

Sept. 10, 1963

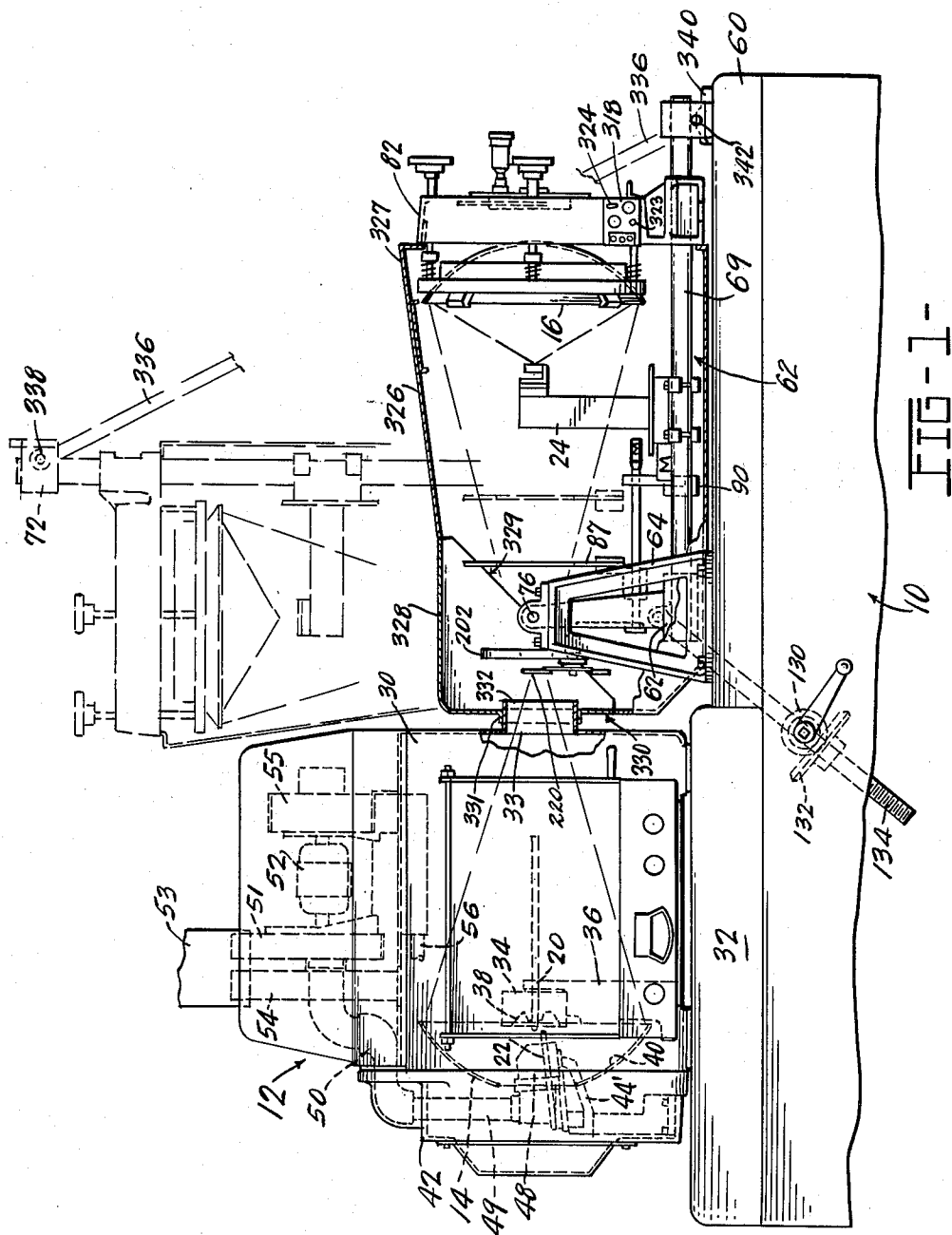
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3,103,574

ARC IMAGE FURNACE

Filed Dec. 3, 1959.

5 Sheets-Sheet 1



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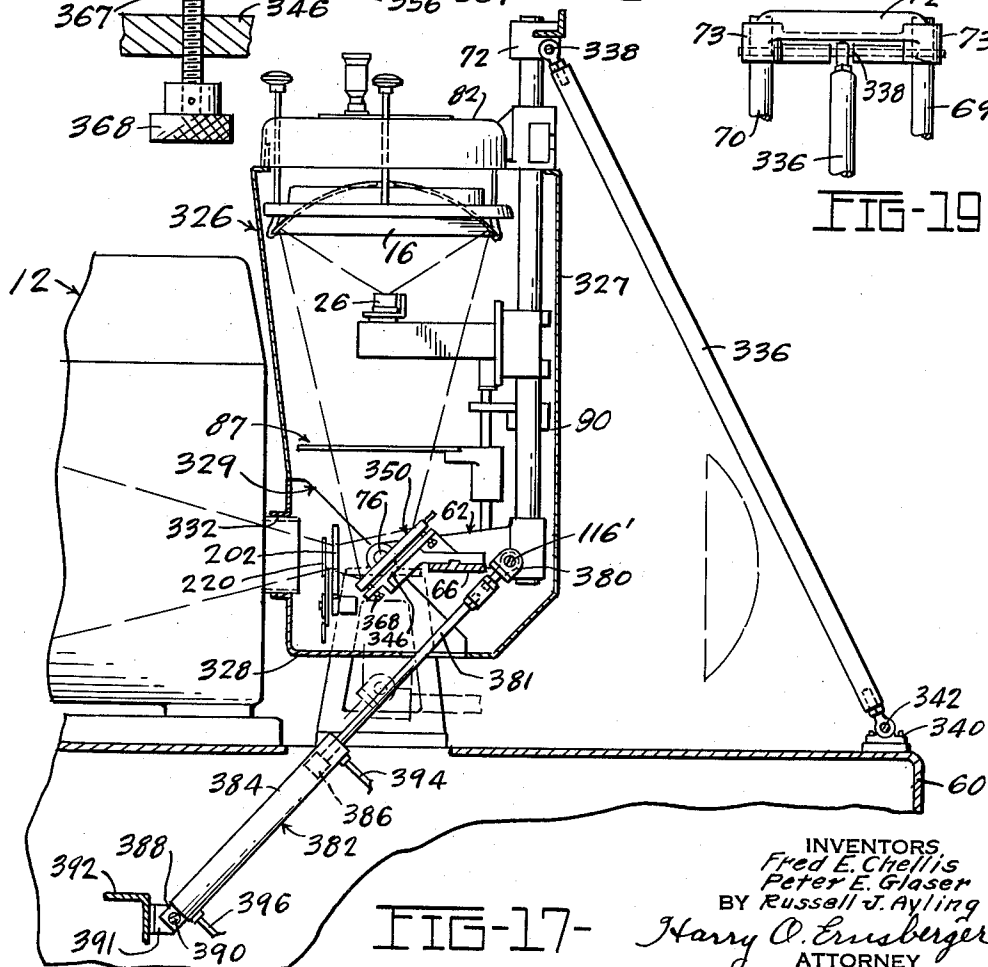
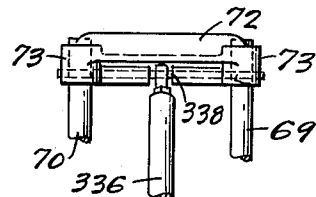
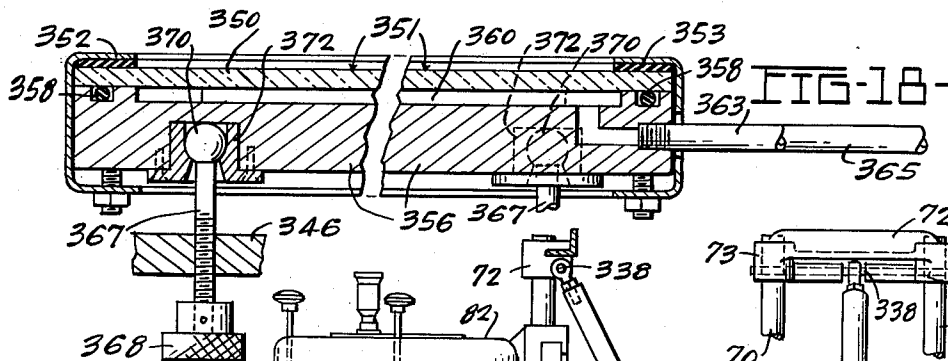
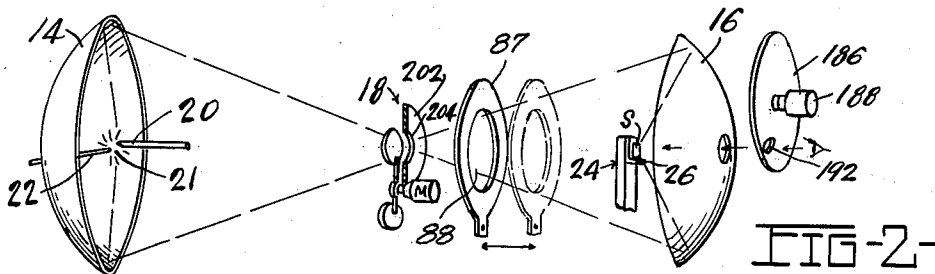
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5 Sheets-Sheet 2



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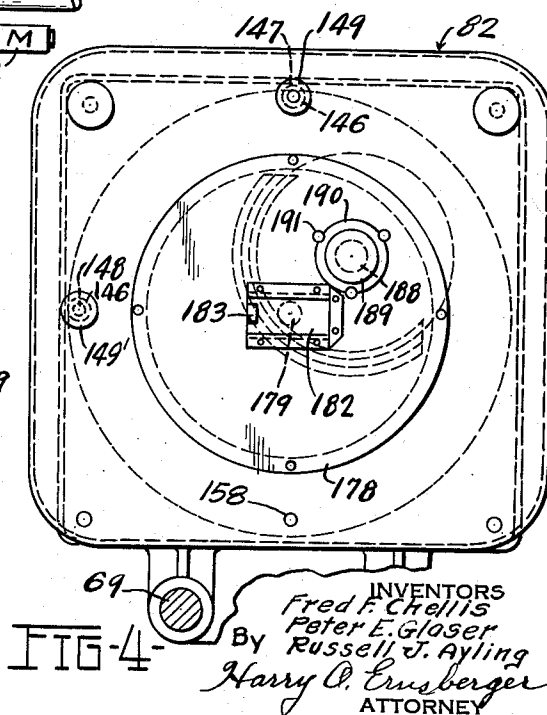
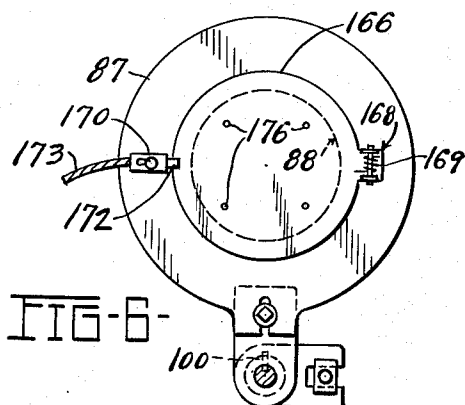
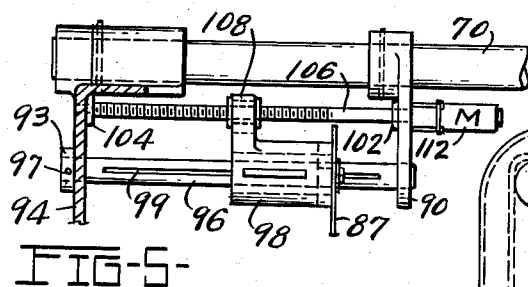
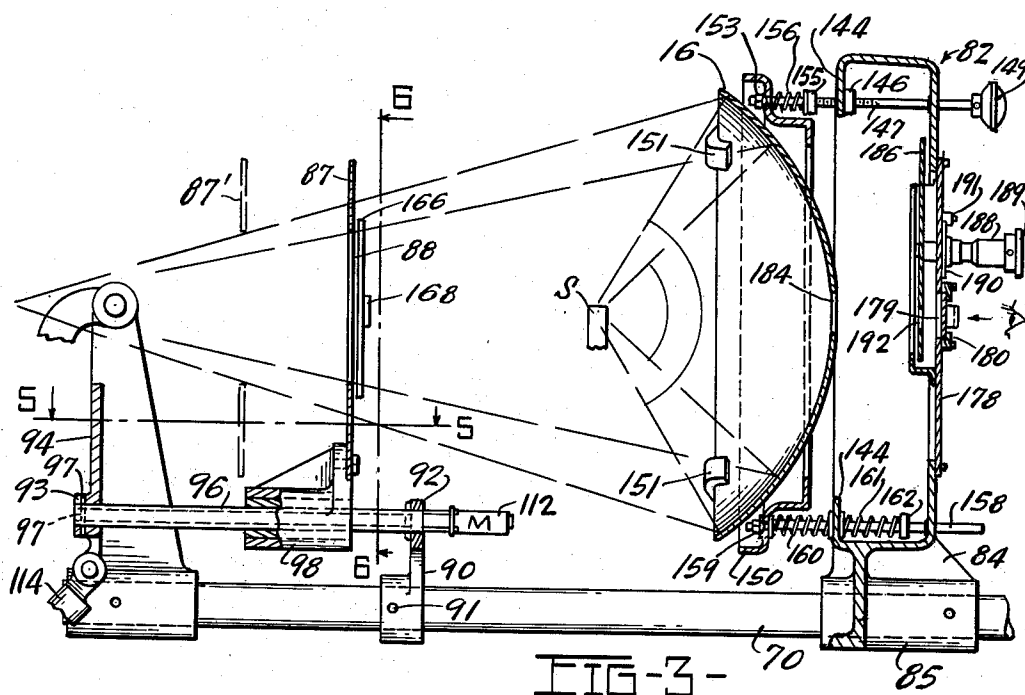
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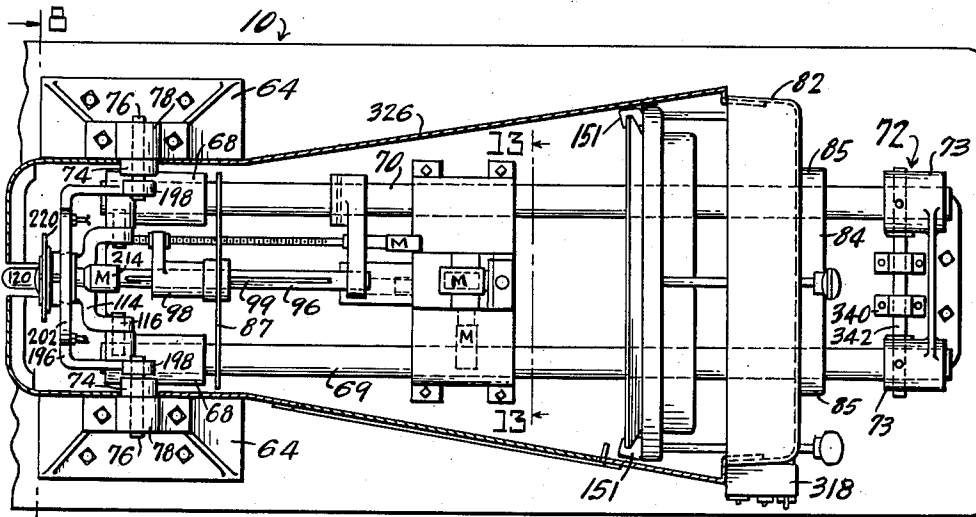


FIG-7-

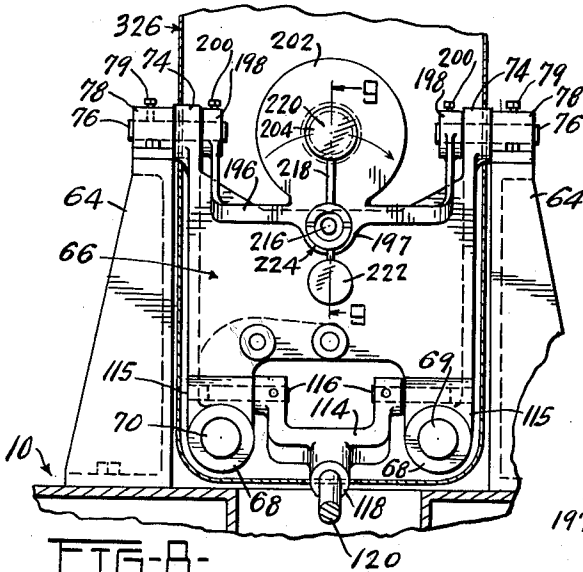


FIG-8-

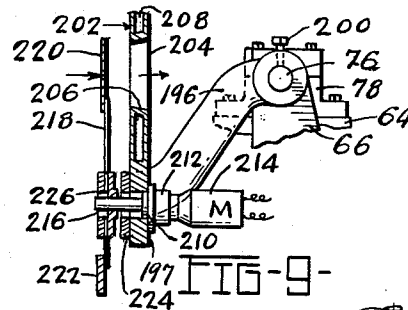


FIG-9-

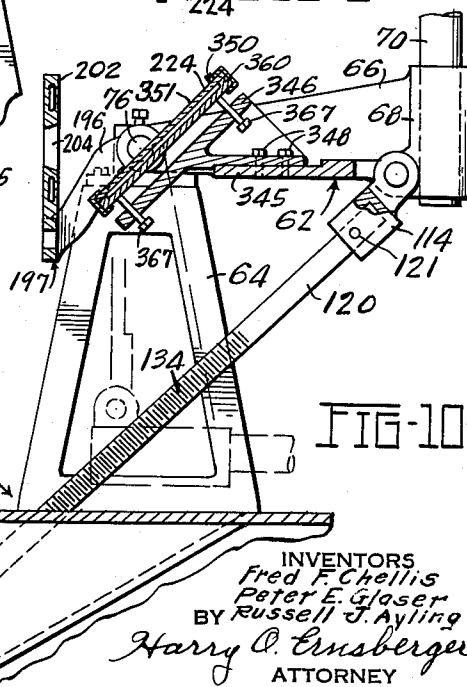


FIG-10-

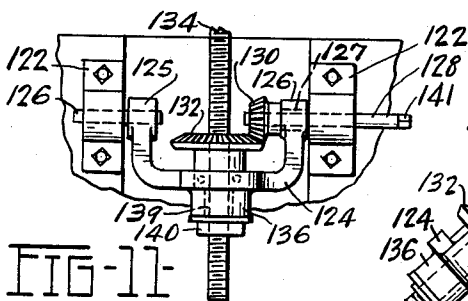


FIG-11-

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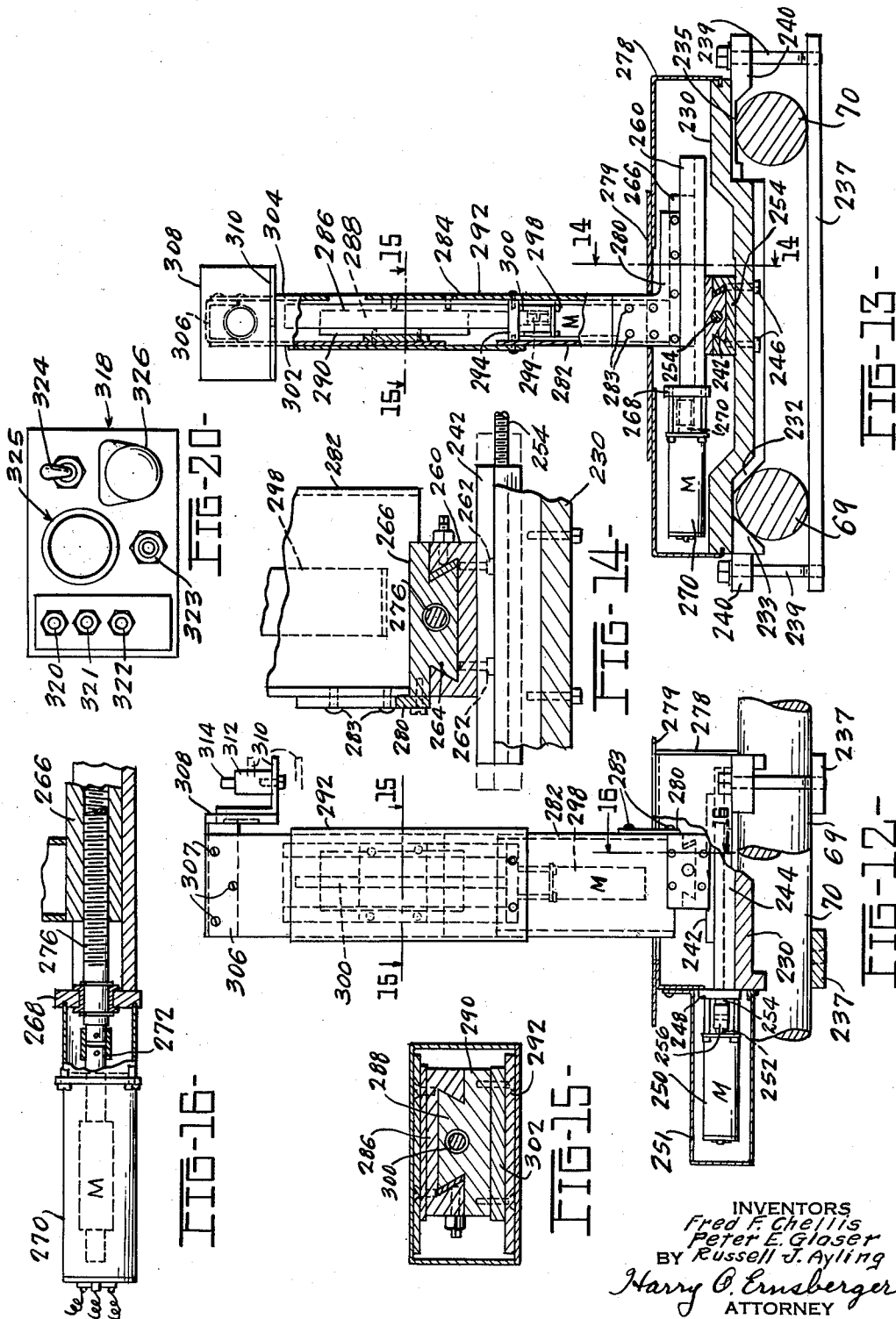
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ARC. IMAGE FURNACE

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3,103,574

ARC IMAGE FURNACE

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17 Claims. (Cl. 219-34)

This invention relates to a radiation image furnace employing an electric arc as a radiant heat source and more especially to a furnace of this character provided with means for the concentration of great heat intensity upon material to be heated.

It has been proposed to utilize an electric arc in connection with a mirror system for producing extremely high temperatures in a small area but such means heretofore employed for the purpose lacked adequate controls for practical operation and lacked stability of concentration and intensity of the heat energy for efficient use.

The present invention embraces the provision of a radiation furnace embodying a controlled arc as a radiant heat source in combination with an energy projecting and reflecting system employing ellipsoidal reflectors arranged to concentrate and converge high intensity radiant heat upon the sample subjected to the heat.

Another object of the invention is to the provision of a high intensity radiation image furnace wherein effective control is exercised over the path of the radiant heat and the amount of heat directed onto the sample.

Another object of the invention is the provision of a sample mounting means for a radiation image furnace wherein the sample is mounted for minute universal adjustment with respect to the concentrated radiant energy.

Another object of the invention is the provision of a radiation image furnace employing an energy projection arrangement capable of being adjusted to various positions whereby the radiant energy may be converged upon a sample in a horizontal position or in a vertical position without appreciable loss of energy.

Another object of the invention resides in the mounting arrangements for the components of a radiation image furnace employing an electric arc as a radiant heat source and utilizing ellipsoidal mirrors or reflectors as energy transmitting means which are arranged for minute adjustments to effectively control the transmission of the radiant energy and its concentration on a sample or specimen to obtain the most efficient utilization of the radiant energy.

Another object of the invention relates to a relatively movable supplemental frame carrying one of the components of the energy concentration system and the specimen to be subjected to the radiant energy wherein the frame is movable for supporting a specimen or sample in a horizontal or vertical position.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

FIGURE 1 is a side elevational view of an arc producing means and radiation image furnace construction of the invention;

FIGURE 2 is a schematic illustration of the arrangement of energy concentrating components of the radiation image furnace;

FIGURE 3 is a longitudinal sectional view illustrating the mounting means for one of the energy concentrating mirrors and adjustable means for controlling the amount of energy transmitted to the sample;

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FIGURE 4 is an end elevational view of the arrangement shown in FIGURE 3;

FIGURE 5 is a detail sectional view taken substantially on the line 5-5 of FIGURE 3;

FIGURE 6 is a sectional view taken on the line 6-6 of FIGURE 3;

FIGURE 7 is a top plan view of the supplemental frame supporting certain components of the furnace and mounting means for the sample;

FIGURE 8 is a sectional view taken substantially on the line 8-8 of FIGURE 7;

FIGURE 9 is a fragmentary sectional view taken substantially on the line 9-9 of FIGURE 8;

FIGURE 10 is a sectional view illustrating an energy reflecting component employed with the ellipsoidal energy transmission system when the specimen supporting means is in a vertical position;

FIGURE 11 is a detail view of an adjusting means forming a component of the furnace construction;

FIGURE 12 is a side elevational view of the means adapted to support the sample or specimen;

FIGURE 13 is a sectional view taken substantially on the line 13-13 of FIGURE 7;

FIGURE 14 is an enlarged sectional view taken substantially on the line 14-14 of FIGURE 13;

FIGURE 15 is an enlarged sectional view taken substantially on the line 15-15 of FIGURE 12;

FIGURE 16 is a sectional view taken substantially on the line 16-16 of FIGURE 12;

FIGURE 17 is a view of the sample supporting means in vertical position illustrating a modified form of actuating means for the movable frame;

FIGURE 18 is a sectional view illustrating a cooling arrangement for a mirror utilized with the sample in a vertical position;

FIGURE 19 is a detail view illustrating the strut connection for the supplemental frame, and

FIGURE 20 is a front elevational view of a control center for electrically energized components for the furnace.

Referring to the drawings in detail, and initially to FIGURE 1, there is illustrated a main support or frame 10 providing a mounting for the unit 12 containing the arc producing construction and control devices for the arc source of radiant energy and for supporting other components of the arc image furnace construction.

FIGURE 2 illustrates schematically the basic optical components including an ellipsoidal mirror or curved reflector 14 which forms a part of the arc producing unit 12 shown in FIGURE 1, a second ellipsoidal mirror or energy converging means 16 and a diaphragm 18 through which the radiant energy is projected from mirror 14 to the mirror 16.

The source of radiant energy is an electric arc 21 formed between a positive electrode 20 and a negative electrode 22, the arc being at the principal focus of the ellipsoidal or curved mirror 14, the radiant energy from the arc being reflected from mirror 14 to the mirror 16 and rereflected to the focus of the second mirror. As shown in FIGURES 1 and 2, the mirrors 14 and 16 are spaced a distance equal to the sum of the working distances of the two mirrors, the working distance being the distance from the surface of a mirror to its far focus or its figure of confusion.

Arranged adjacent the axis of the ellipsoidal mirror 16 and near the principal focus of the mirror 16 is a sample supporting means 24 which is mounted for adjustment through the medium of means hereinafter described. The sample support is inclusive of a chamber 26 with a sample S mounted therein.

The chamber may be composed of fused quartz or other transparent heat-resistant materials which do not

appreciably impede the transmission of the radiant energy. The chamber 26 may be provided with means for evacuating the same or filling the chamber with gases or liquids.

The arc lamp or structural arrangement for producing the electric arc utilized as the radiant energy source includes a housing 30 supported upon a member 32 mounted upon the supporting frame 10. The positive electrode or carbon 20 is supported by a suitable head 34 mounted upon a pedestal 36. The electrode supporting head 34 is formed with a spherically shaped surface 38 arranged to redirect heat energy from the arc 21 through the arc onto the reflecting surface 40 of the ellipsoidal mirror 14 whereby the major amount of radiant heat emanating from the arc is projected upon the ellipsoidal reflecting surface 40 and effectively utilized.

The housing 30 is provided with a relatively movable end closure or door 42 which may be hinged or otherwise articulately supported by the housing. The mirror 14 is adjustably mounted by means (not shown) carried by the end closure 42 whereby the mirror may be properly adjusted with respect to the arc at the focal point of the mirror 14. The positive electrode supporting means includes a controlled arrangement (not shown) for feeding the electrode 20 forwardly at a rate to compensate for the burning away of the material of the electrode.

The negative electrode 22 is supported by a mounting means 44 which is angularly adjustable to dispose the tip or extremity of the electrode 22 slightly below the tip of the positive electrode 20 in producing an arc between the electrodes. A driving means (not shown) is provided for the negative electrode 22 for advancing this electrode at a rate to compensate for the burning away of the material of the electrodes. The driving means for both the positive and negative electrodes are motivated by electric motors and suitable controls are provided to adjust the feed rates of the respective electrodes in order to maintain the arc at the principal focus of the ellipsoidal reflector 14.

As the driving and control means for the electrodes are of conventional construction, they have not been shown in detail. The region of the arc flame is ventilated in order to minimize the deposition of volatiles from the arc on the reflecting surface 40. A hollow shroud 43 is disposed above and adjacent the negative electrode 22 and is connected by means of ducts 49 and 50 with a blower 51 driven by a motor 52.

The rotation of the blower 51 exhausts air from the region of the arc through shroud 43 and conduits 49 and 50 for discharge through an exhaust pipe or chimney 53. An additional vent tube 54 is in communication with the interior of the housing 30 for ventilating of the housing. The motor 52 operates a second blower 55 which is connected by suitable duct means, a portion of which is shown at 56, with the supporting head 34 for the positive electrode 20 for delivering jets of air toward the arc formed at the extremity of the electrode 20 and generally along the positive electrode for bending the arc flame toward the shroud 43.

The apparatus above described for producing the arc or source of radiant heat is contained within the housing 30 and the electrodes controlled so as to maintain the arc or source of radiant heat at the principal focus of the ellipsoidal mirror 14. The electrodes and the electrode feed control motors are supplied with electric current from a suitable power source. The front wall 31 of the housing is provided with an opening 33 through which the radiant heat energy is projected by the mirror 14.

The frame 10 is provided with a platen portion 60 upon which is mounted a supplemental frame 62 supporting the second ellipsoidal mirror or reflector, the sample supporting means and controls for regulating the amount of radiant energy projected onto the second mirror 16 and other controlling devices pertaining to the arc image furnace construction. The supplemental frame 62 is

articulately mounted with respect to the radiant energy source and housing 30 containing the components and controls for producing the arc.

With particular reference to FIGURES 1, 7, 8, 10 and 11, the articulately mounted means or supplemental frame 62 is carried by a pair of spaced pedestals or supports 64 bolted or otherwise securely fastened to the platen 60. The supplemental frame 62 includes a yoke-like member 66 formed with spaced boss portions 68 which are bored to accommodate rods or shafts 69 and 70, which, as shown in FIGURE 7, are arranged in parallelism. The distal ends of the rods 69 and 70 are held in spaced relation by means of a transversely extending member 72, shown particularly in FIGURE 19.

The member 72 is formed with boss portions 73 bored to accommodate the ends of the shafts 69 and 70. As shown in FIGURES 7 and 8, the member 66 is formed with upwardly extending boss portions 74 which are bored to accommodate transversely aligned pins or shafts 76 which form pivotal supports or trunnions for the member 66. The pins 76 are mounted by journal blocks 78 secured to the upper ends of the pedestals 64. The blocks 78 are equipped with set screws 79 which are drawn into engagement with the pins 76 to secure the pins in the blocks 78.

In this manner the supplemental frame 62 is supported for pivotal or articulate movement about the axis of the pins 76. The parallel rods or shafts 69 and 70 provide ways or track means supporting components of the arc image furnace construction whereby certain of the components may be adjusted lengthwise of the ways. Mounted upon the rods 69 and 70 is a member 82 upon which is mounted the second ellipsoidal mirror or reflector 16. The member 82 is of hollow configuration as shown in FIGURE 3 to accommodate the mirror 16 and is formed with a section 84 having boss portions 85 bored to receive the rods 69 and 70.

The boss portions 85 are of substantial length in order to provide a stable mounting for the reflector 16. The rods 69 and 70 provide a support for a diaphragm 87 formed with a central circular opening 88. The diaphragm 87 provides a mask which is movable axially of the reflector 16 along the rods 69 and 70 for regulating or controlling the amount of heat transmitted to the reflector 16 from the reflector 14. Mounted upon the rod 70 is a bracket 90, shown in FIGURES 3 and 5, which may be secured to the rod by a pin 91 or other securing means.

A boss portion 93 formed on the central web section 94 of member 66, is provided with an opening to accommodate a shaft 96 which is arranged in parallelism with the shaft 70 and which is secured to the boss 93 by a pin 97. The diaphragm or heat controlling means 87 is secured to a member 98 slidably mounted upon the shaft 96. The shaft 96 is formed with a longitudinally extending spline or groove 99 and the bracket or member 98 provided with a key 100, shown in FIGURE 6, which cooperates with the spline 99 to prevent relative rotation between the shaft 96 and the bracket 98.

Rotatably supported in openings formed in boss portion 102 of the arm 90 and boss portion 104 on the web 94 is a threaded shaft 106. The bracket 98 is provided with a transverse projection 108 provided with a threaded bore into which the shaft 106 is threaded whereby rotation of shaft 106 effects longitudinal movement of the bracket 98 and the mask 87. A motor 112 is mounted by the arm 90 and is arranged to rotate the shaft 106 to adjust the relative position of the diaphragm 87, the motor 112 being of the reversible type so as to effect movement of the bracket 98 in either direction.

The supplemental frame 62 including components carried thereby is movable or adjustable about the axes of the trunnions or pins 76 from a horizontal position as shown in FIGURES 1 and 3 to a vertical position illustrated in broken lines in FIGURE 1 and in full lines in

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the form of the modification illustrated in FIGURE 17. FIGURES 1, 7, 8, 10 and 11 illustrate a manually operable means for adjusting the position of the frame structure 62.

As particularly shown in FIGURES 7, 8 and 10 a yoke 114 is disposed between depending portions 115 of the member 66, the yoke being provided with pins 116 which extend into bores formed in the depending portions providing a pivotal or articulate connection between the yoke 114 and member 66. The yoke is provided with a boss 118 bored to receive the end of a shaft 120 secured to the boss 118 by a pin 121. Disposed interiorly of the base frame 10 and secured to suitable means provided therein are brackets 122.

Disposed between the brackets 122 is a yoke 124 having boss portions 125 and 126. The boss portion 125 is equipped with a pin 126 which is journaled in the bracket 122. The boss 126 is bored to accommodate a bearing sleeve or bushing 127 through which extends a shaft 128, the shaft being journally supported by the bracket 123 and bushing 127. A mitre pinion 130 is fixedly mounted on the shaft 128 and is in mesh with a mitre gear 132 as shown in FIGURES 10 and 11.

The axial bore in the mitre gear 132 is threaded to cooperate with a threaded portion 134 of the shaft 120. The yoke 124 is formed with a boss portion 136 having an opening receiving a tenon portion 139 on the gear 132, an abutment or collar 140 being secured to the tenon 139 on the gear 132. Through this arrangement the gear 132 is rotatable relative to the yoke 124 but is restrained against longitudinal movement.

The end of the shaft 128 is provided with a polygonally shaped portion 141 adapted to receive a crank or other suitable tool for rotating the shaft. When it is desired to change the position of the supplemental frame structure 62, the operator affixes a crank to the shaft 128 rotating the pinion 130 and the mitre gear 132, and through the threaded connection between the mitre gear and the threaded portion 134 of shaft 120, the frame may be raised to a vertical position or lowered as desired. FIGURES 1 and 7 illustrate the supplemental frame 62 in a horizontal position with the axes of the mirrors 14 and 16 in aligned relation.

FIGURE 10 illustrates the positions of the frame operating components with the frame 62 disposed in a vertical position. The mirror 16 is supported by the rectangularly shaped hollow member 82. The member 82 is formed with an inwardly extending flange 144 as shown in FIGURE 3. Welded or otherwise secured to the flange 144 are members 146 which are bored and threaded to accommodate respectively rods 147 and 148 shown in FIGURES 3 and 4. The rods 147 and 148 are provided respectively with manipulating knobs 149 and 149'.

Arranged adjacent and peripherally of the mirror 16 is an annular member or mirror support 150, lugs 151 being supported by the annular member 150 and engaging the rim or periphery of the mirror 16. The rods 147 and 148 extend through openings formed in the annular member 150, the extremities of the rods being provided with abutments or nuts 153, one of which is shown in FIGURE 3.

Mounted on each of the rods and spaced from the annular member 150 is a collar 155, a coil spring 156 being disposed between the collar 155 and the annular member 150 to resiliently retain the annular member and the mirror 16 in a predetermined position dependent upon the adjustment effected through rotation of the rods 147 and 148.

The flange portion 144 at the lower region as viewed in FIGURE 3 is provided with an opening to accommodate a rod 158, the forward end of the rod extending through the flange 144 and being provided with a nut or abutment 159. A spring 160 surrounds the rod and is disposed between the flange 144 and the annular member 150, and a second spring 161 surrounds the rod and is dis-

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posed between the flange 144 and a collar 162 fixed to the rod. Through this arrangement the annular member in the region of the rod 158 is resiliently held in a relatively stationary position.

The reflector 16 may be tilted or adjusted about the rod 158 as a pivot zone by manipulation of the knobs 149 and 149', rotation of the knobs moving the reflector 16 in angular positions for the purpose of causing the radiant energy from the reflector 16 to be directed or converged onto the sample or specimen S at the principal focus of the reflector as illustrated schematically in FIGURES 2 and 3.

Means is provided for visually determining the angles of convergence of the radiant energy from the reflector 16 to assure that the sample or specimen is subjected to the concentration of flux from the mirror 16.

With the particular reference to FIGURES 3 and 6, there is disposed adjacent the diaphragm or temperature modulator 87 a relatively movable mask or door 166 which is articulately or pivotally secured to the temperature modulator 87 by a hinge 168.

The temperature modulator plate 87 is provided with a cylindrical tubular member 170 in which is slidably mounted a latch or keeper 172 connected to a flexible cable 173 for manipulating the latch 172. The hinge structure 168 embodies a spring means 169 normally biasing the mask 166 toward an open position, the latch 172 being arranged to retain the mask 166 in a position as shown in FIGURES 3 and 6 blocking or interrupting the projection of heat energy from the mirror 14. The mask 166 is adapted to be closed manually.

As shown in FIGURE 6, the mask 166 is provided with a plurality of small openings 176, there being four shown in FIGURE 6, which are equally spaced from the center of the mask 166 aligned with the axis of the mirrors when the mask is in energy flux obstructing position. Mounted upon the reflector supporting member 82 is a plate 178 provided with an opening 179. Secured to the plate adjacent the opening is a rectangularly shaped frame or bracket 180 in which a member 182 of dark colored glass is slidably supported having a finger grip portion 183 to facilitate manual movement of the member. The crown of the reflector 16 is provided with an opening 184. The axis of the openings 179 and 184 coincide with the axis of the mirror 16.

A rotatable plate or shutter 186 of circular contour is journally mounted by the housing of an electrically energizable motor 188, the motor housing being provided with a manipulating knob 189. The motor housing is provided with a circular plate 190 which is held in frictional contact with the outer surface of the plate 178 by means of lugs 191 arranged about the periphery of the circular plate 190.

The shutter 186 is formed with a circular opening 192 at a radial distance from the axis of the shutter whereby it is adapted to be aligned with the axis of the mirror 16 during each revolution of the shutter. The shutter 186 is rotated for certain purposes hereinafter explained. The operator, by grasping the manipulating grip 189, is enabled to adjust the housing of the motor 188 and the shutter 186 about the axis of the motor in order to bring the opening 192 into alignment with the openings 179 and 184 as shown in FIGURE 3, when the motor 188 is not energized.

When the operator desires to position the specimen S at the region of the principal focus of energy flux from the mirror 16, that is, at the point of convergence of the energy flux from the mirror, the mask 166 is moved to closed or energy interrupting position as shown in FIGURE 6. The arc is then struck or formed between the electrodes 20 and 22, and the heat and light energy from the arc projected through the several small openings 176 in the mask 166 permitting minute rays of heat and light energy to reach the reflector or mirror 16 for rereflection toward the sample S.

The purpose of the mask 166 is to block practically all of the light and heat energy while the operator makes the proper adjustments to concentrate the energy on the sample or specimen S. With the mask 166 in closed position, the operator moves the housing of the motor 188 manually to a position bringing the opening 192 in the shutter 186 in line with the axis of the mirror 16 as shown in FIGURE 3.

The operator is thus enabled to view the specimen S through the aligned openings and by adjusting the specimen supporting mechanism to be hereinafter described is enabled to adjust the position of the sample or specimen at the region of convergence of the energy reflected from the mirror 16. In the embodiment illustrated, there are four openings 176 in the mask 166, and four minute converging beams of light and heat energy will therefore be reflected from the mirror 16. When the operator has made the proper adjustments, these rays will appear as a single small area or point of light on the specimen.

Thus through the use of the aligned sight openings 179, 184 and 192, and the mask 166 in closed position, the operator is enabled to accurately position the sample without the eyes of the operator being subjected to the intense light and heat energy which would otherwise be transmitted with the mask 166 in open position. This arrangement likewise facilitates adjustment of the mirror 16 so that the energy flux converges at the focal point of the mirror 16. The shutter 182 may be pivotally supported upon the plate 178 in lieu of the slidable mounting.

Disposed between the pedestals 64 supporting the frame 62 is a U-shaped member 196, the furcations of which are provided with boss portions 198 bored to accommodate the trunnion pins 76 as shown in FIGURES 8 and 9. The member 196 is fixedly secured to the pins by set screws 200. As the pins 76 are locked to the blocks 78 by set screws 79, the member 196 is held in a relatively fixed position.

Mounted upon the member 196 is an aperture plate 202, shown in FIGURES 1 and 9, formed with an opening 204 adjacent the zone of confusion of the maximum flux density, the opening 204 being defined by a frusto-conically shaped surface 206, the taper of the surface being in substantial coincidence with the angle of divergence of the radiant energy projected through the opening toward the mirror 16. The plate 202 is of sufficient thickness to provide for a cooling channel 208 connected with a coolant supply such as water by tubular means (not shown). It is essential to employ a coolant for the aperture plate 202 by reason of its being positioned adjacent a region of maximum concentration of radiant energy.

The invention is inclusive of means cooperating with the rotatable shutter 186 to enable the operator to inspect the sample through the opening 179 during the projection of radiant energy onto the sample. As particularly shown in FIGURES 9 and 10, the bight portion 197 of member 196 is bored to accommodate a tenon portion 210 of a housing 212 containing reduction gearing. An electrically energizable reversible motor 214 is supported by the housing 212 and adapted to drive an output shaft 216 through the reduction gearing contained within the housing 212.

Secured on the shaft 216 is an arm 218 having at one extremity a circular disk or element 220. The disk 220 is positioned a distance from the axis of the shaft 216 so that during rotation of the motor, the disk 220 intermittently blocks or intercepts the energy flux which would normally be projected through the aperture 204. The opposite end of the arm 218 is provided with a weight 222 which substantially balances the arm 218 about the axis of the shaft 216. Both motors 188 and 214 are preferably of a high speed hysteresis type.

When the operator desires to examine the specimen or sample S without interrupting the transmission of ra-

diant energy for a sustained period of time, the motors 188 and 214 are energized to simultaneously rotate the disk 220 and the shutter 186. The motors operate at the same speed and the operator manually adjusts the position of the housing of the motor 188 by rotating the knob 189 to shift the relative angular position of the aperture 192 so as to enable the synchronization of the disk 220 in a position blocking the energy aperture 204 at the same instant that the opening 192 in the shutter 186 is in registry with the sight opening 179.

Thus at each revolution of the disk 220 and the shutter 186, the operator may visually inspect the specimen or sample through the sight opening 179 without viewing the light energy from the arc. The provision of manual adjustment for the housing of the motor 188 driving the shutter 186 provides an effective means for quickly synchronizing the position of the opening 192 in the shutter with the position of the disk 220.

If a higher frequency of interruption of the energy flux is desired, a similar disk may be secured to the opposite end of the arm 218 in lieu of the weight 222 and a second opening formed in the shutter 186 diametrically opposite the opening 192. In such arrangement the frequency of interruptions of the energy flux may be doubled without modifying the rotational speed of the shutter 186 and the arm 218.

It is imperative that the disk 220 be maintained out of registration with the aperture 204 when the motor 214 is not rotating. Secured to the member 196 is a two-pole magnet 224 and a similar two-pole magnet 226 is secured to the arm 218, the magnets being in contiguous relation as shown in FIGURE 9. Thus when current flow to the motor 214 is interrupted and the same comes to rest, the magnets 224 and 226 are positioned in relation to each other so that the magnetic flux is effective to maintain the arm 218 in a position with the disk 220 out of registration with the radiant energy flux. This avoids any possibility of burning the disk 220.

FIGURES 1, 7 and 12 through 16 illustrate means for supporting a sample or specimen, the arrangement including adjustable components whereby the specimen may be adjusted in various directions to accurately position the specimen or sample or a particular portion thereof in the zone of convergence or focal point of the energy transmitted or reflected from the ellipsoidal mirror 16. The sample or specimen supporting arrangement is mounted upon the parallel ways or rods 69 and 70.

As particularly shown in FIGURES 12 and 13, the arrangement includes a plate-like member 230 extending across the rods 69 and 70. The member 230 is formed with portions 232 and 233 having angular surfaces adapted to form a V-shaped configuration, the angular surfaces engaging the rods 69 in the manner shown in FIGURE 13. The converging surfaces of portions 232 and 233 prevent transverse displacement of the mounting plate 230.

The portion of the plate 230 adjacent the rod 70 is formed with two longitudinally spaced pad portions 235 adapted for engagement with the rod 70. Disposed beneath the rods 69 and 70 are transversely extending clamp plates 237 provided with threaded openings accommodating bolts 239 which extend through openings in lugs 240 formed on the plate 230. Through this arrangement the mounting plate 230 may be adjusted lengthwise of the ways or rods 69 and 70 and clamped in an adjusted position.

The mounting plate 230 supports a member 242 which is slidably mounted by means of a dove-tail configuration formed on a member 244 which is secured to the mounting plate 230 by means of screws 246. As shown in FIGURE 12, there is secured to an end region of the mounting plate 230 a motor mounting 248 which supports a reversible motor 250 contained within a suitable sheet metal casing 251.

The motor 250 is provided with high ratio speed re-

ducing gearing, the output shaft 252 of the motor being coupled to a lead screw 254 through the medium of a coupling 256.

The threaded or spiral portion of the lead screw 254 cooperates with a threaded opening in the slide 242 whereby rotation of the reversible motor 250 rotates the lead screw in one direction or the other to move the slide 242 lengthwise of the mounting plate 230.

The slide 242 supports a member 260 which is secured to the member 242 by means of bolts 262 and is formed with a dove-tail configuration adapted to receive a tang portion 264 formed on a transverse slide 266 as particularly shown in FIGURES 13 and 14. Secured to the member 260 by mounting means 268 is a motor 270 provided with high ratio speed reducing gearing. The output shaft 272 of the motor 270 is coupled to a lead screw 276, the lead screw being threaded into a threaded bore in the transverse slide 266.

A rectangularly shaped sheet metal casing 278 encloses the slides 242 and 266 to prevent the ingress of foreign matter into the ways supporting the slides and associated components. Secured to the slide 266 is a bracket 280 and an upwardly extending leg of the bracket 280 is secured to a tubular casing or member 282 fastened to the bracket by means of rivets 283. One wall 284 of the rectangularly shaped housing 282 projects upwardly beyond the remaining walls as shown in FIGURE 13.

Secured to the wall portion 284 is a vertically disposed member 286 having a dove-tailed configuration adapted to slidably receive a tang 288 of a vertical slide 290 as shown in FIGURES 12, 13 and 15. A sheet metal housing 292 encloses the member 286 and associated components.

Secured to the tubular housing 282 and the member 286 is a motor mounting 294 which supports a motor 298. The motor 298 is of the same construction as motors 250 and 270, the output shaft thereof being coupled with a lead screw 300 which is threaded into a threaded bore in the vertical slide 290.

The vertical slide 290 supports upwardly extending plates 302 and 304, the plates being connected to a U-shaped bracket 306 by means of rivets 307. The bracket 306 is provided with a mounting plate 308 to which is secured a platform 310 adapted to carry a sample or specimen mounting 312 arranged to support a sample or specimen 314. The motor 298 is reversible to elevate or lower the bracket 306.

The motors 250, 270 and 298 are of the high speed type, the armatures rotating at several thousand r.p.m. and the reduction gearing associated with each motor reduces the speed so that the output shafts rotate at approximately 30 r.p.m. Through this arrangement very small high speed motors may be used and sufficient power derived through the high ratio reduction to drive the longitudinal, transverse and vertical slides at a comparatively low speed.

A flat plate 279 having an opening to accommodate the upwardly extending housing or casing 282 and the upwardly extending leg of bracket 280 lies upon the upper surface of the horizontal portion of housing 278 and is movable with the housing 282 during longitudinal and transverse adjustments. The plate 279 serves to close the enlarged opening in the housing 278 to accommodate movements of the casing or housing 282, thereby providing an enclosure for the slides 242 and 266 and associated mechanism.

Through the arrangement above described, a substantially universal adjustment is provided for the specimen or sample support 310. Energization of the motor 250 moves the longitudinally movable slide 242, the bracket 280, housing 282 and specimen support 310 in a direction longitudinally of the axis of the mirror 16. Energization of the motor 270 moves the slide 266, housing

282 and support 310 in directions transversely of the axis of the mirror 16, and energization of the motor 298 effects vertical movement of the members 302, 304 and the support 310 so that the specimen may be adjusted in a vertical plane.

A control box 318 for the several electrically energized components of the mechanism is illustrated in FIGURE 20 mounted on the member 82. The switches on the box are of manually operable toggle type. In the central neutral position of the toggle switches the motors are deenergized, in one angular position of each switch its respective motor is driven in one direction and in another angular position of the toggle member, the motor is driven in the opposite direction. In FIGURE 20 the toggle switch 320 controls the motor 270 for moving the transverse slide 266.

The toggle switch 321 actuates or controls the motor 298 for raising and lowering the specimen support 310. The toggle switch 322 controls the motor 250 for moving the longitudinal slide lengthwise of the axis of the reflector to bring the specimen to the focal point of the mirror 16. The toggle switch 323 controls the motor 112 for moving the temperature modulator or mask 87 lengthwise of the principal axis of the mirrors. Toggle switch 324 controls both motors 188 and 214 for rotating the shutters 186 and 220.

The control center or box 318 includes a master motor speed control member 325 which regulates the speed of the several motors 270, 112, 250 and 298. An emergency stop switch controlled by a knob 319 is also contained in the control box 318 adapted to interrupt the power supply to the apparatus.

The components of the apparatus forwardly of the housing enclosing the arc producing mechanism, the supplemental frame 62 and the mirror 16 and supporting means are contained in a sheet metal housing 326 shown in section in FIGURE 1. The housing is fashioned in two sections 327 and 328 which are removably joined together in a diagonal region or plane indicated at 329 passing through the axis of the trunnion pins 76.

The section 327 of the enclosure 326 is secured to the member 82 supporting the mirror 16 and to the rods 69 and 70 by suitable means (not shown). The section 328 is made removable to facilitate adjustment of the supplemental frame to a vertical position as hereinafter described. The transverse wall 330 of the housing section 328 is formed with an aperture bounded by a flange 331 in which is slidably telescoped a collar 332. The collar is adjustable in order that the same may be engaged with the wall 31 of the arc enclosing housing at a region surrounding the aperture 33.

The frame structure 62 is movable about the axis of the trunnion pins 76 to a position wherein the ways or shafts 69 and 70 are disposed in a vertical position and with the specimen support mounted in a vertical position as shown in broken lines in FIGURE 1.

A vertical position of the specimen is particularly advantageous where the specimen provides its own container and a region thereof fused by downwardly directed radiant energy from the mirror 16 when disposed with its axis in a vertical position. When the mechanism is adjusted to the vertical position shown in broken lines in FIGURE 1, a strut 336 is connected with the bracket 72 as shown in FIGURES 17 and 19 by means of a pin 338, the other end of the strut being connected to a fitting 340 by means of a removable pin 342.

When the arrangement is in horizontal position, the use of the strut 336 is dispensed with by removing the pins 338 and 342. The function of the strut is to stabilize or lend rigidity to the mechanism when the same is adjusted to or disposed in a vertical position. With the mirror arrangement of the furnace construction disposed in a vertical position, means is provided at the axis of the trunnion pins 76 for redirecting radiant energy from

the mirror 14 to the mirror 16 when the axis of one mirror is normal to the axis of the other.

FIGURES 10 and 17 show the arrangement of supplemental energy reflecting means in position adjacent the trunnion pins 76, and FIGURE 18 illustrates the arrangement for adjusting the position of the energy reflecting means and water cooling the same. Frame member 66 is formed with a pad portion 345 adapted to accommodate a bracket or fitting 346 which is adapted to be mounted on the pad by means of removable screws 348.

The supplemental reflecting means comprises a planar mirror 350 mounted within a rectangularly shaped metal casing or frame 352, a gasket 353 being arranged between the mirror and a peripheral flange of the casing for effecting a sealed structure. Disposed at the obverse side of the mirror 350 is a plate 356 provided with a peripheral groove accommodating a sealing gasket 358 which engages the mirror. The central region of the plate 356 is recessed as at 360 providing a chamber to accommodate cooling fluid such as water.

The plate is provided with a suitable inlet tube 363 and an outlet tube 365 to convey circulating cooling water through the chamber or recess 360 from a water supply. The bracket 346 is provided with at least three threaded openings adapted to accommodate the threaded portions of adjusting members 367, the members being provided with knurled manipulating knobs 368. Each of the adjusting members 367 is formed at its end with a ball or spherically-shaped portion 370 which is disposed in a socket formed in a fitting 372 secured to the plate 356 as particularly shown in FIGURE 18.

In the embodiment illustrated, three adjusting screws 367 are employed spaced to provide for a universal adjustment of the planar mirror 350. By manipulating the knobs 368 of the screws, the operator is enabled to redirect the radiant energy from the mirror 14 passing through the aperture 204 in plate 202 onto the surface of the mirror 16 when the axis of mirror 16 is in a substantially vertical position for transmission to the specimen or sample S.

It is desirable to coat the obverse surface 351 of the mirror 350 to effect efficient reflection of the radiant energy to the mirror 16. It has been found that the surface 351 of the mirror coated with evaporated aluminum and silicon monoxide provides higher energy reflecting efficiency and such coating materials are not appreciably impaired by the high temperatures of the radiant heat energy. The fitting 346 carrying the mirror 350 is removably carried by the frame member 66 as it is used only when the frame 62 is arranged in a vertical position as shown in broken lines in FIGURE 1 and in FIGURE 17.

FIGURE 17 includes a modified form of means for moving the articulately supported frame 62 from a horizontal to a vertical position. In this form the pins 116' journaled in openings in frame member 66 are carried by a U-shaped yoke 380 which is connected with a piston rod 381 forming a part of a fluid actuator 382. The rod 381 extends into a cylinder 384 of the actuator and is equipped with a piston 386 reciprocable in the cylinder.

The lower end of the cylinder is provided with a tenon portion 388 which accommodates a pivot shaft 390 carried by a bracket 391 which is secured to a frame member 392 forming part of the main frame structure of the apparatus. Connected to the upper and lower end regions respectively of the cylinder 384 are tubes 394 and 396 which are adapted to convey fluid under pressure into and away from the cylinder 384 to effect reciprocation of the piston.

In FIGURE 17, the supplemental frame 62 is illustrated in a vertical position and is rigidly secured in such position by means of the removable strut 336. When it is desired to move the frame 62 into a horizontal position to align the axes of the ellipsoidal mirrors 14 and 16, the strut 336 is removed as described in reference to the

form of construction shown in FIGURE 1 and fluid under pressure such as oil or compressed air is introduced into the upper end of the cylinder 384 through the duct or tube 394.

The pressure fluid moves the piston 386 downwardly, which action effects pivotal movement of frame 62 about the trunnion pins 76 until the frame reaches a horizontal position. When it is desired to move the frame 62 into a vertical position, fluid under pressure is introduced into the opposite end of the cylinder through the tube 396. The strut 336 may then be replaced in the position shown in FIGURE 17 to lend stability to the structure in such position.

If desired, the interior of the housing 326 may be ventilated by means of a suitable blower (not shown). The arc image furnace of the invention provides a concentration system for radiant energy of improved efficiency and capable of producing temperatures at the region of the sample or specimen of upwards of 3500° C. or more. A higher temperature furnace of this character facilitates fusion of samples where the sample provides its own container thus avoiding contamination. The universal adjustment provided for the sample facilitates the concentration of maximum energy flux at a desired point or area and the heat modulator enables accurate control of the amount of energy directed onto the sample.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than as herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

We claim:

1. Apparatus of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, a first curved mirror disposed with the arc at the principal focus thereof, a frame, a second curved mirror mounted upon the frame and disposed to receive radiant energy from the arc reflected from the first mirror, means mounting the second mirror for adjusting the position of said second mirror relative to the frame, a sample support associated with the frame and disposed in the region of the principal focus of said second mirror, means mounting the sample support upon the frame arranged for adjusting the position of the sample support in longitudinal, transverse and vertical directions relative to the second mirror, and electrically energizable means for actuating the adjusting means for the sample support.

2. Apparatus of the character disclosed, in combination a pair of electrodes adapted to form an arc upon current flow through the electrodes, a first ellipsoidal mirror disposed with the arc at the principal focus thereof, a support, a frame articulately mounted on the support, a second ellipsoidal mirror mounted upon the frame and disposed to receive radiant energy from the arc reflected from the first ellipsoidal mirror, a sample support disposed in the region of the principal focus of the second ellipsoidal mirror, means carried by said frame adjustably mounting the sample support, adjustably mounted means for modulating radiant energy flux from the first mirror to the second mirror, means associated with said frame arranged to move the frame relative to the first ellipsoidal mirror, and radiant energy deflecting means for directing radiant energy flux from the first ellipsoidal mirror to the second ellipsoidal mirror when the axes of the ellipsoidal mirrors are in angular relation.

3. Apparatus of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, a first ellipsoidal mirror disposed with the arc at the principal focus thereof, a support, a frame articulately mounted on the support, a second ellipsoidal mirror mounted upon the frame and disposed to receive radiant energy from the arc reflected from the first ellipsoidal mirror, a sample support disposed in the region of the principal focus of the second

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ellipsoidal mirror, means carried by said frame adjustably mounting the sample support, adjustably mounted means for modulating radiant energy projected from said first mirror to said second mirror, and means for adjusting said second mirror relative to the frame.

4. Apparatus of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, a first ellipsoidal mirror disposed with the arc at the principal focus thereof, a support, a frame articulately mounted on the support, a second ellipsoidal mirror mounted upon the frame and disposed to receive radiant energy flux from the arc reflected from the first ellipsoidal mirror, a sample support disposed in the region of the principal focus of the second ellipsoidal mirror, means carried by said frame adjustably mounting the sample support, a housing enclosing said electrodes and said first ellipsoidal mirror, a second housing mounted by said frame enclosing the second ellipsoidal mirror, and means for adjusting the position of said frame and second housing relative to said first housing.

5. Apparatus of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, mounting means for the electrodes, a first ellipsoidal mirror disposed with its focus substantially coincident with the arc, a second ellipsoidal mirror, a support, a frame mounted by the support, said second ellipsoidal mirror being mounted on said frame, a sample supporting member disposed in the region of the principal focus of the second ellipsoidal mirror, means carried by said frame associated with the sample supporting member for adjusting the position of the said sample supporting member, electrically energizable means for actuating said member adjusting means, a plate having an opening formed therein for controlling radiation directed toward the second ellipsoidal mirror, a relatively movable mask arranged to obstruct radiant energy at the opening in said plate, said mask being provided with a plurality of small energy flux transmitting openings, and a sight opening in the second ellipsoidal mirror whereby the paths of the energy may be visually inspected to determine the path of the energy flux with respect to a sample mounted by the sample supporting member.

6. Apparatus of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, mounting means for the electrodes, a first ellipsoidal mirror disposed with its focus substantially coincident with the arc, a second ellipsoidal mirror, a support, a frame mounted by the support, said second ellipsoidal mirror being carried on said frame and disposed to receive radiant energy from the arc reflected from the first mirror, a plate formed with an opening of defined area, the center of the opening in the plate being substantially coincident with the axis of the second mirror, said plate being supported for movement along the axis of the second mirror for modulating radiant energy flux from the arc reflected from the first mirror, means for moving the plate, a door pivotally mounted on said plate and arranged when in closed position to cover the opening in the plate, spring means normally biasing the door toward open position, said door being manually movable to closed position, a keeper arranged to retain said door in closed position, means for actuating the keeper to release the door for movement to open position under the influence of the spring means, a sample supporting member disposed in the region of the principal focus of the second mirror, means carried by the frame adjustably mounting the sample supporting member, said door being provided with a plurality of small energy flux transmitting openings, and a sight opening in the second mirror whereby the paths of energy flux passing through the openings in said door may be visually inspected to determine the path of the energy flux with

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respect to a sample mounted by the sample supporting member.

7. Apparatus of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, a first ellipsoidal mirror disposed with the arc at the principal focus thereof, a support, a frame articulately mounted on the support adapted for adjustment to horizontal and vertical positions relative to the axis of the first ellipsoidal mirror, a second ellipsoidal mirror mounted upon the frame, means mounting said second ellipsoidal mirror on the frame for adjusting the relative position of said second ellipsoidal mirror, a sample support disposed in the region of the principal focus of said second ellipsoidal mirror, means associated with said frame for adjusting the relative position of the sample support, a temperature modulator associated with the frame, means for adjusting the temperature modulator for regulating the radiant energy flux projected to the second ellipsoidal mirror, electrically energizable means for adjusting the sample support, and radiant energy deflecting means for directing radiant energy to the second ellipsoidal mirror when the axes of the ellipsoidal mirrors are in angular relation.

8. Apparatus of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, a first ellipsoidal mirror disposed with the arc at the principal focus thereof, a support, a frame mounted on the support, a second ellipsoidal mirror mounted upon the frame and disposed to receive radiant energy from the arc reflected from the first ellipsoidal mirror, means mounting said second ellipsoidal mirror for adjusting the relative position of said second ellipsoidal mirror, a sample support disposed in the region of the principal focus of said second ellipsoidal mirror, means associated with said frame for adjusting the position of the sample support in longitudinal, transverse and vertical directions, a temperature modulator associated with the frame, electrically energizable means for adjusting the temperature modulator for regulating radiant energy flux to the second ellipsoidal mirror, and electrically energizable means for actuating the adjusting means for the sample support.

9. An arc image furnace comprising, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, mounting means for the electrodes, a first ellipsoidal mirror disposed with its principal focus substantially coincident with the arc, a second ellipsoidal mirror, a support, a frame mounted by the support, said second ellipsoidal mirror being carried by said frame, a sample supporting member disposed in the region of the principal focus of the second ellipsoidal mirror, means carried by said frame associated with the sample supporting member for adjusting the position of the said member, means for intermittently obstructing radiant energy flux from said first ellipsoidal reflector at the zone of least confusion, a plate rotatably supported adjacent the second ellipsoidal reflector and rearwardly thereof, said plate and said second ellipsoidal reflector each having an opening formed therein, and means for rotating said energy obstructing means and said plate in synchronism whereby the radiant energy is obstructed simultaneously with the registration of the opening in said plate with the opening in said reflector to facilitate visual inspection of the sample.

10. An arc image furnace comprising, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, mounting means for the electrodes, a first ellipsoidal mirror disposed with its focus substantially coincident with the arc, a second ellipsoidal mirror, a support, a frame mounted by the support, said second ellipsoidal mirror carried on said frame, a sample supporting member disposed in the region of the principal focus of the second ellipsoidal mirror, electrically ener-

gizable means associated with the sample supporting member for adjusting the position of the said member, rotatable means for intermittently obstructing radiant energy flux from said first ellipsoidal reflector at the zone of least confusion, a plate rotatably supported adjacent the second ellipsoidal reflector and rearwardly thereof, said plate and said second ellipsoidal reflector each having an opening formed therein, means for rotating said energy flux obstructing means and said plate in synchronism whereby the radiant energy is obstructed simultaneously with the registration of the opening in said plate with the opening in said reflector to facilitate visual inspection of the sample, and magnetic means for normally maintaining said energy flux obstructing means out of the path of the energy flux.

11. An arc image furnace comprising, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, mounting means for the electrodes, a first ellipsoidal mirror disposed with its principal focus substantially coincident with the arc, a second ellipsoidal mirror, a support, a frame mounted by the support, said second ellipsoidal mirror being carried by said frame, a sample supporting member disposed in the region of the principal focus of the second ellipsoidal mirror, means carried by said frame associated with the sample supporting member for adjusting the position of the said member, movable means for intermittently obstructing radiant energy flux from said first ellipsoidal reflector at the zone of least confusion, and shutter means movable in synchronism with said energy flux obstructing means to facilitate visual inspection of the sample when the latter is subjected to radiant energy from the arc.

12. An arc image furnace of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, mounting means for the electrodes, said mounting means being adapted to maintain the arc in a relatively fixed position, a first ellipsoidal mirror disposed with its principal focus substantially coincident with the arc, a second ellipsoidal mirror, a support, a frame mounted by the support, said frame including a pair of substantially parallel rods, means securing the rods in spaced relation, a temperature modulating member, means associated with said rods arranged to support the temperature modulating member, electrically energizable means for adjusting the position of said temperature modulator relative to the path of radiant energy flux, a sample support disposed in the region of the principal focus of the second ellipsoidal mirror, an element associated with the rods, and means adjustable relative to said element for controlling the position of the sample support relative to the principal focus of the second ellipsoidal reflector.

13. An arc image furnace of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, mounting means for the electrodes, said mounting means being adapted to maintain the arc in a relatively fixed position, a first ellipsoidal mirror disposed with its principal focus substantially coincident with the arc, a second ellipsoidal mirror, a support, a frame mounted by the support, said frame including a pair of substantially parallel rods, means securing the rods in spaced relation, a sample supporting means disposed in the region of the principal focus of the second ellipsoidal mirror, said sample supporting means including a platform supported by said rods, a member mounted on said platform and adjustable relative to the platform and lengthwise of said rods, second member supported upon said first member and adjustable in directions transversely of said rods, a third member extending upwardly from said second member and mounted thereon, said third member mounting said sample support and being adjustable in directions normal to the axis of said second ellipsoidal reflector, electrically energizable means for adjusting the relative position of

said first, second and third members, and manually operable switch means individual to each electrically energizable means to effect universal adjustment of the sample.

14. An arc image furnace of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, mounting means for the electrodes, said mounting means being adapted to maintain the arc in a relatively fixed position, a first ellipsoidal mirror disposed with its focus substantially coincident with the arc, a second ellipsoidal mirror, a support, a frame mounted by the support, said frame including a pair of substantially parallel rods, means securing the rods in spaced relation, a temperature modulating member, means associated with said rods arranged to support the temperature modulating member, electrically energizable means for adjusting the position of said temperature modulator relative to the radiant energy flux, a sample supporting means disposed in the region of the principal focus of the second ellipsoidal mirror, said sample supporting means including an element supported by said rods, a member mounted on said element and adjustable relative thereto, second member supported upon said first member and adjustable relative thereto, a third member mounted by said second member, said third member carrying said sample support and being adjustable relative to the second member, electrically energizable means for adjusting the relative position of said first, second and third members, and manually operable switch means individual to each electrically energizable means to effect universal adjustment of the sample.

15. An arc image furnace of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, a first ellipsoidal mirror disposed with the arc at the principal focus thereof, a support, a frame articulately mounted on the support adapted for adjustment to horizontal and vertical positions relative to the axis of the first ellipsoidal mirror, a second ellipsoidal mirror mounted upon the frame and disposed to receive radiant energy from the arc reflected from the first ellipsoidal mirror, means mounting said second ellipsoidal mirror for adjusting the relative position of said second ellipsoidal mirror, a sample support disposed in the region of the principal focus of said second ellipsoidal mirror, means associated with said frame for adjusting the relative position of the sample support, a temperature modulator associated with the frame, means for adjusting the temperature modulator for regulating the amount of radiant energy projected to the second ellipsoidal mirror, a housing enclosing the electrodes and said first ellipsoidal mirror, and a second housing enclosing said second ellipsoidal mirror, sample supporting and adjusting means and the temperature modulator.

16. An arc image furnace of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, first ellipsoidal mirror disposed with the arc at the principal focus thereof, a support, a frame articulately mounted on the support adapted for adjustment to horizontal and vertical positions relative to the axis of the first ellipsoidal mirror, a second ellipsoidal mirror mounted upon the frame and disposed to receive radiant energy from the arc reflected from the first ellipsoidal mirror, means mounting said second ellipsoidal mirror for adjusting the relative position of said second ellipsoidal mirror, a sample support disposed in the region of the principal focus of said second ellipsoidal mirror, means associated with said frame for adjusting the relative position of the sample support, a housing enclosing the electrodes and said first ellipsoidal mirror, a second housing enclosing said second ellipsoidal mirror and the sample supporting and adjusting means, a third housing disposed between said first and second

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housings, said second and third housings being in engagement at a diagonal plane through the articulate mounting of the frame, said second housing being movable with said frame to a vertical position, and said third housing being reversible and adapted to engage said first and second housings when the second housing is disposed in a vertical position.

17. An arc image furnace of the character disclosed, in combination, a pair of electrodes adapted to form an arc upon current flow through the electrodes, a first ellipsoidal mirror disposed with the arc at the principal focus thereof, a support, a frame articulately mounted on the support adapted for adjustment to horizontal and vertical positions relative to the axis of the first ellipsoidal mirror, a second ellipsoidal mirror mounted upon the frame and disposed to receive radiant energy from the arc reflected from the first ellipsoidal mirror, means mounting said second ellipsoidal mirror for adjusting the relative position of said second ellipsoidal mirror, a sample support disposed in the region of the principal focus of said second ellipsoidal mirror, means associated with said frame for adjusting the relative position of the sample support, a temperature modulator associated with the frame, means for adjusting the temperature modulator for regulating the amount of radiant energy projected to the second ellipsoidal mirror, a first housing enclosing the electrodes and said first ellipsoidal mirror, a second housing enclosing said second ellipsoidal mirror, the sample supporting and adjusting means and the temper-

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ature modulator, a housing section disposed between said first and second housings, said second housing and housing section being engaged about a diagonal plane through the articulate mounting of the frame, a collar carried by said third housing and engageable with said first housing, said second housing being movable with said frame to a vertical position, said housing section being reversible and adapted to engage the said second housing in vertical position with the collar in engagement with said first housing, means for adjusting the angular position of said frame, and removable strut means for securing said frame in rigid position when said frame is adjusted with the axes of said ellipsoidal mirrors in normal relation.

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