Dec. 25, 1956 W. N. YOUNG 2,775,440

AUTOMATIC BATCH FURNACE APPARATUS

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Fig.2

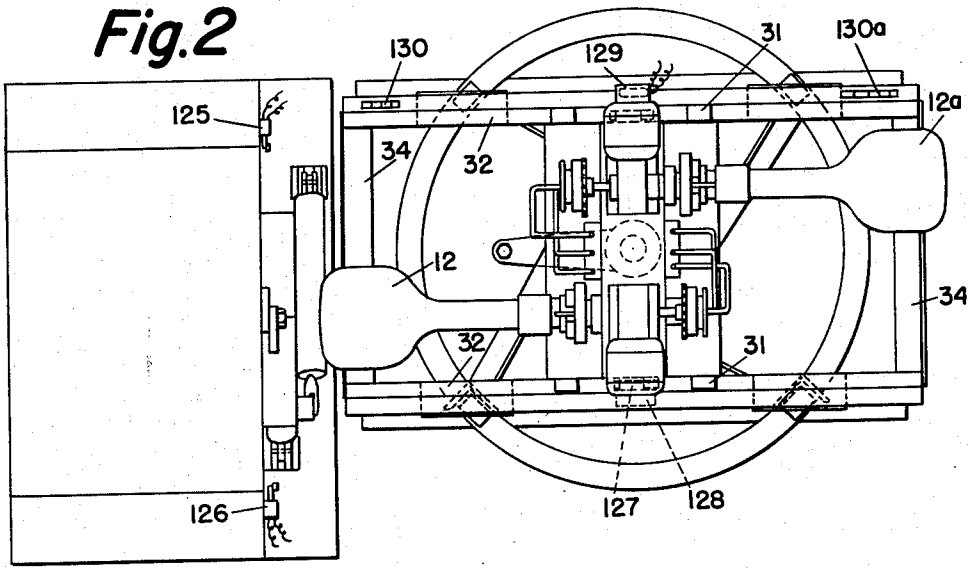
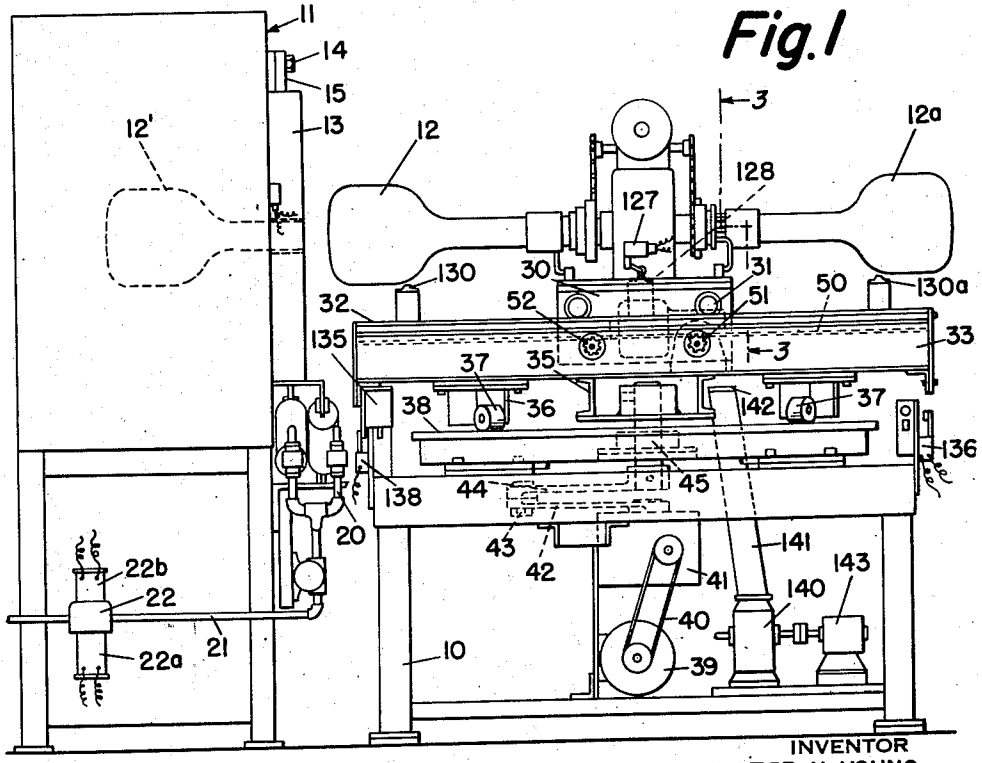


Fig.1



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AUTOMATIC BATCH FURNACE APPARATUS

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Fig.3

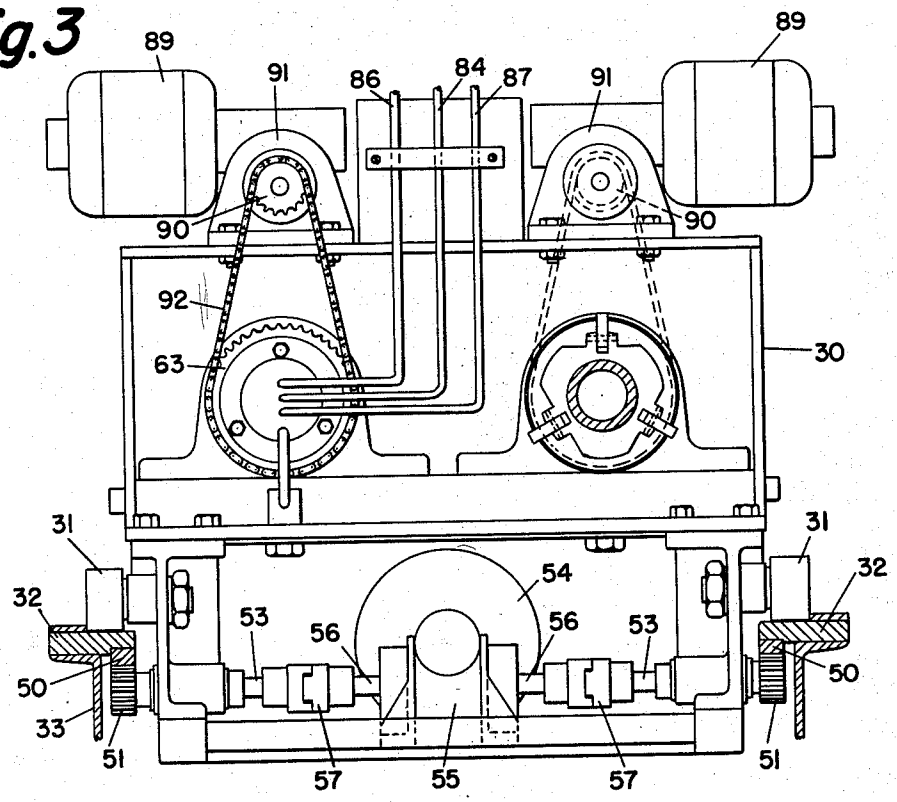

Fig.4

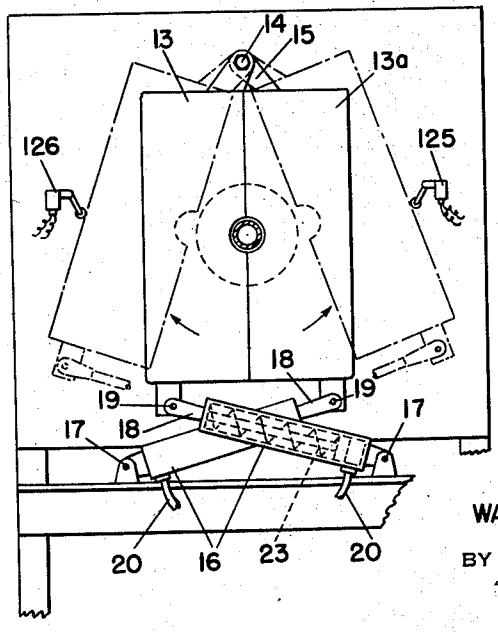

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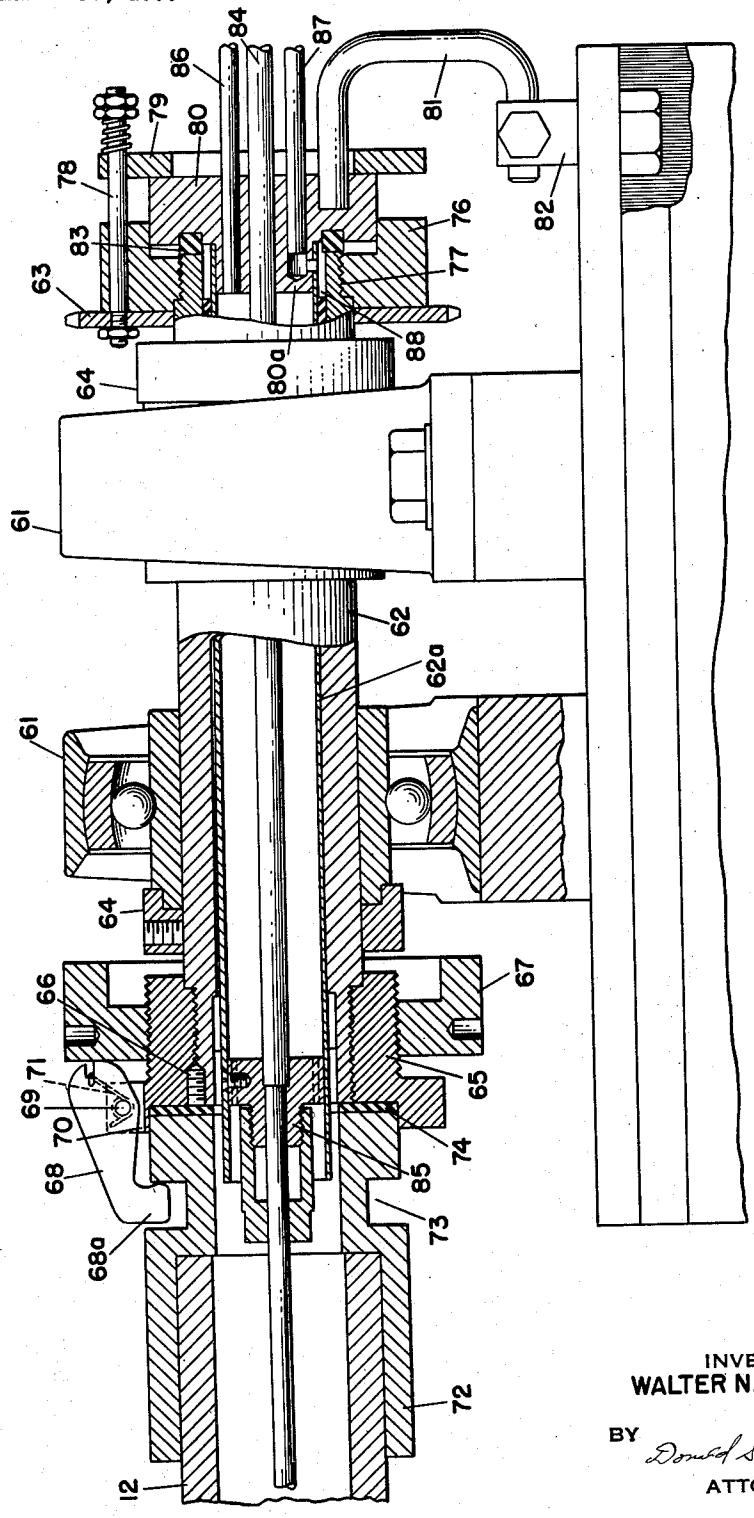
Fig. 5



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AUTOMATIC BATCH FURNACE APPARATUS

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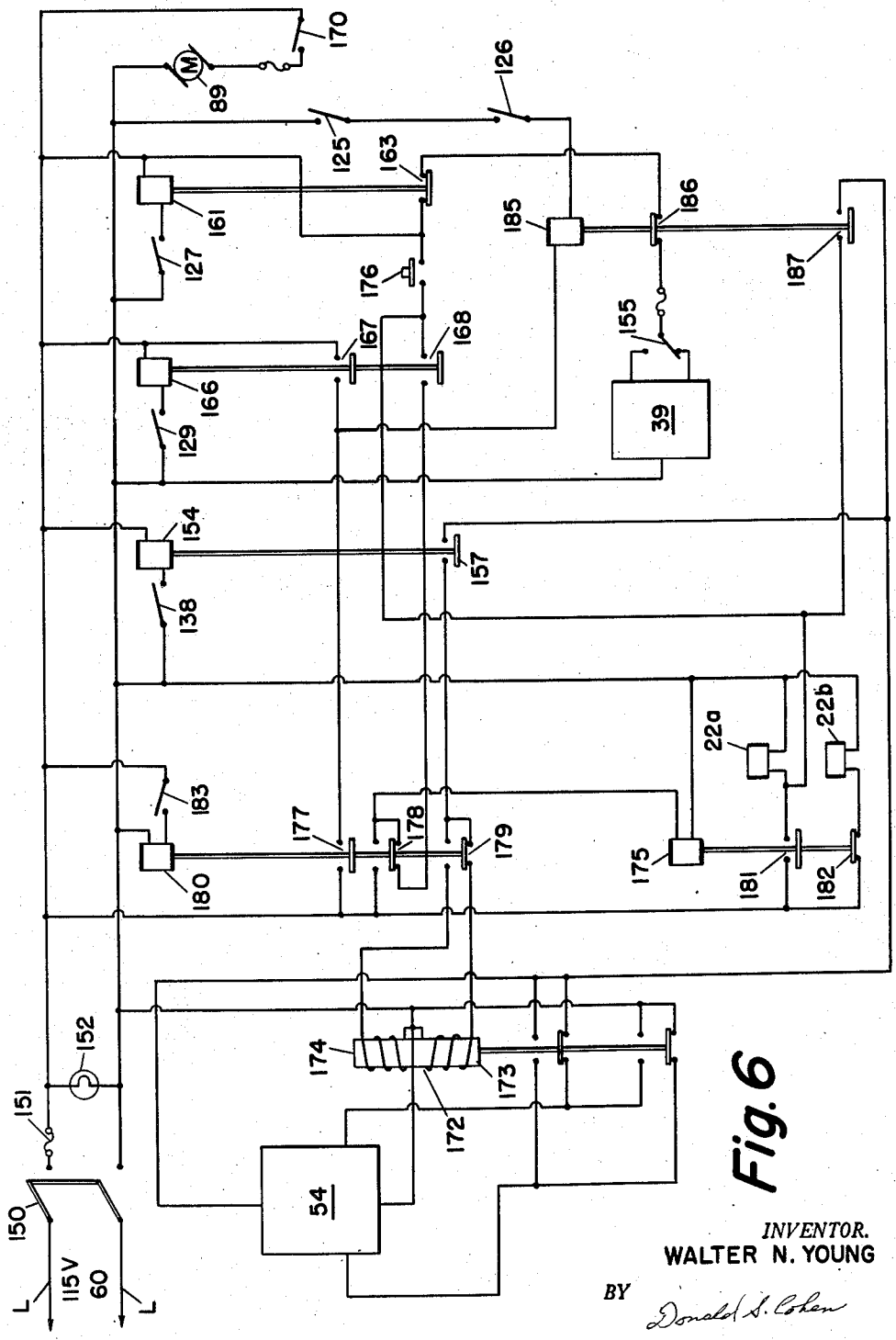

Fig. 6

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2,775,440

AUTOMATIC BATCH FURNACE APPARATUS

Walter N. Young, Doylestown, Pa., assignor to International Resistance Company, Philadelphia, Pa., a corporation of Delaware

Application March 13, 1953, Serial No. 342,067

5 Claims. (Cl. 263—7)

The invention is concerned with an apparatus for treating articles in a furnace by an automatically controlled batch type of operation. The apparatus is particularly adapted to the deposition of carbon on small ceramic bodies or substrates in the making of deposited carbon resistors.

The manufacturing processes for such articles involve the application and maintenance of particular conditions of gaseous mixtures under particular temperatures in closed chambers for considerable periods of time which may total several hours and to ensure articles which are uniform in character and of high quality requires careful and exacting control of various critical factors. Attempts to meet the conditions by an apparatus designed to operate on the continuous principle have encountered various difficulties which the present arrangement avoids.

The apparatus of the present invention achieves a high quality product and adequate production capacity and efficiency in a machine combination adapted to operate on the batch principle. Its general features include the combination of a furnace and associated mechanism in which a plurality of treating flasks are detachably mounted on a movable support which is bodily translatable and also rotatable whereby the flasks may be successively positioned in the furnace each flask in addition being individually and independently rotatable on its own axis. While one flask is being treated in the furnace, the other flask or flasks may undergo a suitable cooling period which is normally necessary before the articles may be exposed to the atmosphere. These functions therefore are carried on simultaneously with a corresponding increase in efficiency and capacity of the apparatus.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a view in elevation from the side of the complete assembled apparatus;

Fig. 2 is a top plan view thereof;

Fig. 3 is a vertical fragmentary view taken on the line 3—3 of Figure 1 showing particularly the carriage traversing means and the flask rotating means;

Fig. 4 is a view in elevation looking at the front of the furnace showing the door arrangement;

Fig. 5 is a detail cross sectional view of the spindle means for supporting and rotating the flask and includes details of the means for detachably securing the flask to the supporting spindle; and

Fig. 6 is an electrical circuit diagram of the controls for the apparatus.

The particular apparatus disclosed as an exemplification of the principles of the invention embodies an operating mechanism supported on a base **10** located adjacent

the front of a furnace **11**. The machine is designed removably to support a pair of containers **12** and **12***a* comprising specifically flasks of ceramic material adapted to contain the articles to be coated, the coating process involving the insertion of the flask into the furnace and the supply to the interior of the flask while it is subjected to the furnace temperatures of appropriate gases, as will be described in more detail.

The furnace is provided with suitable closure means adapted to be opened to permit the insertion in the furnace of the respective deposition flask. The particular closure means shown comprises a pair of doors **13**, **13***a* supported on a common pivot **14** by means of appropriate bracket parts **15** (Figs. 1 and 4). To admit a flask to the furnace the doors are swung open to the positions shown in dotted lines in Figure 4 by suitable automatically controlled power means comprising in the present case a pneumatic cylinder **16** for each of the doors pivoted to the furnace frame structure at **17**. Operating in each cylinder is a piston connected to the piston rod **18** the outer end of the piston rod being pivoted at **19** to a lug extending from the respective furnace door. The particular arrangement of operating means and controls may be varied but the operation may be suitably effected by the admission of air through the pipes **20**, the air being supplied through a conduit **21** under the control of valve **22** which is adapted to be operated by electrical solenoid means. In general, admission of air through the pipes **20** causes the piston rods **18** to be moved outwardly opening the doors and shifting of the valve **22** releases the air pressure permitting the pistons to be moved inwardly by compression springs **23** located interiorly of the cylinders.

The flasks **12** and **12***a* are mounted on a carriage **30** provided with two pairs of supporting rollers **31** adapted to travel on the horizontal spaced tracks **32** whereby the carriage may be translated along the tracks to advance the corresponding flasks into the furnace and retract it. The carriage supporting tracks **32** form part of a turntable which include frame beams **33** upon which the tracks are supported, joined together by cross frame members **34** and having a depending central cylindrical bracket part **35**. The under part of the carriage also has depending therefrom four angularly spaced brackets **36** each carrying a roller **37** adapted to ride on a circular track **38** which is rigidly supported on the main frame part **10**.

The turntable is adapted to be oscillated through an angle of 180° to bring selectively either of the flasks **12** or **12***a* into position in front of the furnace. As will be later pointed out, various conduits for admitting gases to the flasks extend from stationary positions to the spindle mounting for the flasks and to avoid progressive accumulative twisting of these conduits, the turntable is moved to its alternative positions by an angular back and forth movement rather than successive angular movements in the same direction. The means for rotating the turntable may be of various types but in the form shown comprises a reversible electric motor **39** connected through a drive belt **40** to a gear mechanism in housing **41** which is adapted to swing an arm **42** which has a pivoted connection **43** at its outer end to the corresponding outer end of an arm **44** secured on depending shaft **45** which in turn is secured coaxially of the turntable in the circular bracket **35** fixed to the turntable frame parts.

The means for reciprocating the carriage **30** on tracks **32** is shown particularly in Figure 3. Secured to the under side of the tracks **32** are stationary racks **50** with which mesh a pair of driven gears **51** and also a pair of idler gears **52** one of which is shown in Figure 1, a corresponding gear **52** being located on the opposite side. Each of the driven gears **51** is mounted on a shaft **53** and the drive for the shafts **53** is from a common electric motor **54** which through a suitable gear box mechanism **55** drives

the opposed shafts **56** which are connected through suitable coupling means **57** to the corresponding shafts **53**. The electric motor **54** is reversible, and upon suitable positioning of a reversing switch **183** (Fig. 6) and closing of the main switch the motor **54** will traverse the carriage **30** to the left to position the flask **12** in the furnace as shown in dotted line at **12'** (Fig. 1). After the processing of the materials in the flask has occurred, the reversing switch **183** for the motor having been moved to the opposite position and the motor thereafter energized, it operates to withdraw the carriage to the mid position shown in Figure 1. After the turntable has been rotated 180° the motor will similarly advance the flask **12***a* into the furnace and withdraw it.

As heretofore noted, the flasks **12** and **12***a* are removably mounted on the carriage. The supporting means for each flask comprises a rotary spindle which serves not only to support the flask but also to rotate it at appropriate times under a suitable control. The details of one of the spindles and the means for securing thereon its flask are shown particularly in Figure 5. A pair of spaced roller bearings **61** mounted on the carriage, support a hollow spindle **62** provided with a driving means through the sprocket **63** at the right end and adapted to have secured thereto at the left end a flask such as the flask **12**. The spindle is held against endwise movement by suitable collars **64**.

The spindle is threaded on the left end thereof a bushing **65** secured in place by a locking screw **66**. A collar **67** is adjustable on external threads of the bushing **65**. The bushing **65** carries a plurality of latches **68** of which there may be three equally spaced around the bushing, each latch being mounted on a pivot **69** between a pair of lugs **70**. The latches are each normally urged to an open position by a spring **71**, but are adapted to be forced in the opposite direction by outward adjustment of the collar **67**. Each flask has secured thereto a metal sleeve **72** provided with an annular groove **73** in which the outer cam fingers **68***a* of the latches **68** are adapted to engage. Outward adjustment of the collar **67** on the bushing **65** forces the cam ends **68***a* of the latches into the annular groove **73** and clamps the end of the flask against the outer end of the spindle, the bushing **65** being provided with an enlarged bore adapted to receive the end of the flask sleeve **72**. Preferably a sealing gasket **74** is inserted between the complemental ends of the flask and the spindle.

At the opposite end of the spindle is located means, as heretofore noted, for rotating the spindle through the sprocket **63** and also means for admitting thereto certain desired gases while the spindle and flask are being rotated. The means referred to includes a collar **76** secured to the end of the spindle as by means of a threaded connection **77**. The sprocket **63** is secured to the collar **76** through the medium of three or more equally spaced bolts **78** extending through holes in the sprocket and collar **76**. The same bolts **78** also extend through an outer ring **79** adapted to rotate with the sprocket **63**. A closure cap **80** is located over the end of the hollow spindle, the cap having an inner diametrically reduced portion **80***a* adapted to fit into the end of an inner sleeve **62***a* with which the spindle is provided. The cap **80** is held nonrotatable by means of a U-shaped finger **81** having one end extending into a hole in the cap and the other end secured in a lug **82** fastened to a portion of the base of the carriage. For effecting a tight seal a gasket **83** is mounted in an annular groove in the cap **80** and is adapted to engage against the end of the spindle **62**.

Suitable conduit means are connected through the cap **80** and spindle into the interior of the flask. These include a main central inlet duct **84** extending through an inner supporting bushing **85** and on into the interior of the cap **80** whereby a continuous flow of gases into and from the interior of the flask may be maintained, the

exhaust gases escaping by way of openings through the bushing **85**, the hollow spindle, and out the duct **86**. The maintenance of the proper gas mixture free of air or impurities within the flask is very important during the deposition portion of the cycle and to this end a continuous flow of inert sealing gas to the outer end of the spindle is provided through means of the duct **87** adapted to direct an inert gas into the space **88** whereby the seal is continuously bathed by a flow of inert gas under sufficient pressure to prevent any air, for example, from leaking into the flask.

Each spindle and its flask are adapted to be independently rotated by power means mounted on and movable with the carriage **30**. Such means comprises an electric motor **89** driving a sprocket **90** through gear reduction means in the gear box **91**. The sprocket **90** is connected to drive the respective sprocket **63** through a chain **92**.

The gears used in the operation of the apparatus are supplied to the inlet duct **84** from suitable sources (not shown). The flow of these gases may be controlled either manually or automatically by suitable valves in the supply lines. Likewise the sealing gas is supplied to duct **87** from a suitable source.

Fig. 6 which shows the electrical conrtol circuit, will be described in detail with regard to the description of the operation of the apparatus. This circuit is connected to the main power line L through the main switch **150**, and the line L is preferably protected by a fuse **151**. Indicator lamp **152** is placed on the control panel to show the operator when the main power switch **150** is in closed position.

The operation of the apparatus is as follows. Assuming a flask **12** has been charged with ceramic blanks and mounted on the apparatus and is in the position shown in Fig. 1 and Fig. 2. In this position of the turntable and carriage, the micro-switch **138** is closed by cam **135** (see also Fig. 1). Through switch **138** closed, relay **154** is energized and contact **157** is closed to condition the latch coil **173** of relay **172** to be energized subsequently when contact **179** of relay **180** is closed.

Since the carriage is at rest in the center of the turntable microswitch **127** is also closed by cam **128** (see also Fig. 1 and Fig. 2). Relay **161** is thus connected across the power line through closed switch **127** and contact **163** is closed. Micro-switch **129** (see also Fig. 2) is also closed by the presence of the carriage at rest in the center of the turntable, and relay **166** is connected across the power line L to close its contacts **167** and **168**. Closure of contacts **167** and **168** conditions the door opening relay **175** to be energized.

Manually-operated switch **170** is now closed by the operator, thereby operating the flask rotation motor **89**. The door-operating relay **175** is now energized by the operator momentarily closing push button switch **176** which completes a circuit to relay **175** through the previously closed contact **168** of relay **166** and the normally closed contact **178** of unenergized relay **180**.

The door opening solenoid **22***a* is energized through closed contact **181** of relay **175**, while the door closing solenoid **22***b* is simultaneously de-energized by the opening of contacts **182** of relay **175**. Door opening solenoid **22***a* operates valve **22** (see also Fig. 1) which admits air to the door opening cylinders **16** (see Fig. 4). The furnace doors now open and in their outermost position engage and close micro-switches **125** and **126** (see also Fig. 2 and Fig. 4). The closing of switches **125** and **126** energizes relay **185** which, by opening its contact **186**, disconnects the circuit to the turntable drive motor **39** to assure that no rotation of the turntable can occur while the flask is in the furnace. Contact **187** of relay **185** closes to complete a circuit through closed contact **181** of relay **175** to energize the carriage drive motor **54** to move the flask into the furnace.

Micro-switch **127** is now opened as it leaves cam **128** (see Fig. 1 and Fig. 2) by the carriage movement from its idle center position and relay **161** is thereby de-energized. Release of relay **161** opens contact **163** which introduces an additional discontinuity in the turntable rotation motor circuit.

When flask **12** reaches its extreme forward position and is all the way inside the furnace, micro-switch **129** is opened by engagement with cam **130** (Fig. 1 and Fig. 2) to de-energize relay **166**. Contacts **168** of relay **166** now open and de-energize relay **175**. The normally closed contact **182** of relay **175** now completes a circuit to operate the door closing solenoid **22***b* which shifts valve **22** (Fig. 1) to cause the furnace doors to close around the neck of the flask **12** as shown by the dotted indication of the flask **12'** in Fig. 1 of the drawing. Simultaneously with this operation, contact **181** of relay **175** opens to de-energize the door opening solenoid **22***a*.

By the opening of contact **167** on de-energized relay **166**, which has just been open-circuited by operation of micro-switch **129** when the flask reached its innermost position in the furnace, relay **185** is open-circuited to disconnect the carriage travel motor **54** through the opening of contact **187**.

The gases are then admitted into the flask through inlet duct **84**. After the desired time for treatment the gases are turned off and the operator closes switch **183**. The closing of switch **183** energizes relay **180** which through its contactors **178** and **179** reverse connection of the circuit to the carriage motor **54**, conditioning this motor to withdraw flask **12** from the furnace. Contactor **177** of relay **180** conditions relay **185** to be energized when micro-switches **125** and **126** are closed. Contactor **178** on relay **180** operated also completes a circuit for the energization of relay **175**. Contacts **181** of relay **175** operated close a circuit to energize the door opening solenoid **22***a*, while contacts **182** open a circuit simultaneously to de-energize the door closing solenoid **22***b*. This, as previously described, opens the furnace doors which, when fully open, close micro-switches **125** and **126** to energize relay **185**. Contacts **187** of relay **185** close to complete the power circuit for carriage motor **54** whereupon the carriage motor withdraws flask **12** from the furnace.

When the carriage reaches its center position and flask **12** has been completely withdrawn from the furnace, micro-switch **127** is closed by cam **128** (see Fig. 2) to energize relay **161**. Contacts **163** of relay **161** close to condition the turntable rotating motor **39** to rotate the turntable through 180 degrees when the operator presses turntable reverse switch **155**. Meanwhile the operator opens switch **183** which de-energizes relay **180**. This causes the relay **175** to be de-energized and the contacts **182** of relay **175** energize the door closing solenoid **22***b* and de-energize the door opening solenoid **22***a*, thereby closing the furnace door. The de-energizing of relay **180** causes the contacts **179** to reverse the carriage travel motor **54** preparatory to moving the next flask into the furnace.

Meanwhile it may be assumed that the operator has charged the second flask **12***a*, as seen in Fig. 1 and Fig. 2 and that the contents of this second flask are now ready for processing. Accordingly, when the operator presses the turntable reverse switch **155**, the second flask **12***a* is moved into the position previously occupied by flask **12** adjacent to the furnace doors, and another cycle of operation can be repeated as herein described.

The mechanism also includes a blower which delivers a blast of air to the withdrawn flask for cooling it. The mechanical parts for this purpose are shown particularly in Figure 1 and include a blower **140** adapted to deliver air through the pipe **141** to a suitable outlet **142** adjacent the corresponding flask when the carriage is moved to the left to position the other flask in the furnace. In other words, when a flask upon the completion of the cycle is withdrawn and the turntable indexed, the other flask will have been recharged and the apparatus is ready for the moving of the recharged flask into the furnace which brings the hot, just-withdrawn flask over the outlet **142** of the blower. The blower is adapted to be driven by any suitable means such as the electric motor **143**. In general, since the normal time of treating a flask in the furnace requires several hours, the blower may continue to operate for some period of time after a flask is withdrawn from the furnace and positioned over the outlet whereby it may be adequately cooled before the operator need remove it, and there will remain ample time for the flask to be recharged and replaced before the completion of the treatment of the flask in the furnace.

It will be understood also that the flasks are continuously rotated at a relatively slow rate while in the furnace and preferably while being exposed to the cooling blast after being withdrawn. When the flask is cooled the rotation is stopped by opening switch **170** so that the flask can be emptied and recharged in preparation for the next cycle.

Since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In an apparatus for successively positioning carbon deposition flasks in a furnace chamber the combination of, a supporting base, a turntable rotatably mounted thereon, a carriage translatably mounted on said turntable, means for independently supporting on said carriage a pair of carbon deposition flasks extending laterally outward in a horizontally angularly spaced relation, the supporting means embodying a rotatable element and means for releasably clamping the neck portion of the flask thereto, means for rotating each of said elements and its flask independently of the other, a furnace chamber positioned adjacent said carriage and adapted to receive successively therein said flasks, means for rotating said turntable to predetermined angular positions appropriate to presenting the respective flasks to said chamber, and means for translating said carriage to move the corresponding flask into and out of said chamber.

2. In a machine for withdrawably positioning elements in a treating chamber the combination of, a base having a horizontal circular track, a turntable rotatably supported on said track, means for rotating said turntable forward and back to predetermined positions angularly spaced by 180°, a pair of spaced horizontal tracks on said turntable, a carriage translatably mounted on said tracks, means for supporting on said carriage a pair of elements to be treated angularly spaced horizontally 180°, said carriage having a normal retracted position midway of the length of said horizontal tracks, and means for selectively translating said carriage to an outer position toward either end of its tracks for presenting the corresponding element to said chamber.

3. In an apparatus for successively holding carbon deposition flasks in a furnace chamber the combination of, a base having a horizontal circular track, a turntable rotatably supported on said track, means for rotating said turntable forward and back to predetermined positions angularly spaced by 180°, a pair of spaced horizontal tracks on said turntable, a carriage translatably mounted on said tracks, means for releasably supporting on said carriage a pair of carbon deposition flasks each projecting outwardly and angularly spaced horizontally 180°, means for independently rotating each of said flasks, said carriage having a normal retracted position midway of the length of said horizontal tracks, and means for selectively translating said carriage to an outer position toward either end of its tracks for presenting the corresponding flask to the furnace chamber.

4. In a machine for withdrawably supporting carbon deposition flasks in a furnace the combination of a supporting base, a turntable rotatably supported thereon, a

carriage mounted for horizontally translatory movement on said turntable, means for translating said carriage, a pair of flasks independently supported on said carriage the mounting means for each flask comprising a rotatable spindle and means for clamping the flask in releasable hermetically sealed relation endwise to its corresponding spindle, and means for rotating each spindle and its corresponding flask independently of the other.

5. In a machine for successively holding carbon deposition flasks in a furnace the combination of, a supporting base, a turntable rotatably supported thereon, a carriage mounted for horizontally translatory movement on said turntable, means for translating said carriage, a pair of flasks independently supported on said carriage the mounting means for each flask comprising a rotatable spindle and means for clamping the end opening of the

flask in releasable hermetically sealed relation endwise to its corresponding spindle with the flask body portion extending outwardly for insertion in the furnace, conduit connections for supplying gases to the interior of the flasks through the respective mounting means therefor, and means for rotating each spindle and its corresponding flask independently of the other.

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