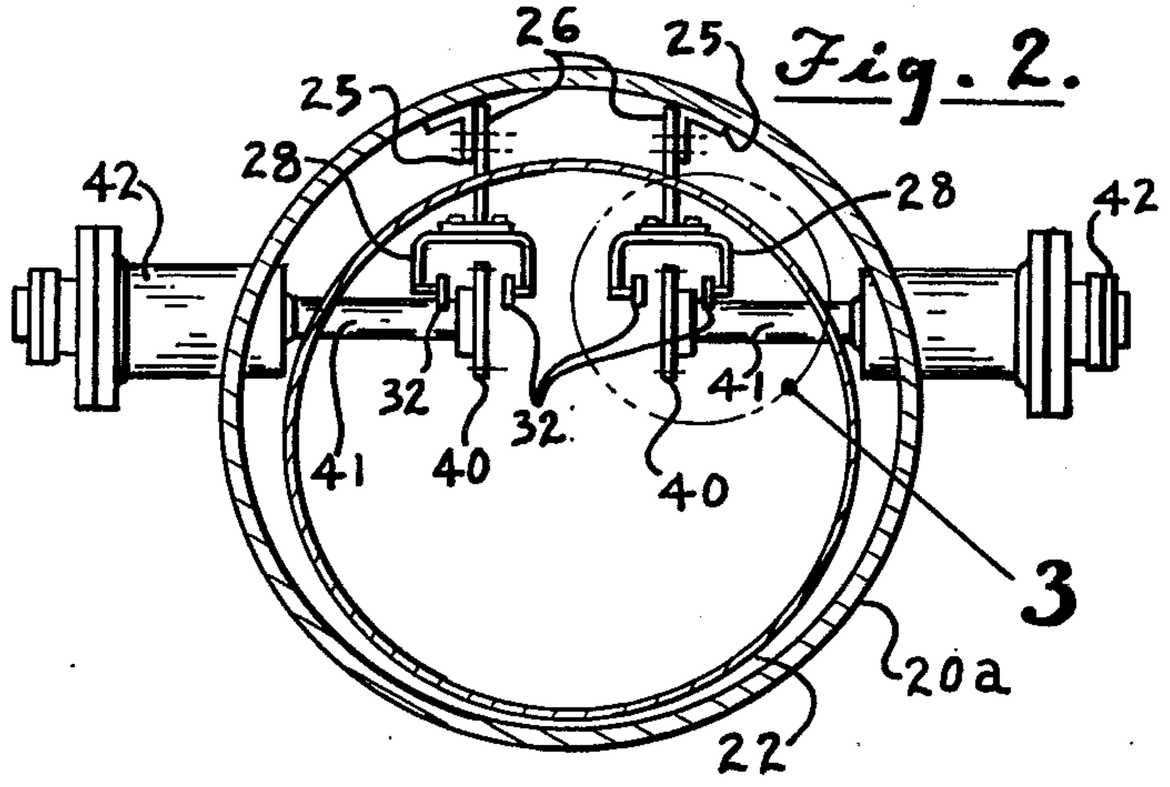


Fig. 3.

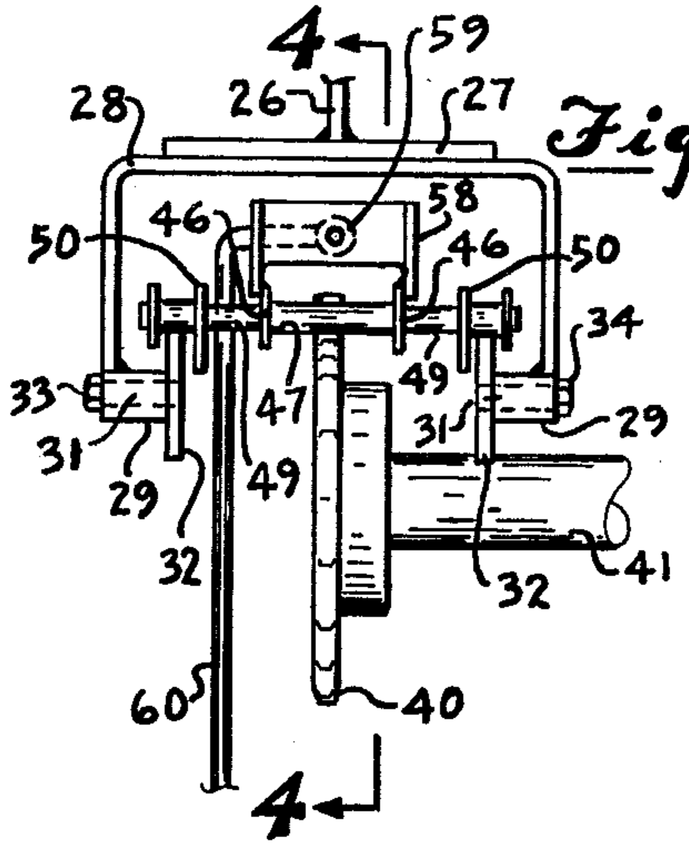
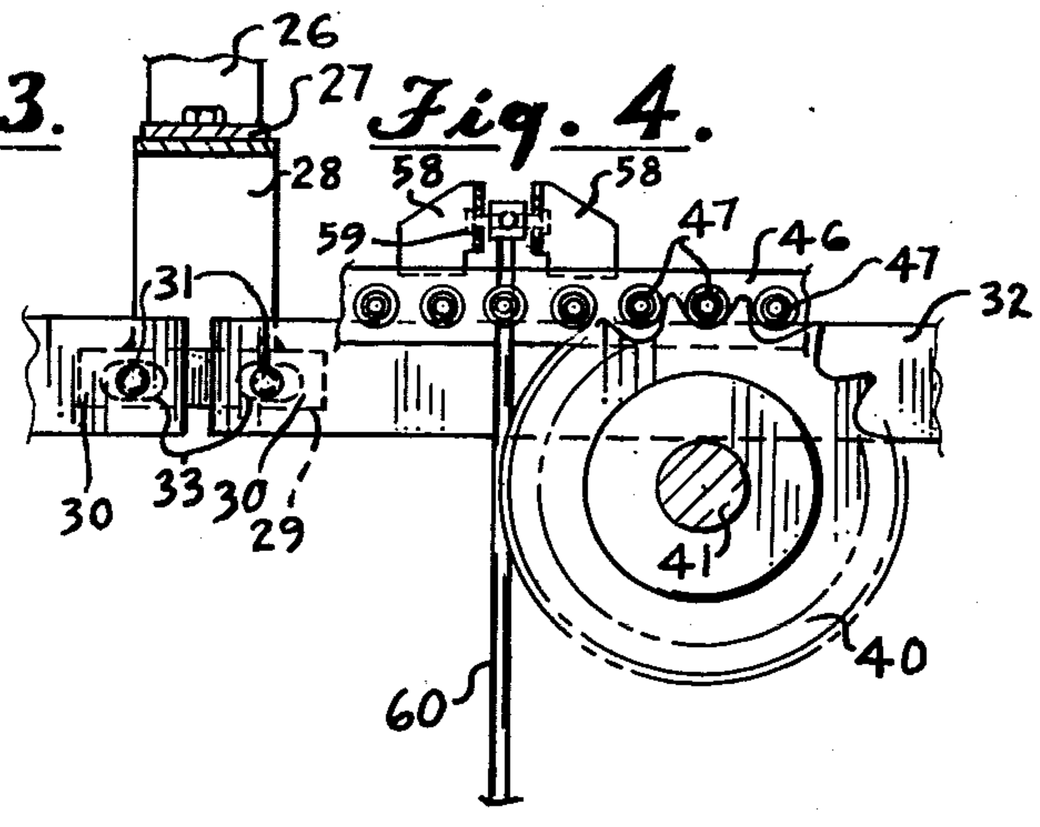


Fig. 4.



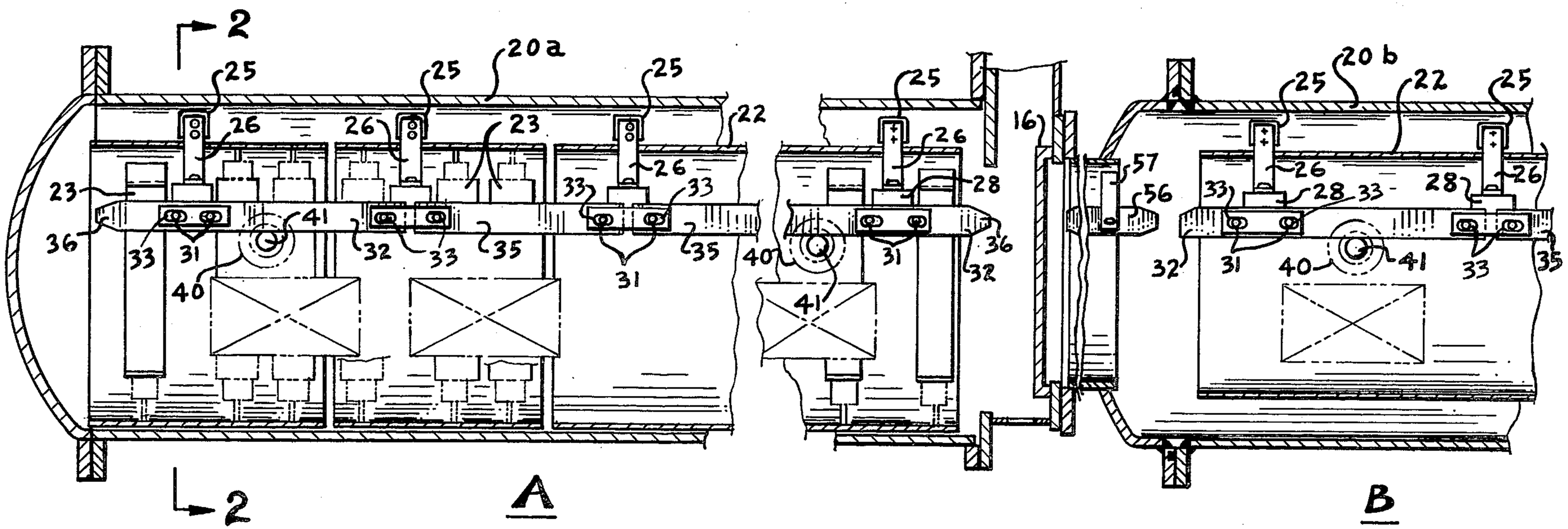


Fig. 1A

Fig. 5.

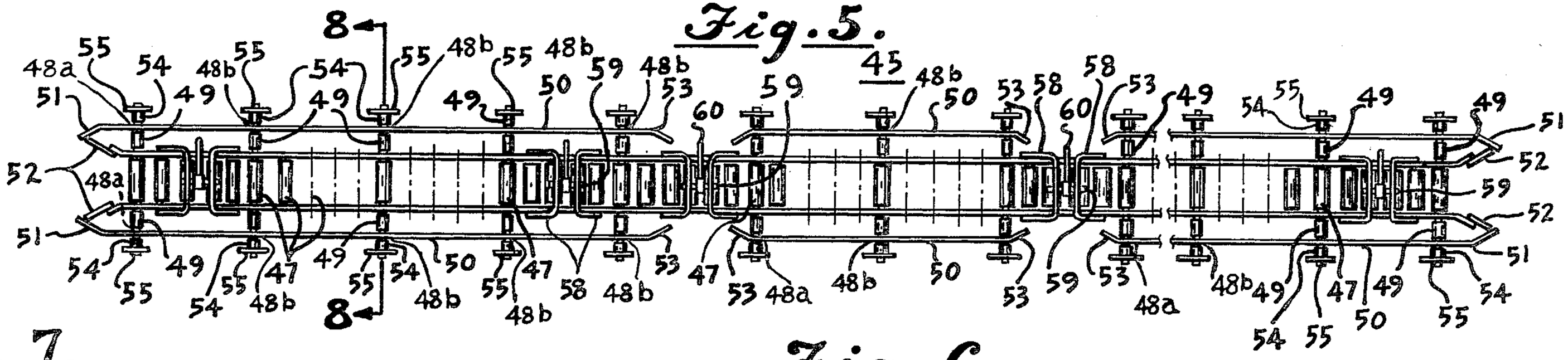


Fig. 7.

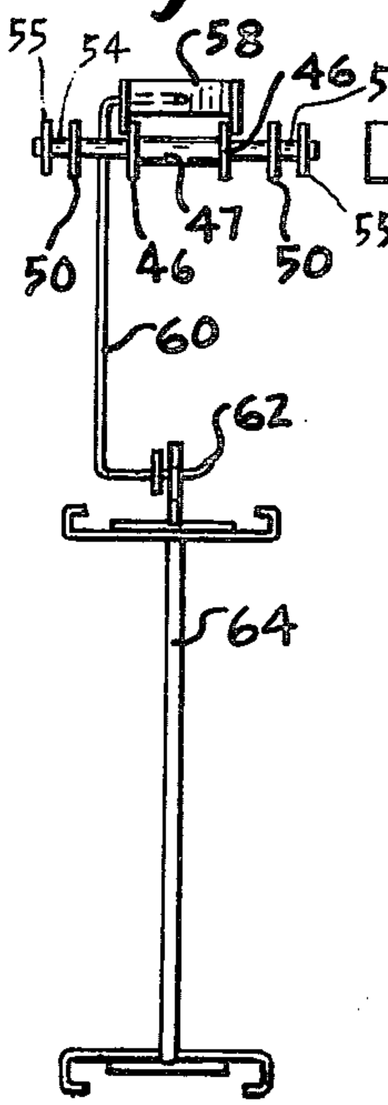


Fig. 6.

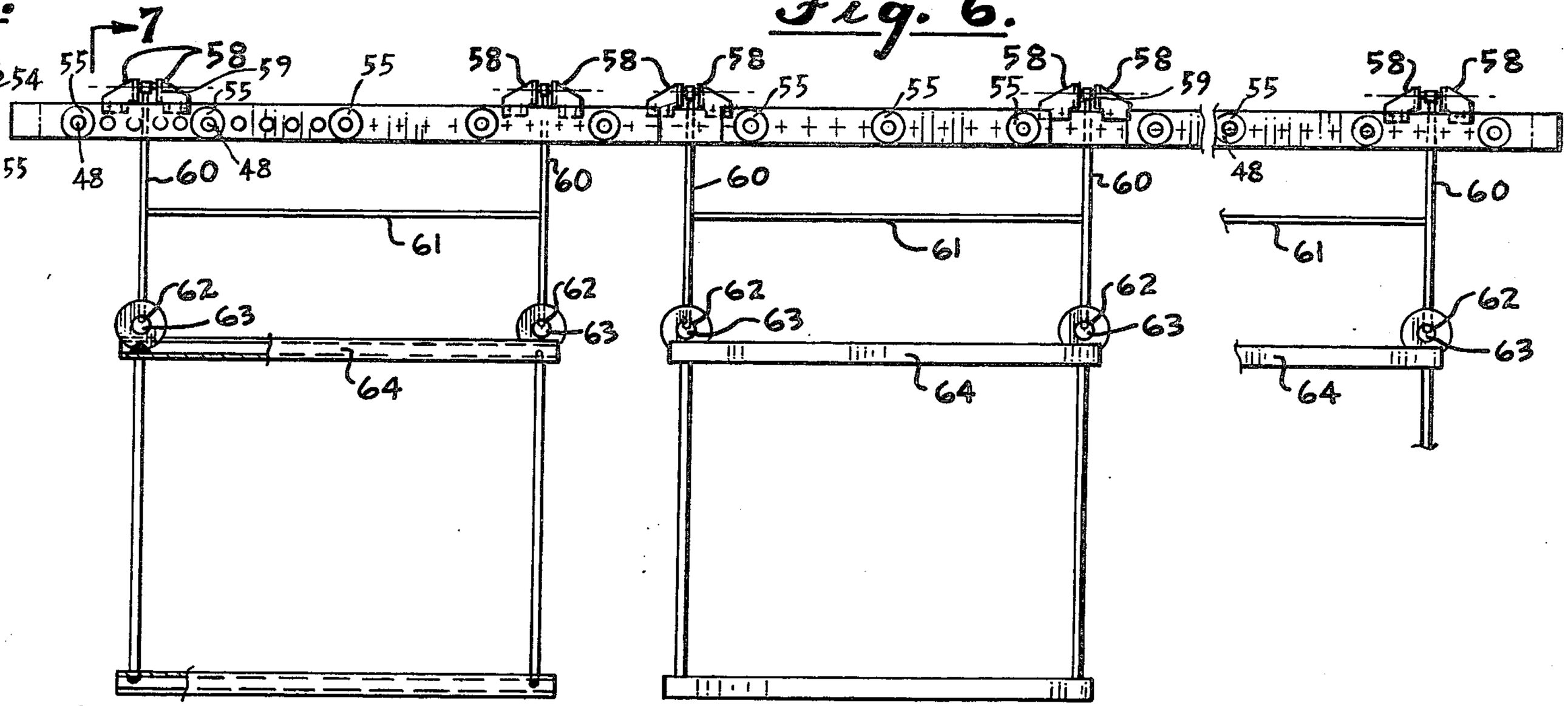


Fig. 9.

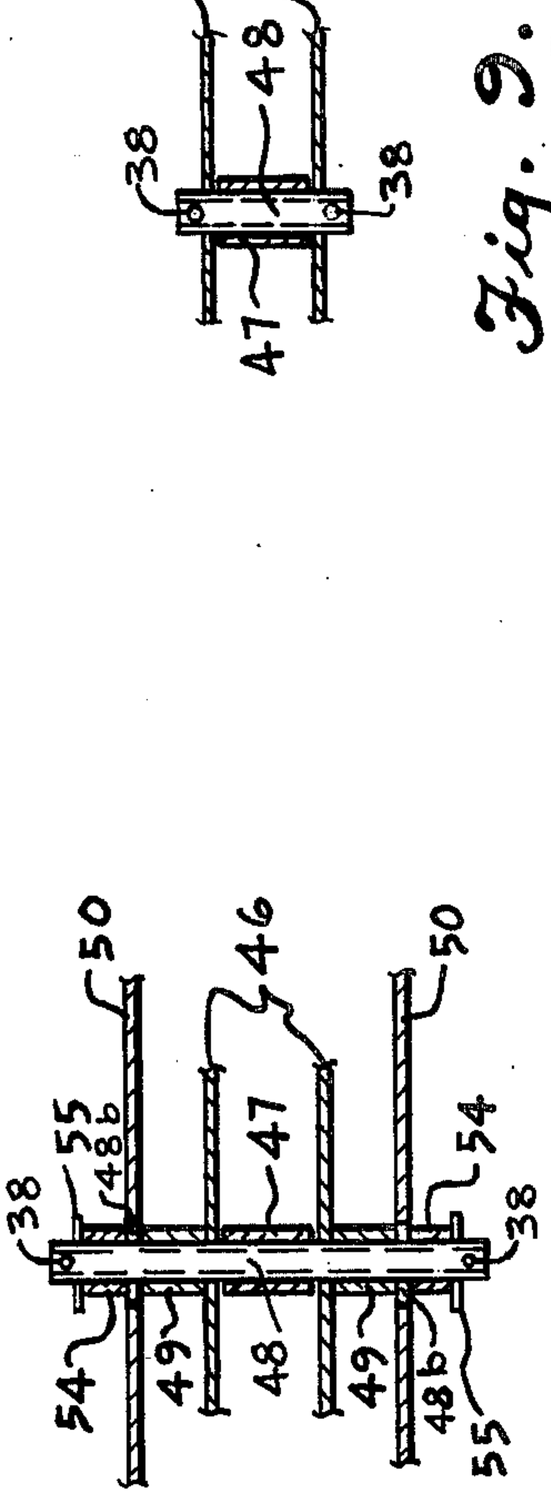


Fig. 8.

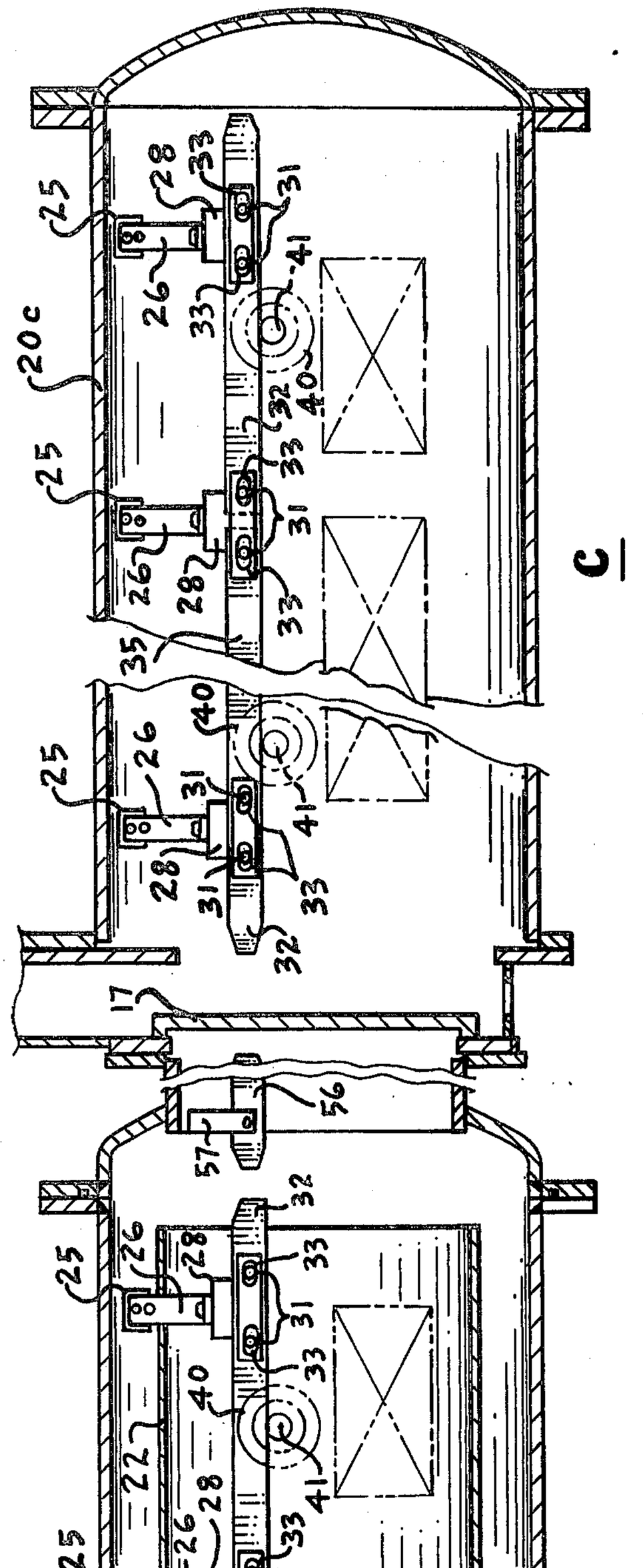


Fig. 1B.

VACUUM ELECTRIC FURNACES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to vacuum electric furnaces having a plurality of aligned treating zones and more particularly to apparatus for moving work pieces through the furnace and supporting the work pieces in the furnace during their stay in the respective treating zones.

2. Brief Description of the Prior Art

Furnaces have heretofore been proposed in which a plurality of treating zones are provided, closed at their outer ends by doors and with movable interior doors for separating and isolating the different zones.

The U.S. Pat. to Kugel, No. 802,517 shows a furnace in which the work pieces are carried on wheeled trucks which are advanced within the furnace in any desired manner such as by pushing the trucks.

Borner, U.S. Pat. Nos. 3,583,690 and 3,625,496 and Austin, et al, British Pat. No. 565,104, refer to the use of cars for carrying the work pieces within a furnace. The trucks and their trackways occupy an excessive space within the interior, do not permit of utilizing heating elements over substantially the entire interior, and can be contaminated and coated, particularly if employed in vacuum furnace operation.

It has also been proposed as in the U.S. Pat. to Wingate, No. 2,776,134, Sylvester, No. 1,868,856 and Bielefeldt, No. 3,410,547 to employ rollers for supporting the workpieces, directly or in trays. These structures have similar shortcomings to those in which trucks, as heretofore referred to, are employed.

It has also been proposed to employ endless chains to advance the work pieces as in the U.S. Pat. to Kochendorfer, No. 1,252,813, but this structure is totally unsuited for use in vacuum furnaces.

Miskella, in U.S. Pat. No. 2,841,684, shows overhead trackways for movable heating elements but the furnace is at atmospheric pressure and the overhead driving mechanism is at the same pressure. This structure would be totally unsuited for vacuum furnaces.

Oetjen, et al., U.S. Pat. No. 3,192,645, shows a vacuum freeze drying tunnel dryer in which an overhead guide rail is supported for vertical movement. Carriers supported on the guide rail are impelled by an interiorly disposed endless chain with a driving sprocket engaged therewith, the sprocket being driven by an intermittently actuated drive motor which forms part of an electromechanical drive system. If the motor were interiorly disposed it could not successfully function in the high temperature environment of a vacuum electric furnace. The endless chain also would not function satisfactorily in such an environment.

Bielefeldt, in U.S. Pat. No. 3,609,295, shows a vacuum electric furnace in which carriers of open ractangular frames are provided for the work pieces. Each carrier is carried on a narrow bar having transverse horizontal axles with small rollers at their ends. Horizontal flanges projecting inwardly from the sides of the vessels provide tracks for the small rollers. The bars are driven by dogs on an endless chain within the vessel, the chain being driven by an exteriorly disposed motor through gearing. The supporting and driving structure is complicated, not adequately leakproof as illustrated either with respect to heat leakage and/or air leakage

and would be particularly likely to be affected by the process.

The structures heretofore available for moving work pieces within a vacuum furnace have various shortcomings, do not make adequate provision to accommodate the growth of both the supporting rails and carrier occasioned by the high temperature differential between operating temperatures and shut down or entrance and exit of work pieces in a vacuum electric furnace, and can be adversely affected by deposition of metal during furnace operation.

SUMMARY OF THE INVENTION

In accordance with the invention improved apparatus is provided in a vacuum electric furnace for supporting and advancing the work pieces within the furnace including track rails and their supports, and carriers supported by and pendant from the track rails with freedom from adverse effects due to thermal expansion and contraction over wide temperature differential, the drive for the carriers and the carriers avoiding undesired stressing of the carriers attendant on temperature changes, the rails and the carriers being disposed within the hot zone of the furnace to prevent collection thereon of contaminants.

It is the principal object of the invention to provide improved structure for supporting and moving work pieces into and along a vacuum electric furnace, with retention as desired for processing.

It is a further object of the invention to provide improved structure for processing work pieces within a vacuum electric furnace but which is not limited to such use.

It is a further object of the invention to provide supporting and impelling apparatus for work pieces in a vacuum electric furnace which is subjected to a minimum of likelihood of deposit of contaminants.

It is a further object of the invention to provide supporting and impelling apparatus which comprises tracks and their supports and carriers supported by and intermittently driven along the tracks which function in the heated zones of the furnace and are particularly suited for operation in that environment.

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:

FIGS. 1A and 1B together show a vertical longitudinal sectional view through a vacuum electric furnace in accordance with the invention;

FIG. 2 is a transverse sectional view taken approximately on the line 2—2 of FIG. 1;

FIG. 3 is an enlarged sectional view taken at the location 3 of FIG. 2;

FIG. 4 is a fragmentary longitudinal sectional view taken approximately on the line 4—4 of FIG. 3;

FIG. 5 is a fragmentary plan view of the carrier;

FIG. 6 is a fragmentary side elevational view of the carrier shown in FIG. 5;

FIG. 7 is a transverse sectional view taken approximately on the line 7—7 of FIG. 6;

FIG. 8 is a sectional view, enlarged, taken approximately on the line 8—8 of FIG. 5; and

FIG. 9 is a sectional view, enlarged, taken approximately on the line 9—9 of FIG. 5.

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 THE PREFERRED EMBODIMENT

Referring now more particularly to the drawings, a vacuum electric furnace is there illustrated which includes a plurality of aligned vessels constituting a preheating section A, a treating section B and a cooling section C. An entrance door **15** is provided supported in any desired manner for movement to an open position for access to the interior of the section A. The entrance door **15** in closed position seals the interior of the furnace against fluid or vacuum leakage.

An isolating valve **16** is interposed between the furnace sections A and B to prevent fluid or vacuum leakage and heat leakage therebetween when in closed position. An isolating gate or valve **17** is interposed between the sections B and C to prevent fluid leakage and heat leakage therebetween when in closed position.

An exit door **18** similar to the door **15** is provided at the outlet end of the section C for sealing against fluid or vacuum leakage when in closed position and for access for removal of work pieces and their carriers, as hereinafter explained.

The furnace sections A, B and C, preferably each consists of a metallic cylindrical wall **20***a*, **20***b* and **20***c* of vacuum-tight construction.

The furnace is provided with suitable provisions for evacuation and for the supply and removal of cooling fluid such as inert gas, but as suitable structure for this purpose is well known a detailed description is not believed to be necessary.

Within the interior of the cylindrical walls **20***a* and **20***b* of each of the furnace sections A and B a reflective shield **22** is provided to reduce the reflection towards the exterior of radiant heat from the heating elements to be described.

The furnace section A, interiorly of the shield **22,** is preferably provided with resistance heating elements **23** of any desired type. The heating elements **23** of any desired type. The heating elements **23** can be like those disclosed in the U.S. application of Cyrway, et al., Ser. No. 376,538, filed July 5, 1973, now U.S. Pat. No. 3,812,276, issued May 21, 1974 or those described in Kreider, et al, U.S. Pat. No. 3,737,553 or of any other suitable type.

The furnace section A, in the interior thereof, and supported by the furnace wall **20***a* has a plurality of transversely spaced pairs of brackets **25** secured thereto from which, on each side, supporting arms **26,** extending through the shield **22** and between the heating elements **23,** depend. Each of the arms **26** has a transverse strip **27** which supports a C-shaped frame **28** with inwardly extending spaced socket plates **29** having spaced sockets **30** through which studs **31** extend. The studs **21** extend through horizontally elongated slots **33** in end track rails **32** and are held against inward displacement by nuts **34** which are not however tightened to the extent to impose any restraint on expansion or contraction.

Intermediate track rails **35** are also provided mounted and supported in the same manner as the end track rails **32.** The rails **32** and **35** are of any suitable metallic material.

The supports thus provided for the rails **32** and **35** accommodate the growth in length of the track rails **32** and **35** upon increase in temperature attendant upon the heating thereof over the wide range of temperatures which occur within the furnace section A from ambient temperature at shut down to operating temperature for heating, as well as the shrinkage thereof upon cooling.

The rails **32** at their terminal ends **36** in the furnace section A, at the entrance and exit of the furnace section A, are preferably relieved to guide the carriers as hereinafter explained.

In order to operate the carriers hereinafter to be described a plurality of operating sprockets **40** on shafts **41** are provided preferably with mounting mechanism **42** activated from outside the furnace section A, two being utilized on each side in a specific embodiment of furnace section A.

The sprockets **40** can be actuated in any desired manner but a suitable drive is shown and described in the U.S. application of Kreider, et al., filed Dec. 3, 1973, Ser. No. 420,796, now U.S. Pat. No. 3,847,539, issued Nov. 12, 1974.

The furnace section B is preferably provided in the manner previously described, and on each side, with brackets **25,** supporting arms **26,** frames **27** with socket plates **29,** end track rails **32** and intermediate track rails **35** disposed within the shield **22** and heating elements **23,** each of the track rails **32** and **35** having elongated slots **33** through which studs **31** extend to permit longitudinal track rail growth as previously described.

The furnace section B is preferably provided with a plurality of driving sprockets **40,** three sets being employed on each side in a specific embodiment of furnace section B.

The furnace section C may have the reflective shields **22** and heating elements **23** omitted, since its function is for cooling but preferably has brackets **25,** supporting arms **26,** frames **27** with socket plates **29,** end track rails **32** and intermediate track rails **35** with elongated slots **33** as previously described.

The furnace section C is preferably provided with a plurality of driving sprockets **40** and their actuating mechanism, two sprockets **40** on each side being employed in a specific embodiment of furnace section C.

Referring now more particularly to FIGS. **5** to **9,** inclusive, the carrier is there shown at **45.**

The carrier **45** preferably includes inner elongated parallel frame bars **46** which are subject to longitudinal expansion and contraction upon increase and decrease of temperature, having a plurality of rollers **47** rotatably carried thereby at spaced locations on shafts **48,** which may be tubes or rods, for engagement of the rollers **47** by the teeth of the sprockets **40** for advancing the carrier **45** as desired. The frame bars **46** can be of any desired length but preferably are such as to be accommodated in single or multiple units within furnace sections.

The carriers **45** (see FIGS. **8** and **9**) preferably have spacer sleeves **49** outwardly of the frame bars **46** with

outer frame bars **50** parallel to the frame bars **46** for substantial portions of their length but interrupted to avoid stress transmission to the bars **46.** The outer frame bars **50** also have inturned end portions **53.** The shafts **48** at predetermined locations are extended outwardly through the frame bars **50** through fixed and elongated openings **48***a* and **48***b* to allow for expansion and contraction and for the reception of track engaging rollers **54** with outer washers **55.** The rollers **54** are supported by the upper edges of the track rails **32** and **35,** the washers **55** being disposed outwardly of the track rails **32** and **35.**

Cotter pins **38** retain the structure carried on the shafts **48** in assembled relation.

Stub track rails **56** supported by brackets **57** secured to the interior of the section B can be provided to bridge the gap at this location between the end track rails **32.**

The frame bars **50** have inturned ends **51** which meet guide bars **52** at the ends of the frame bars **46** to orient the ends of the carriers **45** to aid in alignment of the rollers **54** with the rails **32, 35** and **56** particularly in the transition from one furnace section to the next.

The carriers **45,** at spaced locations, have spaced carrier brackets **58** secured thereto which support, on pivot pins **59,** pendant hanger rods **60.** The rods **60** are connected by stabilizer rods **61** and have hooks **62** at their lower ends to engage in openings **63** of work carrier fixtures **64.**

It will be noted that the carriers **45** are carried on the tops of the track rails **32** and **35,** have the sprockets **40** in engagement therewith from below, are held downwardly only by gravity and are movable upwardly if necessary to accommodate dimensional changes with changes of temperature.

The mode of operation will now be pointed out.

The furnace in operation and with the furnace sections separated by the valves **16** and **17** in closed condition has the first section A heated to preheat the work pieces, the second section B being employed for treating the work pieces, such as by aluminum brazing, and the third section C being utilized for controlled cooling such as with a controlled inert atmosphere.

When it is desired to introduce work pieces the door **15** is opened and carriers **45** in supporting relation to work pieces are advanced so as to be supported with the rollers **54** on the upper edges of the track rails **32** and **35.** The sprockets **40** can be utilized for advancing movement when the carrier **45** has been advanced to a sufficient extent.

Subsequent advancing movement of the carriers **45** into the furnace section B, therefrom into the furnace section C and with delivery from the furnace section C upon opening of the door **18** can also be effected by the engagement of the sprocket **40** with the rollers **47.**

The valves **16** and **17** are controlled as desired to isolate the carriers **45** and their work pieces in the furnace section B.

It will be noted that the carriers **45** with their work pieces are supported on the track rails **32** and **35** and disposed entirely within the heating zone interiorly of the heating elements **23** and the reflective heat insulating shield **22** so that contamination of these parts is avoided.

We claim:

1. In a vacuum electric furnace having an elongated furnace chamber with an interior heat reflective shield and heating elements disposed within the reflective shield, the improvement which comprises

spaced parallel longitudinal track rails within the chamber and interiorly of the heating elements,

members for supporting said longitudinal track rails,

said connecting members between supporting members and said track rails accommodating longitudinal expansion and contraction of said track rails upon changes of temperature within said chamber,

a carrier for work pieces having spaced supporting elements supported by said track rails,

said carrier having a pair of spaced elongated longitudinal frame members of predetermined length less than that of the furnace chamber and drive members carried thereon, and

driving members extending interiorly of said shield in driving engagement with said drive members on said carrier for advancing said carrier within said furnace chamber.

2. The combination defined in claim **1** in which

said connecting members include longitudinally elongated slots.

3. The combination defined in claim **2** in which said slots are in said rails.

4. The combination defined in claim **1** in which

said supporting members have portions connected to the interior of the furnace chamber at upper portions thereof, and

said supporting members have portions extending through said shield.

5. The combination defined in claim **1** in which

said supporting members have portions connected to the interior of the furnace chamber, and

said supporting members have portions extending through said heating elements.

6. The combination defined in claim **1** in which

said supporting members have pendant portions with C-shaped brackets carried thereby, and

said rails are disposed between ends of said brackets.

7. The combination defined in claim **1** in which

said driving members have sprockets disposed between said rails, and

said sprockets engage said carrier from below.

8. The combination defined in claim **1** in which

said carrier comprises spaced parallel side frame members with transverse connecting members for engagement by said driving members.

9. The combination defined in claim **1** in which

said carrier comprises spaced parallel side frame members with track engaging rollers mounted to said side frame members for engagement with top portions of said track rails.

10. The combination defined in claim **9** in which

outer spaced side frame members are provided in spaced relation to said parallel side frame members and outwardly thereof,

said track engaging rollers are disposed outwardly of said outer frame members,

one set of frame members being continuous and the other set of said frame members being interrupted to avoid stress transfer upon temperature change from one set to the other set.

11. The combination defined in claim **1** in which

said carrier comprises spaced parallel side rails,

said side rails have carrier brackets carried thereon, and

work supporting members are carried in pendant relation on said carrier brackets.

12. The combination defined in claim **11** in which said work supporting members are pivotally carried in pendant relation on said carrier brackets.

13. The combination defined in claim **10** in which one set of frame members is loosely mounted with respect to the other set to avoid stress transfer upon temperature change from one set to the other set.

14. In a vacuum electric furnace having at least two aligned elongated chamber sections and isolating gate means for interposition between said chamber sections, and at least one of said chamber sections having an elongated furnace chamber with an interior heat reflective shield and heating elements disposed within the reflective shield, the improvement which comprises

spaced parallel longitudinal track rails within each of the chamber sections and interiorly of the heating elements and of a length less than that of chamber section for accommodating said gate means between the ends of the rails of each chamber section,

said gate means being movable in the space between the ends of said rails for cutting off communication between adjoining chamber sections,

a carrier for work pieces having spaced supporting elements supported by said track rails,

said carrier having a pair of spaced longitudinal frame members of predetermined length less than that of the chamber sections and drive members carried thereon, and

driving members extending interiorly of said shield in driving engagement with said drive members on said carrier for advancing said carrier within each chamber section,

said work carrier in its advancing movement bridging the track rails of adjoining chamber sections.

* * * * *