Aug. 17, 1954

H. A. PAINE

2,686,826

FURNACE STRUCTURE

Filed Dec. 26, 1952

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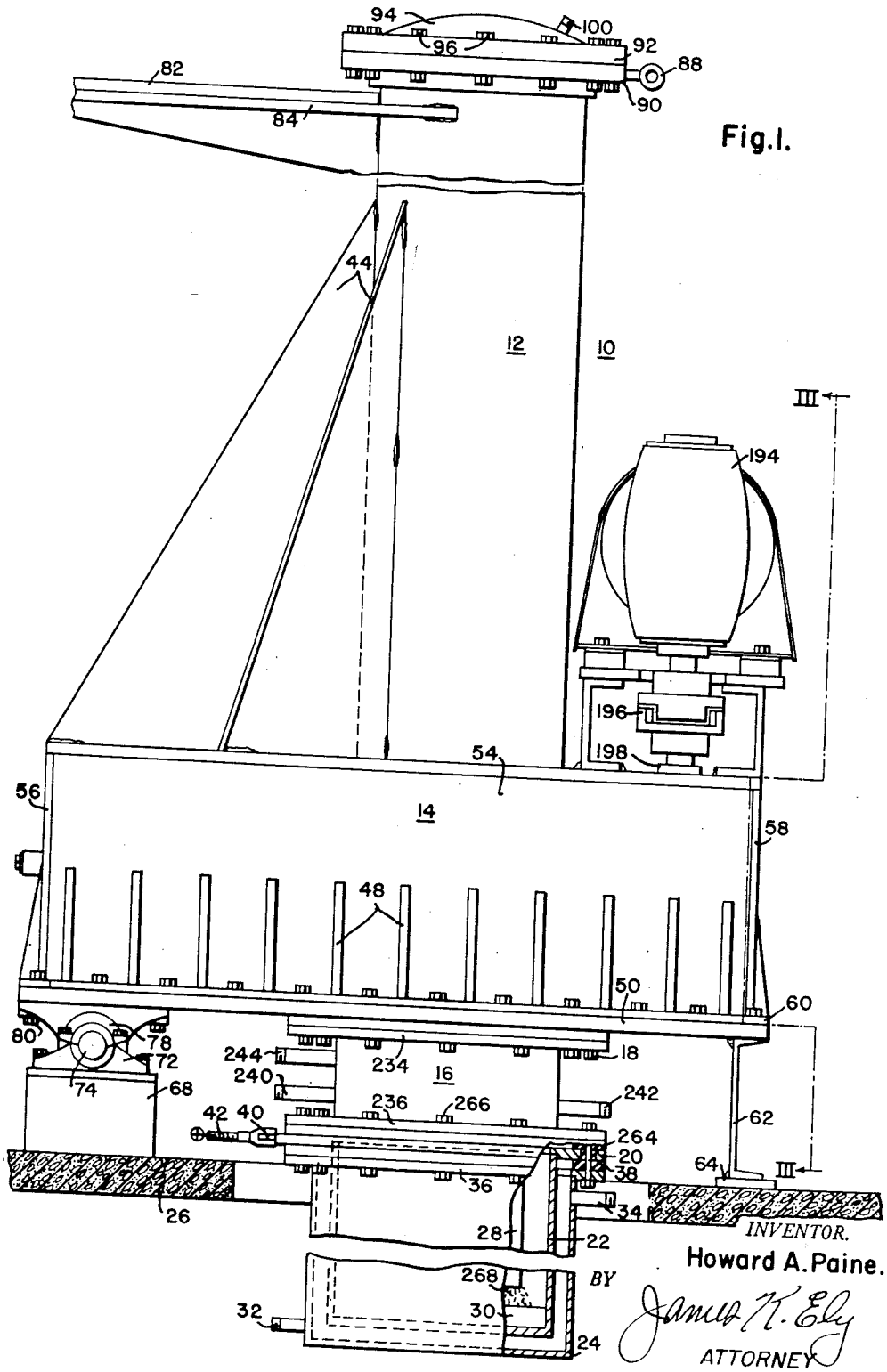


Fig. I.

INVENTOR.

Howard A. Paine.

BY

James N. Ely

ATTORNEY

Aug. 17, 1954

H. A. PAINE

FURNACE STRUCTURE

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7 Sheets-Sheet 2

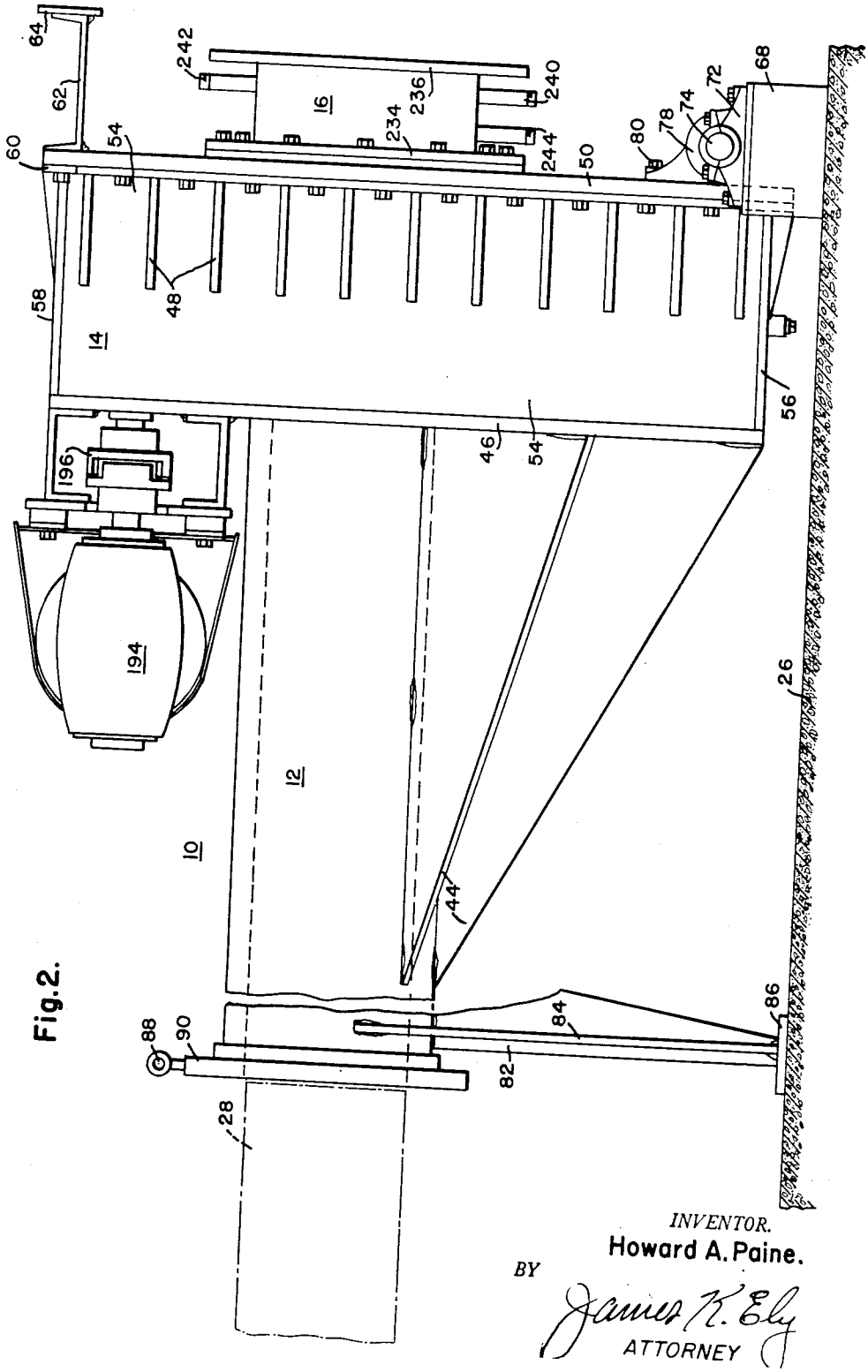


Fig. 2.

INVENTOR.
Howard A. Paine.

BY

James K. Ely

ATTORNEY

Aug. 17, 1954

H. A. PAINE

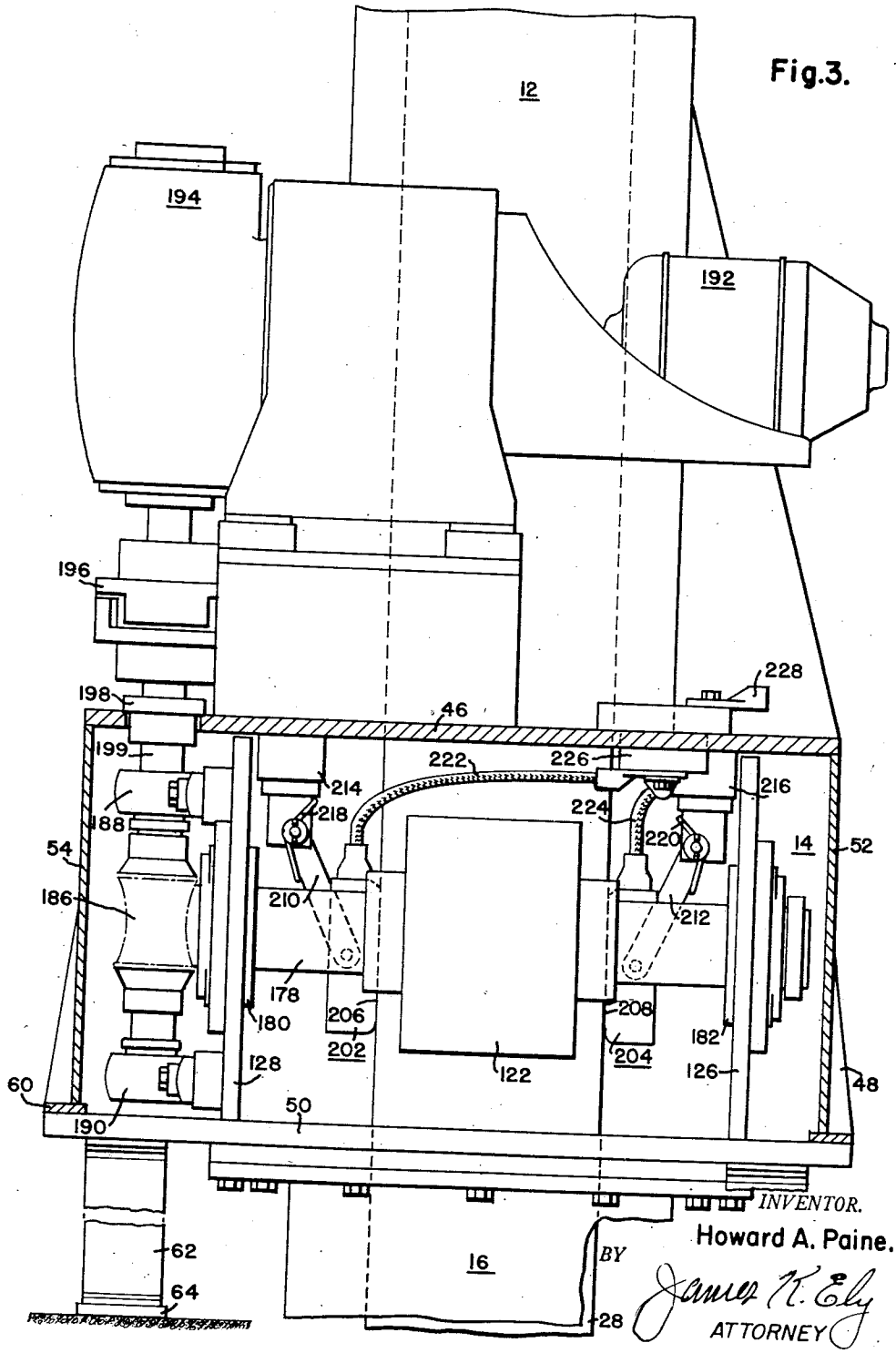
FURNACE STRUCTURE

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Fig.3.



INVENTOR.
Howard A. Paine.
BY
James R. Ely
ATTORNEY

Aug. 17, 1954

H. A. PAINE

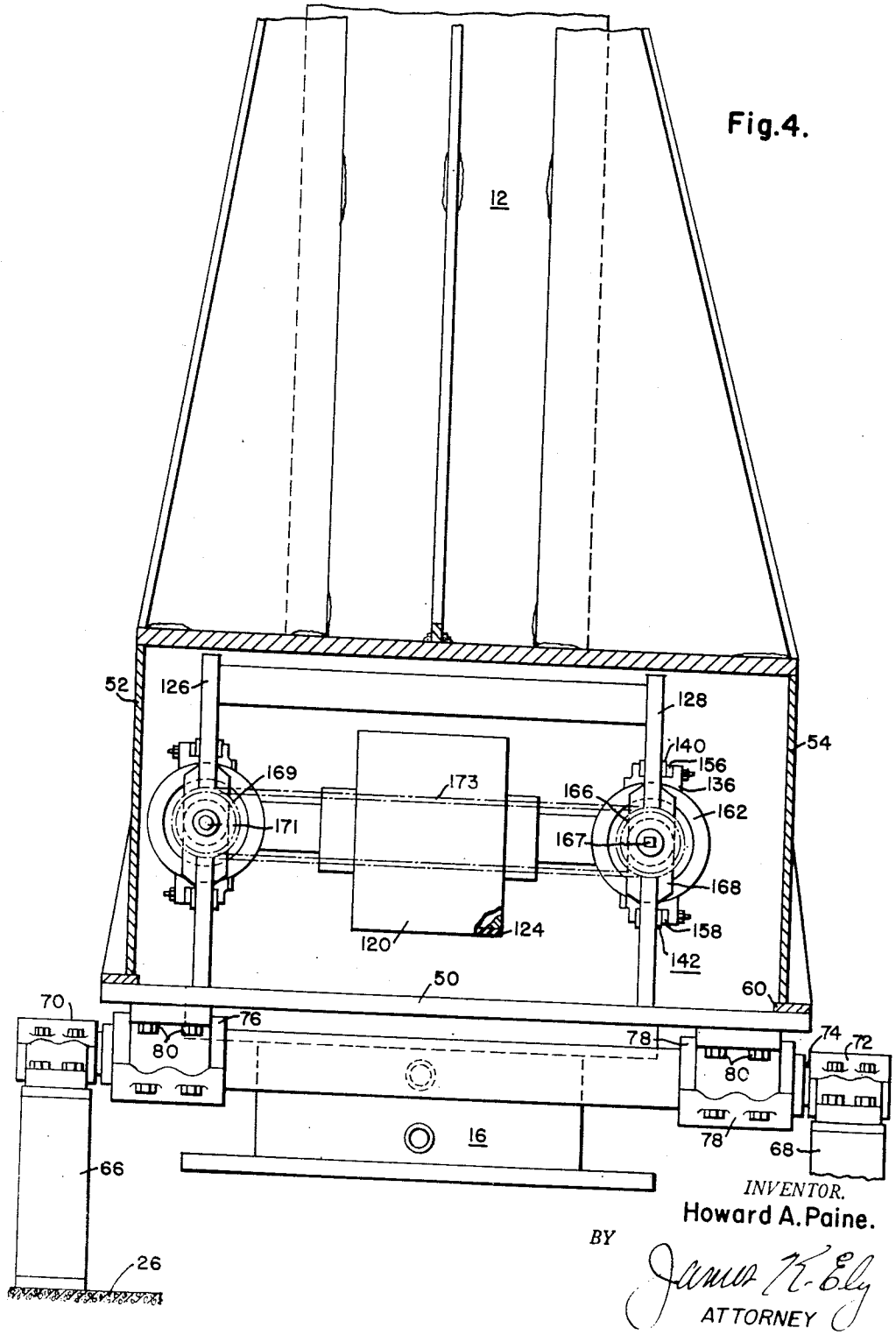
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Fig.4.



INVENTOR.
Howard A. Paine.

BY

James K. Ely

ATTORNEY

Aug. 17, 1954

H. A. PAINE

FURNACE STRUCTURE

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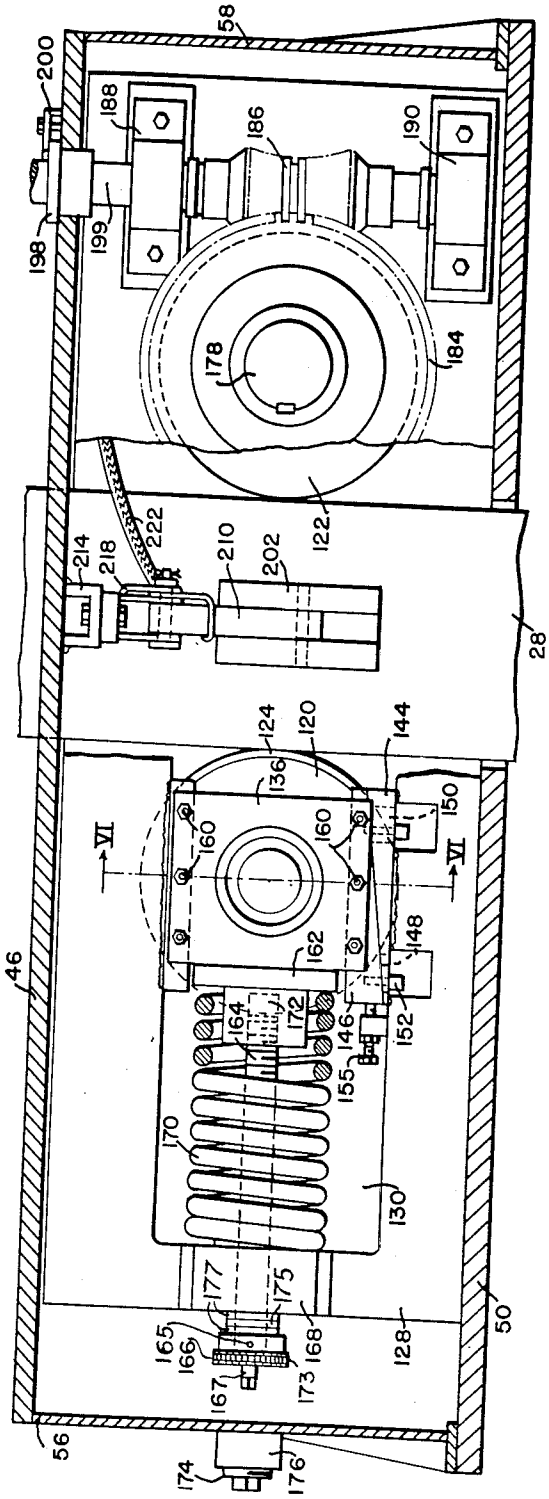
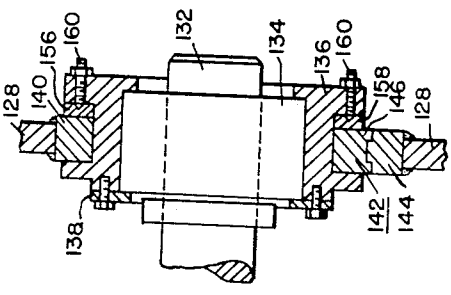


Fig.5.

Fig.6.



INVENTOR.
Howard A. Paine.

BY James K. Ely
ATTORNEY

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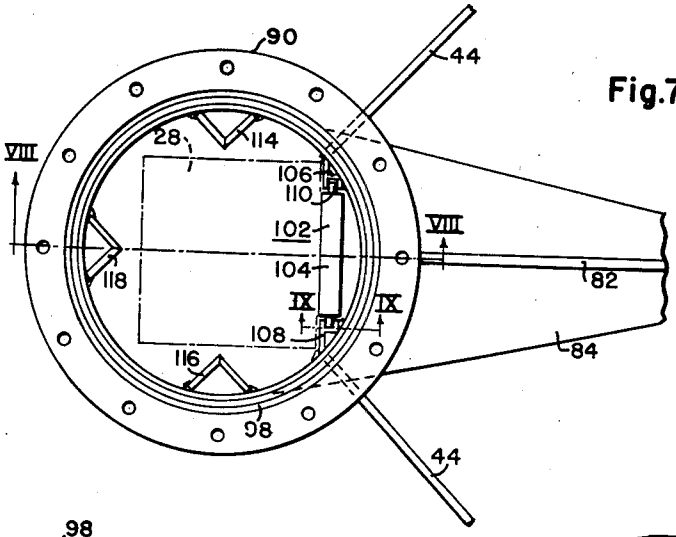


Fig.7.

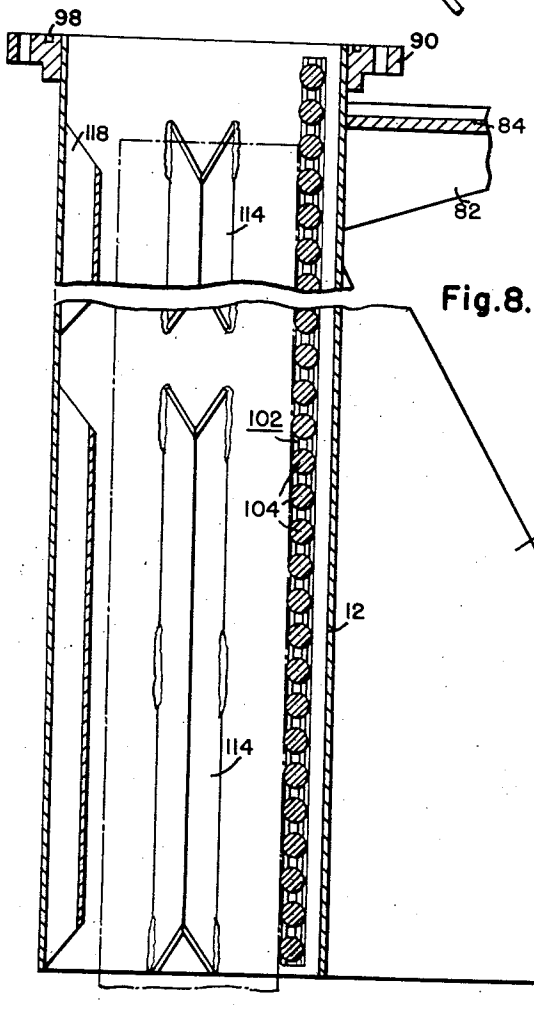


Fig.8.

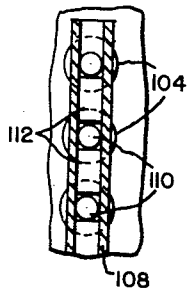


Fig.9.

INVENTOR.
Howard A. Paine.

BY James R. Ely
ATTORNEY

Aug. 17, 1954

H. A. PAINE

2,686,826

FURNACE STRUCTURE

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Fig.10.

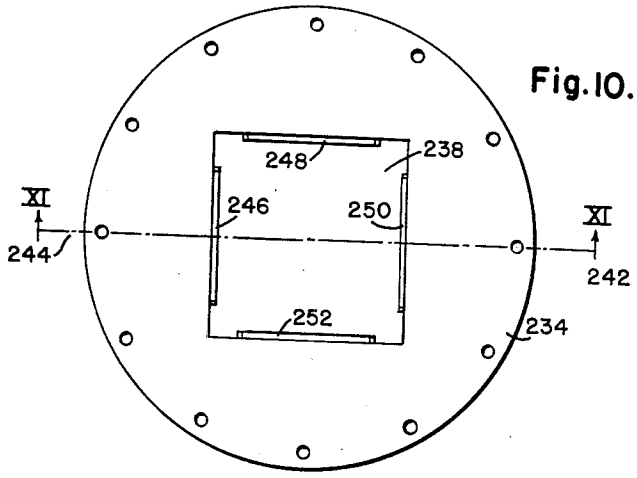


Fig.11.

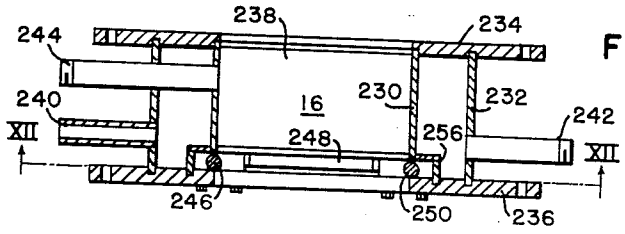


Fig.12.

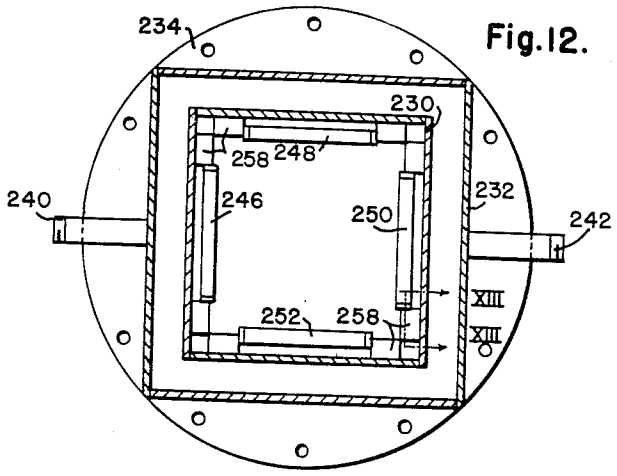
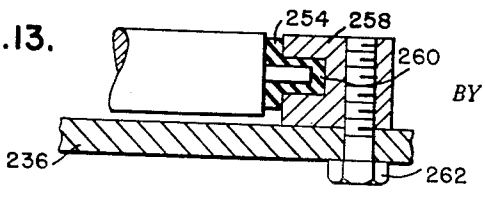


Fig.13.



INVENTOR.
Howard A. Paine.

BY

James K. Ely

ATTORNEY

Patented Aug. 17, 1954

2,686,826

UNITED STATES PATENT OFFICE

2,686,826

FURNACE STRUCTURE

Howard A. Paine, Las Vegas, Nev., assignor to Allegheny Ludlum Steel Corporation, Brackenridge, Pa., a corporation of Pennsylvania

Application December 26, 1952, Serial No. 328,023

6 Claims. (Cl. 13—14)

1

This invention relates to furnaces and in particular to furnace structure for use in conjunction with the melting of consumable electrodes.

Recent developments in the titanium base alloy field have made possible the production of commercially desirable titanium base alloys. However, the melting facilities for commercially producing such desirable alloys have proven to be entirely inadequate for the high production of alloys of commercial quality. A recent advance in such production practices has been to melt consumable electrodes of sponge titanium or scrap titanium metal and/or alloy to form ingots of the metal.

It has been difficult heretofore to produce large ingots of titanium base metal where consumable electrodes are employed because the furnace facilities available have been inadequate to handle large electrodes weighing in the order of several hundred pounds. Where attempts have been made to form the large ingots by using a multiplicity of the small consumable electrodes fed in sequence, it has been found that the resulting ingot is usually contaminated. On the other hand, where attempts have been made to use large electrodes, the weight of the electrode is so great that difficulty has been encountered in loading the electrode into the furnace, the electrode often breaking under its own weight when held in a horizontal position. Further, it has been difficult to guide the electrodes during the melting thereof to minimize undesirable arcing between the electrode and the walls of the crucible in which the ingot is formed.

An object of this invention is to provide a furnace structure for facilitating the loading and melting of large consumable electrodes.

Another object of this invention is to provide a furnace structure having a portion thereof tiltable for facilitating the loading of large consumable electrodes therein.

A further object of the invention is to provide a furnace structure having a portion thereof tiltable in a predetermined manner and in which means are disposed to support and guide a large consumable electrode as it is loaded into the furnace.

A more specific object of this invention is the provision in a tiltable furnace structure of a roller track and guide means for facilitating the loading of a consumable electrode therein, the roller track and guide means being disposed to cooperate with a drive mechanism for guiding the electrode as the electrode is melted.

A still further object of this invention is the

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provision of a tiltable furnace structure having supporting and guiding means disposed to facilitate the loading of a consumable electrode therein and for cooperating with a drive and roller means for guiding the electrode as the electrode is melted.

Other objects of this invention will become apparent from the following description when taken in conjunction with the accompanying drawings in which:

Figure 1 is a view in elevation of a furnace structure embodying the features of this invention;

Fig. 2 is a view in elevation of the structure of Fig. 1 illustrating the structure as tilted;

Fig. 3 is a view partly in elevation and partly in section and greatly enlarged of a portion of the structure of Fig. 1 as taken along the line III—III thereof;

Fig. 4 is an elevational view partly in section and greatly enlarged of a portion of the structure of Fig. 1 illustrating the tiltable mounting of the structure and the mounting of the adjustable drive roll;

Fig. 5 is a view with parts broken away and partly in section and greatly enlarged illustrating the adjustable drive mechanism of the furnace structure;

Fig. 6 is a view in section taken along the line VI—VI of Fig. 5 illustrating the mounting of the adjustable drive roll;

Fig. 7 is a top end view with cover removed of the vertical housing of the furnace structure;

Fig. 8 is a view in section of the vertical housing taken along the line VIII—VIII of Fig. 7;

Fig. 9 is a fragmentary view in section and greatly enlarged of the roller track within the housing taken along the line IX—IX of Fig. 7;

Fig. 10 is a top plan view of an insulating water jacket forming a part of the furnace structure of Fig. 1;

Fig. 11 is a view in section of the water jacket taken along the line XI—XI of Fig. 10;

Fig. 12 is a bottom plan view of the water jacket taken along the line XII—XII of Fig. 11; and

Fig. 13 is a fragmentary view greatly enlarged of the mounting for the rolls of the water jacket as taken along the lines XIII—XIII of Fig. 12.

Referring to the drawing and in particular Figs. 1 and 2 thereof, this invention is illustrated by reference to a furnace structure 10 embodying the features of this invention. The furnace structure 10 comprises a vertical housing 12 disposed to seat on a substantially rectangular base portion 14 to which an insulating water jacket 16

is connected as by means of bolts 18, the water jacket 16 in turn being disposed to seat on the rim 20 of a copper crucible 22 contained within a water jacket 24. As illustrated in Fig. 1 the crucible 22 and the enclosing water jacket 24 therefor are disposed in a pit or in any event disposed with the rim members thereof on the level of a foundation member 26. The furnace structure 10 is disposed to support, guide and feed a consumable electrode 28 into the crucible 22 where it is melted by passing current therethrough to effect arcing between the end of the electrode 28 and an initial deposit 30 of titanium base metal whereby the melting of the electrode 28 will form an ingot in the crucible 22.

The structure of the water jacket 24 which is provided with an inlet 32 and an outlet 34 and the structure of the crucible 22 are well-known and need not be described in detail, it being apparent that both the water jacket 24 and the crucible 22 are formed with rim members 36 and 20, respectively, whereby when a gasket 38 is disposed between the rims 20 and 36 an effective seal will be maintained therebetween. The rim 20 of the crucible 22 is provided with a terminal lug 40 disposed to be connected to the positive terminal of a direct current source of supply (not shown) by a cable 42.

In order to strengthen the vertical housing 12 so that it may support the weight of the electrode 28 under certain operating conditions, a plurality of outwardly extending and spaced rib members 44 are disposed lengthwise of the housing 12 on one side thereof to connect the housing 12 with the top plate 46 of the lower portion 14 which carries the housing 12. The lower rectangular portion 14 is also reinforced as illustrated in Figs. 1 through 4 by a plurality of spaced ribs 48 disposed between the base plate 50 and the outer periphery wall of the lower portion 14.

As more clearly illustrated in Figs. 1 through 4 the lower portion 14 comprises a rectangular housing formed of the top plate member 46 and a base plate member 50 and having side walls 52 and 54 and end walls 56 and 58. The base plate 50 is of a size to extend beyond the end and side walls a slight distance for receiving a strip member 60 about its outer edge upon which the end walls and side walls seat and which forms a base for receiving the reinforcing ribs 48 which are spaced about the outer periphery of the end and side walls. The upper plate 46 and the base plate 50 have aligned openings therein for receiving or permitting the passage of the electrode 28 therethrough in a manner to be referred to hereinafter.

In order to support the furnace structure 10 in an operative relation with respect to the crucible 22, provision is made for supporting the weight of the furnace structure at two of the outer edges of the rectangular lower portion 14. Thus as illustrated in Figs. 1, 2 and 4, a pedestal 62 provided with a foot 64 extends along the one edge of the base plate 50, the upper edge of the pedestal 62 being secured as by welding to the base plate 50. The opposite edge of the lower portion 14 is disposed to be supported through a pivotal mounting on the foundation 26. Thus as more clearly illustrated in Fig. 4, a pair of pedestals 66 and 68 are disposed in spaced relation on the foundation 26, each of the pedestals 66 and 68 carrying a bearing housing 70 and 72, respectively, containing bearings (not shown) for receiving the ends of a shaft 74 about which the housing 10 is disposed to be rotated. The base plate 50 is also provided with a pair of bearing housings 76 and 78 secured to its lower outer edge in spaced relation and being provided with bearings (not shown) for cooperating with the shaft 74 to permit tilting of the furnace structure 10. The bearing housings 76 and 78 can be secured to the lower base plate 50 in any suitable manner, for example by the bolts 80 as illustrated. Likewise, the bearing housings 70 and 72 may also be suitably bolted to the pedestals 66 and 68, respectively, so as to maintain the shaft 74 in an operative relation with respect to the housing 10.

In order to support the housing 12 in a horizontal position when the housing 10 is tilted or rotating about the shaft 74 to the horizontal position as illustrated in Fig. 2 an outwardly extending rib 82 is disposed on the one side of the housing 12 in alignment with one of the reinforced ribs 44, the rib 82 being reinforced by ribs 84, extending at right angles thereto and partially extending about the periphery of the housing 12, the ribs 82 and 84 being suitably welded together and to the housing 12. The ribs 82 and 84 preferably extend outwardly from the housing 12 and terminate in a foot 86 disposed to seat on the foundation 26, the length of the rib 82 being sufficient to maintain the housing 12 in a horizontal position when the foot 86 is seated against the foundation 26. Where desired a ring 88 may be provided, being secured to the rim 90 on the upper end of the housing 12 to which a lift hook (not shown) can be attached for facilitating movement of the furnace structure 10 about the pivot shaft 24.

The housing 12 comprises a tubular member having the rim 90 disposed about its upper end for receiving the rim 92 of a cover member 94, the rims being secured together as by means of bolts 96. Preferably each of the rims 90 and 92 are recesssed as at 98 (Figs. 7 and 8) for receiving a gasket material (not shown) to thereby render the joint between the cover and the upper end of the housing leak-proof. The cover 94 may be provided with a gas inlet 100 for admitting gas to the furnace structure as will be referred to more fully hereinafter.

The tubular housing 12 is provided with a roller track 102 as more clearly shown in Figs. 7, 8 and 9, the roller track 102 extending along the one side of the housing 12 that is reinforced by the rib 82 and the ribs 44. The roller track 102 is formed of a plurality of rollers 104 disposed in spaced relation to one another and carried in spaced channel members 106 and 108 which are secured to the inner wall of the housing 12. The rollers 104 have the outer ends of their shafts 110 disposed to ride in the channels 106 and 108, the spacing between the rolls 104 being maintained by blocks 112 disposed in the channels 106 and 108 between corresponding ends of the shafts 110. The rolls 104 are preferably formed of steel to withstand wear thereon as the electrode passes thereover as will be referred to hereinafter. Preferably the roller track 102 extends substantially throughout the length of the housing 12 terminating closely adjacent the lower portion 14 of the furnace structure.

In order to provide guiding means, the purpose of which will be more clearly explained hereinafter, a plurality of angle members 114, 116 and 118 are disposed in spaced relation about the inner periphery of housing 12 being welded in assembled position. The guide members 114, 116 and 118 are preferably spaced 90° apart with the guide members 114 and 116 opposite one another and about 90° from the center of the roller track

102. The size of the guide members 114, 116 and 118 will depend somewhat upon the size of the electrode 28 which is to be employed in the furnace structure, in all cases the spacing between the guide members 114, 116 and 118 and the roller track 102 being sufficient to accommodate the electrode 28 therebetween.

The lower portion 14 is disposed to contain a drive mechanism for supporting and feeding the electrode 28 into the crucible 22 when the furnace structure 10 is in the vertical position illustrated in Fig. 1. As illustrated in Figs. 3, 4 and 5 the drive comprises a pair of rollers 120 and 122 preferably provided with an outer coating 124 of rubber or other suitable material having a high coefficient of friction for frictionally engaging the electrode 28 to maintain the weight thereof between the rolls and when actuated to feed the electrode 28 into the crucible 22. In the embodiment illustrated, the roller 120 comprises a pressure roller whereas the roller 122 comprises the positive drive for the electrode. In order to support the roller members, side plates 126 and 128 are disposed in spaced relation to seat on the base plate 50 being secured thereto in any well-known manner and extending upwardly toward the top plate member 46 of the lower housing 14. The side plate member 128 has a section removed therefrom to leave a window or opening 130 therein for receiving an adjustable mounting for the pressure roller 120.

As more clearly illustrated in Figs. 5 and 6, the pressure roll 120 is disposed to be carried by a shaft 132 the end of which is mounted in a bearing housing 134 which is secured in an adjustable plate 136. In Fig. 6, the adjustable plate 136 is provided with a retaining ring 138 for retaining the bearing housing 134 in position therein, the adjustable plate being disposed for slidable movement with respect to an upper block member 140 which is welded to the upper edge of the window 130 and on a take-up wear member 142 carried by the lower edge of the window 130. The take-up wear member 142 is formed of two components 144 and 146 which are correspondingly bevelled and are provided with a tongue and groove fit on their cooperating bevelled surfaces. The lower portion 144 of the take-up portion is slotted as at 148 and 150 for permitting slidable movement relative thereto of the upper portion 146, setscrews 152 and 154 being disposed to extend through the slots 148 and 150, respectively, into the upper portion 146 so that when tightened to seat against the lower edge of the lower portion 144, the upper portion 146 will be held in a fixed position relative to the lower portion 144, the latter being preferably welded in position to the lower edge of the window 130. A setscrew 155 is disposed to be actuated to control movement of the upper portion 146 relative to the lower portion 144 of the wear take-up member 142. In order to provide for a tight sliding fit of the adjustable plate 136 a gib 156 is disposed between an edge of the slidable plate member 136 and the block member 140, a gib 158 also being disposed between the plate member 136 and the upper portion 146 of the wear take-up member 142. The gibs 156 and 158 are secured in position by means of setscrews 160 which extend through the plate member 136 into the gibs.

Provision is made for manually adjusting the position of the pressure roller 120. Thus a thrust plate or pad 162 is disposed to seat against an edge of the slidable plate 136, the thrust plate or pad being connected as by means of a threaded arm 164 to a sprocket 166 carried at the outer end of the arm 164, the sprocket 166 being pinned as at 165 or otherwise secured to the outer end of the arm 164 which terminates in a square end 167 disposed to receive a socket wrench (not shown). As illustrated the end of the side plate 128 is provided with a pressure plate 168 through which the arm 164 is disposed to extend, the pressure plate 168 being secured in the side plate 128. A helical spring 170 is disposed to seat against and between the pressure plate 168 and the thrust plate or pad 162 to apply a biasing pressure against the thrust plate 162 to maitain the sliding plate 136 in a position where the pressure roll 120 will be carried in pressure frictional engagement with the electrode 28. As illustrated the thrust plate or pad 162 is provided with a threaded recess 172 for receiving the threaded end of the arm 164 whereby a turning movement of the square end 167 will effect movement of the thrust plate 162 and consequently movement of the slide plate 136 and pressure roller 120 carried thereby to maintain the pressure roll 120 in frictional engagement with the electrode 28. The sprocket 166 is preferably disposed on the arm 164 to seat against a thrust bearing assembly formed of the thrust bearing 175 disposed between thrust collars 177. Such a mounting of the sprocket 166 allows some movement of the pressure roll 120 under the influence of the spring 170 to maintain the pressure roller 120 in a tight frictional engagement with a surface of the electrode 28 regardless of irregularities or non-uniformities of the surface so engaged. In order to manually turn the end 167 of the arm 164, a plug 174 is provided in the end wall of the lower portion 14, the plug 174 being threaded in a housing 176 which extends through the end wall 56. Thus by removing the threaded plug 174 from the housing 176 access may be had to fit a socket wrench (not shown) to the end 167 to effect a manual operation of the sprocket 166 and the arm 164 to slidably adjust the position of the pressure roll 120.

The other end of the shaft 132 is similarly mounted in a bearing housing which is adjustably mounted in a manner identical to that of the bearing housing 134 and disposed to be adjusted by movement of a sprocket 169 carried on the end of the arm 171. The sprockets 166 and 169 are connected as by means of a chain drive 173 so that a manual adjustment of the end 167 of arm 164 will effect a simultaneous movement of sprockets 166 and 169 to position the roller 120.

The drive roll 122 is carried by a drive shaft 178, the ends of which extend through bearing housings 180 and 182 carried by the side plates 128 and 126, respectively, the bearing housings having bearings (not shown) for obtaining an efficient transmittal of force to the drive roll 122. The one end of the shaft 178 extends through the bearing housing 186 and carries a cone worm gear 184 at its outer end thereof, the cone worm gear 184 being disposed to be driven by a pinion 188 which is carried on a shaft disposed to rotate in babbitted bearing pillow blocks 188 and 190 when actuated. The drive roll 122 is also preferably provided with an outer cover of rubber or other material of high coefficient of friction to effect a good frictional engagement with a surface of the electrode 28.

In order to drive the drive roll 122 a driving motor 192 is supported externally of the housing 12 on a suitable platform carried by the top plate member 46, the motor 192 being connected through a right angle gear reducer 194, a flexible drive 196 and a flush type seal 198 contained in

the top plate 46 of the lower portion 14 of the furnace structure, the shaft 188 extending through the shaft seal. The shaft seal 198 may be maintained in position by any suitable means as for example the clamp 200.

In order to provide a good electrical contact with the electrode 28 a pair of contact shoes 202 and 204 are disposed in the space between the pressure roll 120 and the drive roll 122 to be biased into engagement with opposite surfaces of the electrode 28. Each of the contact members 202 and 204 are of similar structure being provided with a relatively flat shoe or contact surface 206 and 208, respectively, such shoe being formed of conducting material and being pivotally carried on arms 210 and 212, respectively, which are pivotally mounted on support members 214 and 216, respectively, carried by the top plate member 46, the arms 210 and 212 being biased as by springs 218 and 220, respectively, to force the shoes 206 and 208, respectively, into engagement with the electrode 28. Each of the shoes 206 and 208 are preferably connected as by cables 222 and 224, respectively, to a terminal block 226 which extends through the top plate member 46 and is provided with a terminal 228 disposed to be connected to a terminal of negative polarity of a direct current source of power (not shown). Since the contact members 202 and 204 have relatively long contacting surfaces 206 and 208, respectively, a good sliding contact will always be maintained between the contact members 202 and 204 and the electrode 28 as the electrode passes therebetween to thereby maintain a good electrical connection with the electrode.

The insulating water jacket 16 carried by the lower portion 14 is better illustrated in Figs. 10, 11 and 12. As illustrated therein, the water jacket 16 comprises two spaced rectangular side wall members 230 and 232 disposed between an upper rim member 234 and a lower rim member 236. The inner rectangular side wall 230 cooperates with openings in the rim members 234 and 236 for defining a passage 238 of a size suitable for accommodating the electrode 28 as it is fed by the drive mechanism into the crucible 22. As illustrated, the water jacket 16 is provided with an inlet 240 and an outlet 242 for supplying a continuous flow of cooling water (not shown) to the water jacket 16 to provide for adequately cooling the jacket 16 and preventing a substantial transfer of heat therethrough from the crucible 22 to the lower portion 14 of the furnace structure 10 containing the driving mechanism. A gas exhaust conduit 244 is provided in communication with the passageway 238 in the water jacket 16.

In order to prevent damage to the water jacket 16 and to cooperate in guiding the electrode 28 as it is fed to the crucible 22, a plurality of rolls 246, 248, 250 and 252 are disposed about the periphery of the passageway 238 in such a position that the surface of the rolls will extend within the passageway 238 defined by the side walls 230. The rolls 246 through 252 are preferably formed of steel and are provided with bearings 254 at their outer ends, the bearings being preferably of heat-resisting fibrous material impregnated with a synthetic resin. As better illustrated in Figs. 11 through 13 the lower edges of the inner walls 230 are stepped as at 256 for receiving supporting blocks 258 which are recessed as at 260 for receiving the bearing ends 254 of the rolls. The supporting blocks 258 are held in position in the stepped side walls 230 as by means of bolts 262 which extend through the rim member 236. Thus each of the rolls 246 through 252 is disposed to be engaged by one of the surfaces of a substantially rectangular electrode 28 as it passes through the water jacket 16 to the crucible 22.

In practice in order to load the electrode 28 into the furnace structure 10 the furnace structure is tilted about its pivot shaft 24 by lifting ring 88 in any suitable manner as by a lifting crane or otherwise to tilt the furnace structure from the vertical position illustrated in Fig. 1 to a horizontal position as illustrated in Fig. 2 with the foot 86 of the supporting rib 82 seated against the foundation 26. The cover 94 is then removed from the end of the housing 12 and an electrode 28 of titanium base metal is raised to a horizontal position where it can enter the housing 10, the electrode resting upon the rolls 104 of the roller track 102. As the ends of the guide members 114, 116 and 118 are bevelled as illustrated in Fig. 8 they aid in guiding the electrode into a central position within the housing 12, the inwardly extending edges of the guide 114, 116 and 118 functioning to maintain the electrode in such central position as it is moved along the roller track 102. The roller track 102 functions to support the weight of the electrode 28 as it is in the horizontal position to prevent breakage thereof as the electrode 28 is loaded into the furnace structure.

Prior to admitting the electrode 28 into the furnace structure it will be understood that the position of the pressure roll 120 is adjusted so that the pressure roll 120 will cooperate with the guide roll 122 to receive the end of the electrode 28 in a supporting frictional engagement. Such adjustment of the position of the pressure roll 120 can be effected either by adjusting the wear take-up blocks 144 and 146 or by removing the plug 174 from the end wall 56 to manually adjust the sprocket 166 to effect an adjustment of the thrust pad 162 relative to the supporting plate 136. Adjustment of the wear take-up blocks 144 and 146 prior to a melting operation can be readily effected by loosening the setscrews 152 and 154 and thereafter turning the setscrew 155 to effect a relative movement of the upper block 146 with respect to the lower block 144.

Assuming that the pressure roll 120 has been adjusted relative to the guide roll 122 for engaging the end of the electrode 28, then by moving the electrode 28 along the roller track 102, the end of the electrode enters the lower portion 14 and is forced between the pressure roll 120 and the drive roll 122. At the same time the spring biased contact members 202 and 204 are brought into engagement with opposed sides of the electrode 28 to provide a good sliding electrical contact therewith as the electrode 28 passes therebetween. In practice the electrode is also forced inward of the furnace structure so that the end thereof enters the passageway 238 of the insulating water jacket 16 to a position where the electrode engages the spaced rolls 246, 248, 250 and 252 thereof.

With the electrode positioned in the furnace structure as just described, the cover 94 is secured in position on the end of the housing 12 and the furnace structure containing the electrode is raised from the horizontal position illustrated in Fig. 2 to the vertical position illustrated in Fig. 1 in which the insulating water jacket 16 seats on a gasket 264 of heat resistant dielectric metal

disposed over the rim 20 of the crucible 22. In such position the pedestal 62 and the pivot supports 66 and 68 for the furnace structure carry substantially all of the weight of the furnace structure to thereby prevent damage to the crucible 22. In raising the furnace structure 10 to the vertical position, it is noted that the guide members 114, 116 and 118 cooperate in the housing 12 to prevent excessive sideways movement of the electrode 28 in the housing 12 as its position is changed from a horizontal to the vertical position. The frictional grip of the drive roll 122 and the pressure roll 120 is sufficient to maintain the electrode 28 in the vertical position until the motor 192 is operated to apply a positive driving force to the roll 122, it being understood that the friction of the worm gear drive will prevent movement of the roll 122 until a positive force is applied to the drive.

In this position the water jacket 16 is connected to a suitable source of supply of cooling water as is also the water jacket 24. The rim 236 of the water jacket 16 is secured in position with respect to the rims 20 and 36 of the crucible 22 and water jacket 24, respectively, as by means of insulated bolts 266 which extend therethrough and through the gaskets between the respective rim members. The gas inlet 100 carried by the cover 94 is then connected to a source (not shown) of gas such as argon or helium which is non-contaminating with respect to titanium and the furnace structure is flushed therewith so as to remove any gaseous impurities that might be present in the furnace structure, it being noted that the gas also flows downwardly into the crucible 22 escaping from the furnace structure through the gas exhaust conduit 244.

When the furnace structure and crucible are thus flushed and the terminals 228 and 40 are connected to a suitable source of direct current power supply, the motor 192 is operated so as to frictionally drive the electrode 28 downwardly into the crucible to a position where an arc 268 is struck between the end of the electrode 28 and the initial supply 38 of titanium metal carried in the crucible 22. The rate of feed of the electrode 28 into the crucible 22 is controlled so as to effect a substantially constant melting thereof. This control can be any of the well-known electrical controls responding to variations in either the arc current or arc voltage, such controls being so well-known that they need not be described herein. The flow of the non-contaminating gas is continued throughout the melting cycle so as to insure obtaining a good sound ingot from the consumable electrode.

After the electrode is melted so that only the butt end thereof is held between the pressure roll 120 and the drive roll 122, the arcing current is interrupted, the bolts 266 are removed and the furnace structure 10 is again tilted about its pivot shaft 74 to the horizontal position illustrated in Fig. 2. With the furnace structure thus removed from the crucible 22, the crucible 22 containing the ingot of titanium metal can be readily removed from its operative assembled position with respect to the water jacket 24 and the ingot formed in the crucible 22 can thereafter be removed from the crucible. The butt end of the electrode 28 is then removed from its position with respect to the drive roll 122 and pressure roll 120 and after the cover 94 is removed, the furnace structure is again ready to receive another electrode 28 for the melting of another ingot.

The furnace structure of this invention is capable of handling large electrodes weighing hundreds of pounds and being of a cross sectional size of up to 18 inches square without encountering breakage during the loading of the furnace structure. The furnace structure is also capable of so guiding the electrode, it being found that the guide means and roller track of the housing 12 cooperate with the pressure roll 120 and drive roll 122 as well as with the rollers 246 through 252 of the insulating water jacket 16 to maintain the electrode in a substantially central position when the furnace structure is in a vertical position so as to prevent arcing between the sides of the electrode and the side walls of the crucible 22. Further, by making the furnace structure tiltable as described it becomes quite apparent that the loading of the furnace is clearly simplified and makes a very efficient loading operation possible.

The furnace structure of this invention is formed of substantially standard components and can be readily reproduced by any one skilled in the art. It has made possible the commercial production of ingots of titanium base metal substantially larger than have ever been commercially produced heretofore.

I claim:

1. In a furnace structure for the feeding and melting of a consumable electrode in a water cooled crucible, the combination of, a tiltable housing disposed for movement to and from an operative vertical position in alignment with the crucible, the housing being disposed to receive the electrode when tilted from said vertical position, means contained within the housing for supporting and guiding the electrode as the electrode is received in the housing, driving means within the housing disposed to engage the electrode as the electrode is received therein, the driving means being disposed to support the electrode when the housing is in said vertical position, means for operating the driving means to control movement of the electrode into the crucible when the housing is in said vertical position, the guiding means also cooperating with the driving means when the housing is in said vertical position to maintain the electrode in a substantially vertical position as the driving means is operated to move the electrode into the crucible, and electrical contact members disposed to be biased into contact engagement with the electrode to facilitate the making of an electrical connection therewith as the driving means is operated to move the electrode into the crucible.

2. In a furnace structure for the feeding and melting of a consumable electrode in a water cooled crucible, the combination of, a housing disposed to be seated in a vertically extending and aligned operative relation with the crucible, a removable cover plate secured to the upper end of the vertically extending housing, a pivot means for the housing disposed to facilitate tilting movement of the housing from said vertical position to a horizontal position to receive the electrode when the cover plate is removed, roller means disposed within the housing along one side thereof to receive and support the weight and facilitate movement of the electrode as the electrode is positioned within the housing, guide means disposed in spaced relation to one another within the housing and about the sides thereof to cooperate with the roller means in guiding the electrode into position within the housing, driving means disposed adjacent the end of the roller

means within the housing disposed to receive and engage the electrode when the electrode is positioned within the housing, the driving means being disposed to support the electrode when the housing is in said vertical position, means for operating the driving means to control movement of the electrode into the crucible when the housing is in said vertical position, the guide and roller means also cooperating with the driving means when the housing is in said vertical position to maintain the electrode in a substantially vertical position as the driving means is operated to move the electrode into the crucible, and electrical contact members disposed to be biased into contact engagement with the electrode to facilitate the making of an electrical connection therewith as the driving means is operated to move the electrode into the crucible.

3. In a furnace structure for the feeding and melting of a consumable electrode in a water cooled crucible, the combination of, a housing disposed to be seated in a vertically extending and aligned operative relation with the crucible, a removable cover plate secured to the upper end of the vertically extending housing, a water jacket carried by the lower end of the vertical housing to seat on the crucible when the housing is in aligned operative relation therewith, a pivot means for the housing disposed to facilitate tilting movement of the housing and water jacket carried thereby from said vertical position to a horizontal position to receive the electrode when the cover plate is removed, means contained within the housing for supporting and guiding the electrode as the electrode is positioned within the housing, driving means within the housing disposed to receive and engage the electrode when the electrode is positioned therein, the driving means being disposed to support the electrode when the housing is in said vertical position, means for operating the driving means to control the feeding of the electrode into the crucible when the housing is in said vertical position, roller means carried by the water jacket for engaging the sides of the electrode as it moves into the crucible, the guide means of the housing and the roller means of the water jacket cooperating in conjunction with the driving means to maintain the electrode in a substantially vertical position as the driving means is operated to feed the electrode into the crucible, and electrical contact members disposed in contact engagement with the electrode to facilitate making an electrical connection therewith as the driving means is operated to move the electrode into the crucible.

4. In a furnace structure for the feeding and melting of a consumable electrode in a water cooled crucible, the combination of, a housing disposed to be seated in a vertically extending and aligned operative relation with the crucible, a cover plate secured to the upper end of the vertically extending housing, pivot means for the housing disposed to facilitate tilting movement of the housing from said vertical position to a horizontal position, the cover plate being removable for admitting the electrode to the housing through said upper end when the housing is in said horizontal position, a plurality of roller members disposed in spaced relation within the housing along one side thereof to provide a carrier track for receiving and supporting the weight and facilitating movement of the electrode as the electrode is admitted to and positioned in the housing in said horizontal position, guide means disposed in spaced relation to one another within the housing about the sides thereof to cooperate with the carrier track in guiding the electrode into position within the housing, driving means disposed in the lower end of the vertically extending housing adjacent the end of the carrier track for receiving and engaging the electrode when the electrode is positioned within the housing in said horizontal position, the driving means being disposed to support the electrode when the housing is in said vertical position, means for operating the driving means to control movement of the electrode into the crucible when the housing is in said vertical position, the guide means and carrier track cooperating with the driving means when the housing is in said vertical position to maintain the electrode in a substantially vertical position as the driving means is operated to move the electrode into the crucible, and electrical contact members disposed in sliding contact engagement with the electrode to facilitate the making of an electrical connection therewith as the driving means is operated to move the electrode into the crucible.

5. In a furnace structure for the feeding and melting of a consumable electrode in a water cooled crucible, the combination of, a housing disposed to be seated in a vertically extending and aligned operative relation with the crucible, a cover plate secured to the upper end of the vertically extending housing, pivot means for the housing disposed to facilitate tilting movement of the housing from said vertical position to a horizontal position, the cover plate being removable for admitting the electrode to the housing through said upper end when the housing is in said horizontal position, a plurality of roller members disposed in spaced relation within the housing along one side thereof to provide a carrier track for receiving and supporting the weight and facilitating movement of the electrode as the electrode is admitted to and positioned in the housing in said horizontal position, guide means disposed in spaced relation to one another within the housing about the sides thereof to cooperate with the carrier track in guiding the electrode into position within the housing, driving means disposed in the lower end of the vertically extending housing adjacent the carrier track, the driving means comprising a pair of spaced roller members for receiving and frictionally engaging the electrode when the electrode is positioned within the housing in said horizontal position, means for adjusting the spaced position of the roller drive members to insure a frictional engagement thereof with the electrode to support the electrode when the housing is in said vertical position, means for operating the driving means to control movement of the electrode into the crucible when the housing is in said vertical position, and electrical contact members disposed in sliding contact engagement with the electrode to facilitate the making of an electrical connection therewith as the driving means is operated to move the electrode into the crucible.

6. In a furnace structure for the feeding and melting of a consumable electrode in a water cooled crucible, the combination of, a housing disposed to be seated in a vertically extending and aligned operative relation with the crucible, a cover plate secured to the upper end of the vertically extending housing, pivot means for the housing disposed to facilitate tilting movement

of the housing from said vertical position to a horizontal position, means carried by the housing disposed to cooperate with the pivot means to support the housing in said vertical position in operative relation with the crucible, the cover plate being removable for admitting the electrode to the housing through said upper end when the housing is in said horizontal position, roller means extending along the inner wall of the housing disposed to receive and support the weight and to facilitate movement of the electrode as the electrode is admitted to and positioned in the housing in said horizontal position, guide means extending along the inner wall of the housing and disposed in spaced relation thereabout for cooperating with the roller means in guiding the electrode into position within the housing, driving means disposed in the lower end of the vertically extending housing adjacent the roller means for receiving and engaging the electrode when the electrode is positioned within the housing in said horizontal position, the driving means being disposed to support the electrode when the housing is in said vertical position,

means for operating the driving means to control movement of the electrode into the crucible when the housing is in said vertical position, the guide means and roller means cooperating with the driving means when the housing is in said vertical position to maintain the electrode in a substantially vertical position as the driving means is operated to move the electrode into the crucible, and electrical contact members disposed to be biased into contact engagement with the electrode to facilitate the making of an electrical connection therewith as the driving means is operated to move the electrode into the crucible.

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