Nov. 29, 1966 O. L. STEWART 3,288,452

HEAT TREATING APPARATUS

Original Filed Jan. 18, 1962 4 Sheets-Sheet 1

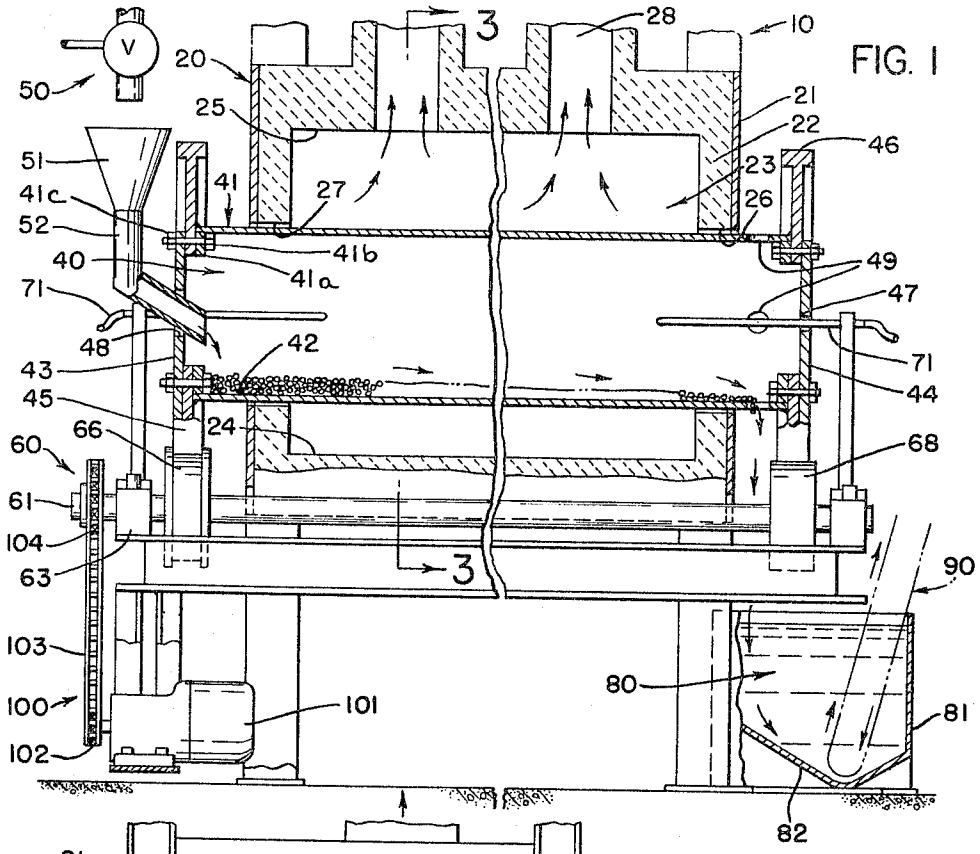


FIG. 1

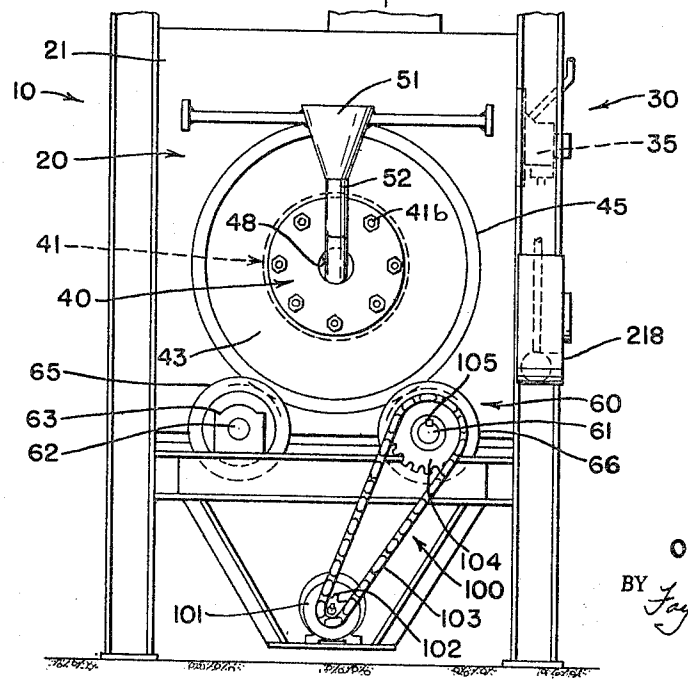


FIG. 2

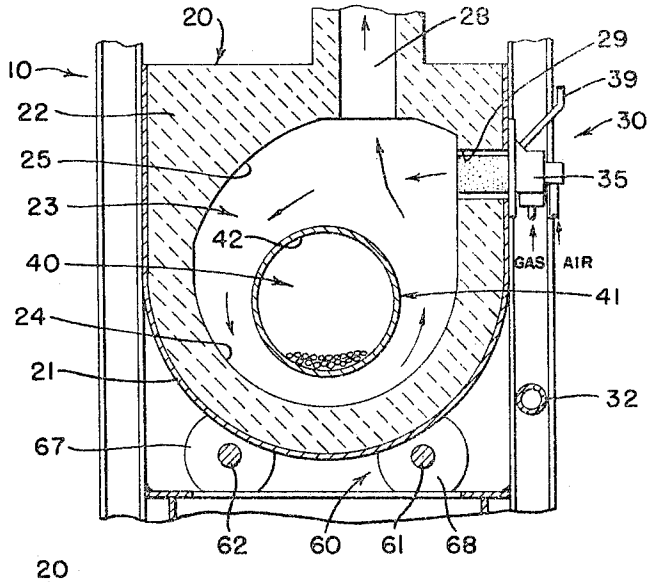
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FIG. 3



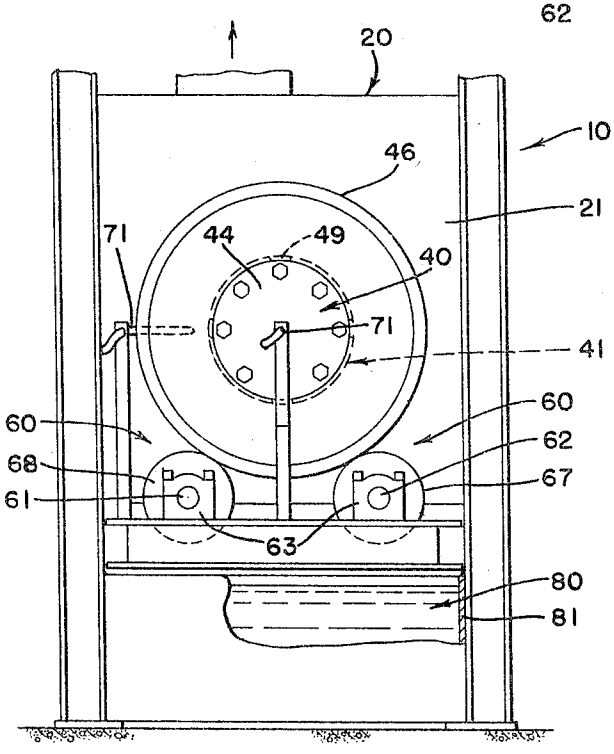


FIG. 4

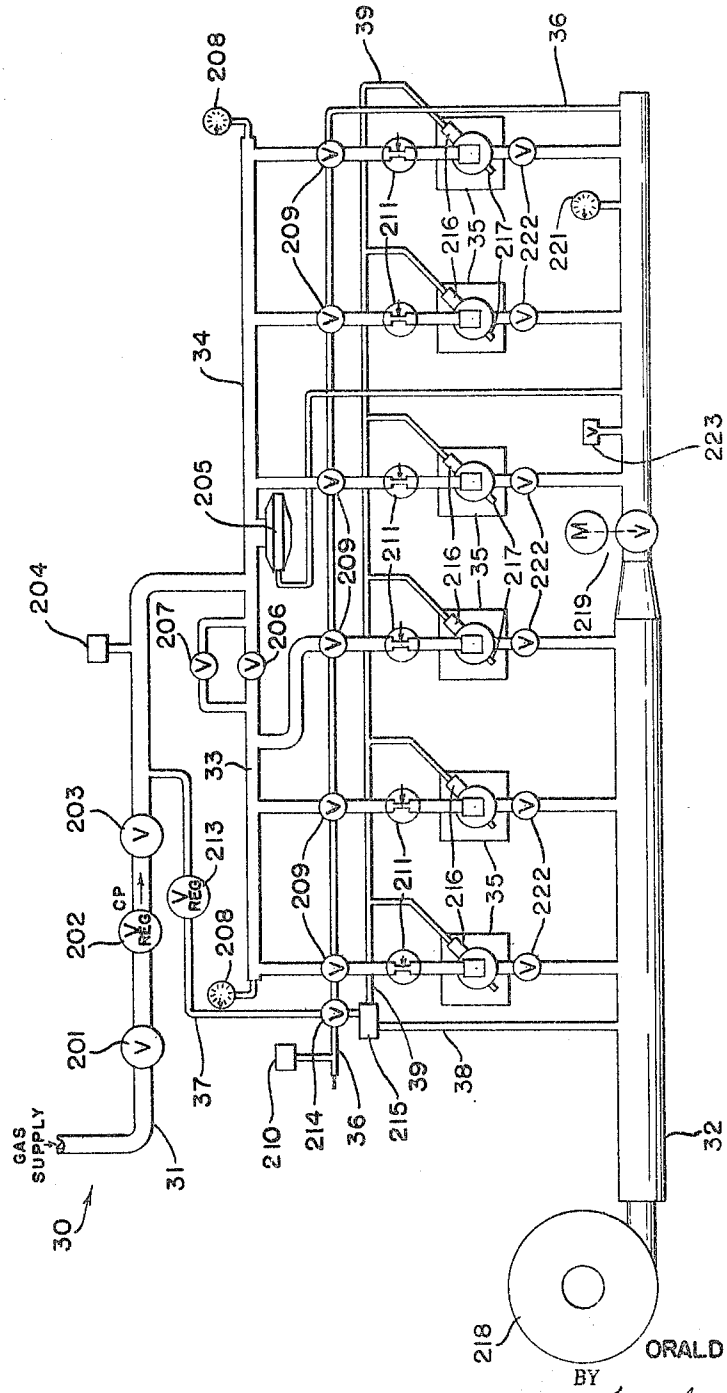
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FIG. 5



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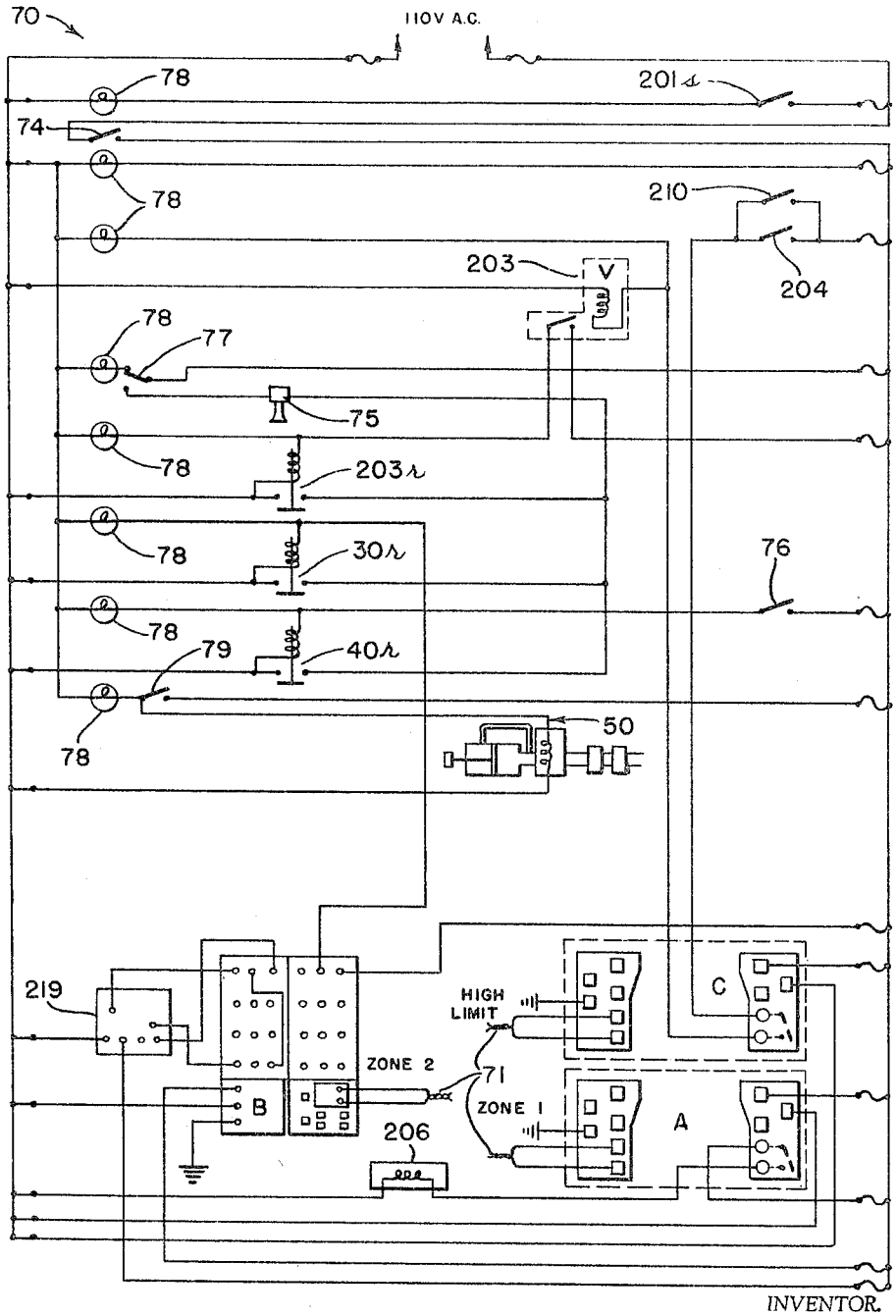


FIG. 6

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3,288,452

HEAT TREATING APPARATUS

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Original application Jan. 18, 1962, Ser. No. 167,021, now Patent No. 3,201,289, dated Aug. 17, 1965. Divided and this application July 20, 1964, Ser. No. 389,814

6 Claims. (Cl. 266—4)

This is a division of application Serial No. 167,021, filed Jan. 18, 1962 and now Patent No. 3,201,289, issued Aug. 17, 1965.

This invention concerns a heat treating apparatus, particularly adapted for use in the heat treating of metal abrasive shot.

A novel apparatus combination is provided for performing the heat treating method and includes housing means, heating means for automatic control of the temperature within said housing means, retort means extending through said housing means and having a smooth cylindrical bore, cap means at either end of said bore substantially closing said retort means, drive means imparting rotational movement to said retort means, automatic feed means supplying said retort means with metal particles adjacent one end of the cylindrical bore, and automatic discharge means dispensing said metal particles into a quenching bath from said retort adjacent the other end of said cylindrical bore on a substantially first-in, first-out basis.

The furnace of this invention is adapted especially to heat small metal particles to any temperature up to approximately 2,000° F. on a continuous flow basis at various rates, depending on the temperature. For example, in one form and size it can heat 2,500 pounds of steel shot per hour to a temperature of 1700° F. The furnace of the invention has a multitude of advantages not found in metal abrasive shot heat treating apparatus of the type heretofore known in the shot producing industry, which result in low initial cost, low operating cost, and low maintenance cost.

Rotary retort furnaces of the general type herein disclosed are not new. In fact, their use in calcining processes is rather well known; however, the novelty and advantages of a furnace constructed according to the principles of this invention for heat treating metal abrasive shot, lies in its efficient retort design, mechanical drive design, and control set up, all of which cooperate to make possible a continuous metal shot heat treating process of extreme efficiency which requires a minimum of manual labor and supervision. The known prior art rotary furnaces for heat treating metal have contained ribbed spirals and uneven sections in the retort which produce excessive stresses in the structure of the retort as its temperature changes. These spirals and uneven sections are both difficult and expensive to cast or fabricate and cause rapid fatigue of the metal retort and its eventual cracking during use. Moreover, the spirals and uneven sections conventionally used in rotary retorts provide obstructions which tend to induce sticking or welding of the heated metal particles to the inside surface of the retort, thus greatly increasing the number of retort cleanings required.

In the prior art apparatus for heat treating metal abrasive shot it has been necessary conventionally to provide some type of positive work driving or propelling means, such as internal retort flights, vibrating chutes, or batch type baskets and trays, to move the metal abrasive particles into and out of the furnace. The use of these expensive prior art propelling means has resulted in high replacement and maintenance costs which

are attributable in a large measure to the sticking of the hot metal particles to the propelilng means within the retort.

The prior art has relied upon the use of expensive and complicated controlled atmosphere systems, to minimize the metal abrasive particle sticking within the retorts, which have been characterized by the provision of elaborate sealing structures and control apparatus. The compact furnace of the instant invention, by eliminating the need for metal abrasive particle propelling means and using a smooth bored retort has eliminated substantial particle sticking and the need for the prior art type of controlled atmosphere and sealing means in heat treating metal abrasive shot and, therefore, has reduced both the manufacturing and maintenance costs of the furance while increasing the capacity thereof. It is possible, however, that for use in metallurgical processes, such as carburizing the case hardening, the furnace of this invention can be converted easily for efficient use with special atmospheres in view of the substantially closed retort means utilized.

Other prior art problems which traditionally have been encountered in rotary retort apparatus are those caused by heat tansfer from the retort to the elements in the drive mechanism for rotating the retort. Heat transfer to these parts has resulted in high maintenance costs due to the fact that the heat softens and weakens the metal and thereby causes wear and distortion which results in misalignment of wheels, damage to bearings, and fatigue of gear and chain elements.

The prior art feeding and control apparatus for rotary retort furnaces has been elaborate and inefficient and has not safeguarded adequately the quality of the products being treated therein. With the increased demands of industry for high quality metal abrasive shot material, there has been a constant problem of volume production due to the heat treating necessary to maintain uniform high quality shot. The continuous heat treating furnace provided by the principles of this invention is adapted particularly for solving the foregoing problems in a more efficient manner than was heretofore thought possible.

It is, therefore, the general object of the invention to provide an improved apparatus useful in connection with the continuous heat treating of metal abrasive shot.

It is a more specific object to provide a heat treating furnace for metal abrasive shot which automatically controls, feeds and discharges the shot into a quench bath with a minimum of human attention and a maximum of high quality uniformity.

Other and more specific objects of the invention will be apparent from the drawings and the detailed description to follow:

In the drawings:

FIG. 1 is a side elevation view with certain of the parts broken away to illustrate one form of furnace according to the principles of this invention;

FIG. 2 is an elevation view of the input end of the furnace of FIG. 1;

FIG. 3 is a cross-sectional view of the furnace along the line 3—3 of FIG. 1;

FIG. 4 is an elevation view of the discharge end of the furnace;

FIG. 5 is a schematic side elevation view showing the furnace burners and controls;

FIG. 6 is a wiring diagram of the furnace control means.

The specific furnace embodiment shown and described utilizes a two-zone heat control system for the furnace combination; however, single or multiple zone versions are contemplated. A single zone type of heat control has been found to be successful but is slightly less efficient than the described two-zone system.

Referring now more particularly to the drawings, the apparatus of this invention comprises a furnace combination **10** which includes housing means **20**, heating means **30**, retort means **40**, feed means **50**, retort drive means **60**, electrical control means **70** (see FIG. 6), quenching means **80**, conveyor means **90**, and power transmission means **100**.

As seen in FIGS. 1 and 3 of the drawings, the housing means **20** of the illustrated furnace combination **10** is an elongated trough-shaped metal casing **21** lined by a refractory brick structure **22** having a central cavity **23** which is of a semi-circular cross-sectional shape in its lower portion **24** and is of an enlarged irregular shape in its upper portion **25** adjacent the heating means **30**. The retort means **40** extends through openings **26** and **27** in the ends of housing means **20** and is supported externally for rotation therein about the axis of the semi-circular lower portion **24** to provide for the efficient distribution of heat within the cavity **23**. Venting passageways **28** are disposed in the upper portion of the cavity **23** to permit removal of the combustion gases generated during operation of the furnace.

The heating means **30** includes conventional air-gas burners **35**, such as the type produced and sold by North American Manufacturing Company of 4455 East 71st Street, Cleveland 5, Ohio, under the designation of Series 4423–3B. These burners include an observation port and combustion tile and are equipped with pilot tips for lighting. The burners **35** are mounted in openings **29** in housing means **20** and are capable of close regulation by varying automatically the air-gas supply thereto in a manner hereinafter to be described. Several different numbers of burners, preferably from 4 to 12, may be used in the furnace depending on the temperature requirements of the desired heat treating process.

For example, in the embodiment described herein a bank of six burners has been found to be satisfactory for a wide range of applications. When operated together with an air pressure of 8 p.s.i., these six burners are capable of producing 1,830,000 B.t.u. per hour from a 20 inch flame.

In geographic areas where electrical power rates are low, electrical heating means for the furnace could be substituted for the gas means described, or, as will be obvious further to those skilled in the combustion art, a suitable oil combustion system also could be used if desired.

The retort means **40** of the furnace **10** is a generally cylindrical metal casting or fabrication, **41**, of greater length than the housing means **20** having a smooth central bore **42** therein. Cylinder **41** has an apertured radially inwardly directed flange **41***a* welded or otherwise provided at each end thereof for connection of the end structure thereto. Suitable fastening means, such as bolts **41***b* extend outwardly through flange **41***a* to secure apertured radially outwardly directed tire-like circular flanges **45** and **46** to the ends of cylinder **41**. The flanges or tires **45** and **46** are retained in place on bolts **41***b*, concentric with cylinder **41**, by suitably apertured and centrally bored end caps **43** and **44** and nuts **41***c* threadedly associated on the bolts extending through the aligned apertures of the members. Rotational motion is imparted to the retort by frictional drive on the outer surfaces of the tires **45** and **46** in a manner to be explained later.

The described fastening arrangement for the end structure of cylinder **41** is preferred, although other fastening means may be used in the combination because of the convenienct of assembly and disassembly which it affords. It has been found in this respect that by mounting the bolts **41***b* close to the bore **42**, as illustrated in FIG. 1, the tool pads on the bolt heads prevent rotation of the bolts relative to the apertured members, and the nuts, therefore, may be threaded or unthreaded without having to hold the bolts with a wrench or other means

on the inside of the structure. A series of holes **49** opening radially through the wall of the retort cylinder **41** are spaced symmetrically around the periphery thereof adjacent the discharge end of the furnace outside of the housing means **20** for substantially continuous discharge of shot from the rotating retort.

An automatic feed valve **50** for introducing metal shot particles into the bore **42** of the retort **40** is connected to be responsive to the furnace when it is operating. The valve **50** is mounted adjacent a funnel **51** and when the valve **50** is open shot flows into the funnel and through a passageway **52** connected thereto, past the hole **48** of the end cap **43**, into the retort bore **42**. The particles then flow along the rotating smooth bore **42** in a manner analogous to the flow of a liquid until they are discharged on a first-in, first-out basis through the ports **49** into a quenching or cooling medium.

The retort cylinder **41**, which is produced either by casting or fabricating, is preferably of heat-resistant high-alloy steel. The uniform cross section of the retort wall and the smooth bore **42** provide a uniform cross section which prevents excessive thermal stresses from building up as the temperature of the retort changes. These stresses, if not reduced in this manner, would cause rapid fatigue of the retort and eventual cracking. This provision greatly prolongs the life of the retort cylinder.

Another particular advantage of the retort is that the smooth finish of bore **42** minimizes sticking of heated metal particles to the inside surface. This significantly increases the operating time between retort cylinder cleanings and renders the use of controlled atmosphere in the furnace unnecessary, thus greatly reducing cost. This sticking problem with retorts for heating metal particles is a critical one because materials sticking to the inside of the retort results in poor heat transfer and consequently reduction in production. This is caused by the formation of a ring of metal from the shot particles with a different expansion rate than the retort itself, thus setting up higher stresses. The reason that the smooth bore type of retort can be used for heat treating shot is that the small metal particles behave as a liquid when agitated by the rotating motion of the retort. This action causes the particles to travel uniformly through the retort in a continuous flow as new material is introduced on the feed end to displace material out of the discharge end outlet on a substantially first-in, first-out basis. Of course, the retort cylinder can be used in other than a horizontal position because of this action and it is possible to give the structure a slight tilt in either direction, but in order to avoid bearing overloading in the drive mechanism or misaligning the driving parts, the horizontal position is preferred.

According to the feed principles used in the furnace of this invention, a rotational motion must be imparted to the retort to effect uniform heating of the retort and to keep the metal particles progressing through the furnace. In the disclosed embodiment of the invention, a rotation rate of 7 to 10 revolutions per minute has been found optimum; however, this may vary widely depending upon the particular heat treating procedure being used. The particular described shape of the cavity **23** of the housing means **20** is designed for optimum distribution of heat in the furnace and creates a circulation of air around the retort as shown by the arrows in FIG. 3.

The retort drive means **60** includes two longitudinal shafts **61** and **62** mounted in pillow blocks **63** at either end axially outwardly from the retort tires **45** and **46**. Adjacent the pillow blocks **63** on the feed end of the furnace are two flanged wheels **65** and **66** conventionally secured on the shafts to rotate therewith. The flanges and wheel width are such that the tire **45** frictionally engages the inner surfaces of the flanged wheels **65** and **66** between the flanges. Similarly positioned on the opposite ends of the shafts **61** and **62** inside the pillow blocks **63**, in alignment and supporting frictional engagement with the tire **46** are two unflanged wheels **67** and **68**. This arrangement

provides constant alignment of the retort tire **45** with respect to the flanged wheels **65** and **66** and permit thermal expansion of the retort to be taken up by the unflanged wheels **67** and **68**.

The wheels **65**, **66**, **67**, and **68** are of rather massive construction with a radius determined by the heat transfer characteristics of the material from which they are made, since it is imperative that a minimum of heat be transferred to the shafts **61** and **62** and, of course, to the bearings of pillow blocks **63**. Moreover, the tires **45** and **46** of the retort means **40** are large enough so that heat does not travel easily to wheels **65**, **66**, **67**, and **68**. This keeps the temperature on the tire peripheries low and results in longer life of both the tires and wheels. Also of importance to the life of the furnace is the fact that shafts **61** and **62** are provided the full length of the furnace so that misalignment of the wheels which would cause rapid wear is eliminated. Moreover, the frictional drive utilized eliminates the use of low speed-high torque gears or sprockets on the retort cylinder itself and exposure of the drive means to heat which would result in high maintenance costs.

The shaft **61** and wheels **66** and **68** of the retort drive means **60** are driven in any conventional manner by generally designated power transmission means **100**, illustrated in FIGS. 1 and 2 as electric gear motor **101**, having a driving sprocket **102** mounted on the shaft thereof and connected by means of chain **103** to a driven sprocket **104** rigidly mounted on shaft **61** by means of key **105**. The means of driving shaft **61** may be varied, of course, as by direct gearing, or by a shaft mounted gear head driven by a standard speed electric motor, if desired, and the illustrated power transmission means is provided merely as an example of one practical form which power transmission means **100** may take.

The shaft **62** and the wheels **65** and **67** mounted thereon are idlers which receive their rotation from frictional engagement with the rotating retort tires **45** and **46** and, therefore, need not be driven directly by power transmission means **100** in the manner in which shaft **61** and wheels **66** and **68** are driven. The idling shaft **62** does serve a function in addition to supplying support for the rotating retort cylinder **41**, however, in that a motion sensitive zero speed switch **76** is connected thereto which, if the retort stops rotating for any reason, actuates an alarm **75**, as will be seen in FIG. 6.

As the power means **100** drives the shaft **61** and retort cylinder **41** and the automatic feed valve **50** is actuated, the metal particles flow through the rotating retort cylinder **41** and are discharged through the ports **49**, as previously explained, into a quenching bath **80** positioned below the ports. The quenching bath for most metal abrasive shot is a water bath, but may, of course, be any conventional quenching medium, such as oil or the like, depending on the structure required. Also disposed in the quenching bath container **81** is a conventional means **90**, preferably with dip buckets thereon which cooperate with a sloped floor **82** of the bath container **81** to pick up the shot from the bottom of the bath **80** and remove it to a cool dryer or storage position. Thus, the furnace is set up to heat treat and quench metal abrasive shot without the attention of a full time attendant.

A control means **70** is provided which alerts responsible persons in the plant to any abnormal condition in the apparatus and an alarm sounds if any of the following things occur:

If the temperature drops below a desired low limit as indicated by the various thermocouples **71**, such as the one projecting into the retort cylinder **41** through the bore **47** of the end cap **44**.

If the furnace temperature rises a predetermined amount above the operating range;

If the retort stops rotating;

If the fuel or air supply fails.

The feed valve **50** preferably is a pneumatically operated type dipper valve connected in the control circuit **70** such that when the first of the aforementioned abnormal conditions occur, the feed of the metal particles to the furnace is stopped. This helps to insure the product is not produced when the furnace is not operating correctly. The pneumatically operated dipper valve **50** controls the feed rate into the furnace accurately by means of a manually movable stop which limits the opening of the feed gate.

FIGS. 5 and 6 relate to the combustion and control systems of the described furnace and are set forth herein only by way of an example of one practical embodiment of the heating means **30** and the control means **70** which may be used in connection with the invention.

The gas combustion system **30** schematically illustrated in FIG. 5 is divided into two zones for accurate temperature control within the furnace. The first zone is the preheat zone and the second zone is the maximum temperature zone. The first zone includes the three burners to the left or feed end of the furnace and the second zone includes the three burners to the right or discharge end of the furnace.

The gas supply line **31** has connected therein a manually actuable main gas cock **201** with a limit switch connected in control circuit **70** which shuts off and opens the supply of gas to the furnace. A gas pressure regulator **202** of the conventional diaphragm type keeps the gas pressure to the furnace constant as the main line pressure varies from seasonal or other causes. A safety shut-off valve **203** is connected electrically in the control circuit **70** to shut off the gas supply from line **31** when the power fails; the gas pressure drops too low to give proper combustion; the air supply fails; or, the furnace overheats. The valve **203** also may be used to keep the gas off until all the burner gas cocks are closed for individual opening and lighting. Its connection in the system will be readily apparent from the drawings and the description to follow.

A low gas pressure switch **204** actuates the safety shut-off valve **203** through the circuit **70** if the gas pressure from the gas supply line **31** drops too low. A control of the air-gas ratio is provided by a conventional diaphragm regulator mechanism **205** connected between gas supply line **31** and air supply line **32** and this control assures that a proper gas-air ratio is provided to all of the burners as the air pressure is changed in the line **32**.

The zone one burners are normally on high fire at all times during operation of the furnace and a solenoid gas valve **206** connected in circuit **70** is provided in the zone one branch **33** of gas supply line **31**, to control the flow of gas to the zone one burners. If the control circuit **70** registers an excess of heat in zone one, the solenoid valve **206** shuts off and the low fire bypass valve **207** provides a restricted gas supply to the burners. The magnitude of the zone one low fire gas supply in such that it is preset by the valve **207** to a level which is combined with the line **33** gas flow to give the proper high fire gas supply during normal operation. The gas pressure gauge **208** is used to check the pressure in line **33**. A similar gas pressure gauge **208** is mounted in the zone two branch **34** of the gas supply line **31**. Where closer control is desired, zone one is provided with a ratio control system the same as in zone two.

The burners **35** of the combustion system **30** are separated from their respective branch gas supply lines by conventional manually operable safety gas valves **209** which are interconnected by check line **36** through safety air passages which must be opened before the safety valve **203** can be opened. To assure that all of the valves **209** are closed, a checking air pressure switch **210** is connected in the line **36** which prevents the operation of valve **203** until the valves **209** have been closed. Also provided between the branch zone supply lines **33**

and 34 and the burners 35 are limiting orifice gas valves 211 for adjusting the flow of gas to each individual burner.

The pilot system for the burners 35 is supplied by a gas line 37 connected to the main gas line 31. The line 37 has therein a conventional atmospheric type pressure regulator 213 and a manually operable on-off valve 214 for simultaneously shutting off and opening the gas line to all the pilots. A pilot air supply line 38 is connected to the main air supply line 32 and is connected with the line 37 to a pilot mixer 215 which mixes the gas and air for all the pilot tips 216. The gas-air mixture is conducted through pilot supply line 39 to the individual pilot tips 216. The gas burners 35 have observation ports 217 located thereon to facilitate their adjustment to the proper flame level.

The air pressure for the combustion system is supplied to the main air supply line 32 by a conventional combustion air blower 218. The air supply to the zone two portion of line 32 is regulated by a power operated butterfly air valve 219 which is controlled by the circuit 70 to be opened at any of three positions depending on the temperature within the zone. The air pressure within the zone may be observed by means of a conventional gauge or manometer 221.

The air supply to the individual burners 35 is adjusted manually by butterfly air valves 222 in the lines between the main air supply line 32 and the burners 35. If the air pressure gets too low for safe operation, an air pressure switch 223 connected in the control circuit 70 shuts off the gas safety valve 203.

FIG. 6 is a circuit diagram schematically showing the wiring of the 110 volt control circuit 70 which actuates the various mechanisms of the combustion system described in connection with FIG. 5. The power circuit which supplies the current for the motor 100, the blower 218, and the conveyor 90 is conventional and is not illustrated.

The control circuit 70 is provided with automatic alarm 75 which may be set by switch 77 to sound off whenever any of the abnormal conditions previously listed occur. In addition, indicator lights 78 are provided to show the condition of the key control system elements at any given time. They are used also as a means of determining the source of abnormal conditions.

A switch 201*s* is provided on manually operable main gas valve 201 to indicate the open-shut position of the valve by means of a light 78 in the control circuit 70. A main electrical switch 74 is provided in the circuit 70 to shut off the power to the remainder of the control circuit.

With the switch 74 closed the control circuit acts such that the pressure switches 204 and 210 are closed as long as proper pressures through them are maintained as explained in connection with FIG. 5. Also, normally open safety valve relay 203*r*, underheat relay 30*r*, and retort stopped relay 40*r*, are connected in the alarm circuit such that if any of the thermocouples 71 indicate an abnormal temperature condition through conventional controllers A and C (such as sold by Minneapolis-Honeywell Regulator Co., Penn and Bay Streets, Fall River, Mass., under the designation Pyr-O-Vane models 105 and 106), or the zero speed switch indicates that rotation of the retort has stopped, the alarm is sounded, and, depending on the nature of the trouble, the safety shut-off valve may be closed. Further provision in the circuit by means of feed switch 79 in connection with the electropneumatic feed valve 50 automatically shuts off feed of shot to the furnace in the event of an abnormal condition.

The two zone control system of the illustrated embodiment is provided such that the gas supply to the zone one burners is controlled by valves 206 and 207. If the thermocouple 71 in zone one, connected in circuit 70 by means of conventional control and amplifying means A, senses that the temperature within the zone is below 1300° F., the solenoid gas valve 206 is opened and the burners in the zone are placed on high fire. If the temperature in zone one exceeds 1300° F., the solenoid closes the valve 206 and the low fire bypass which has been preset by gas 207 is the sole supply of gas for these burners until the temperature drops below 1300° F., and the valve 206 again opens. The burners can be adjusted so that this zone levels off at about 1295° F. and remains on high fire.

The air supply valve 219 to zone two is actuated similarly by a thermocouple connected by means of conventional control and amplifying means B (such as sold by Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Philadelphia, Pa., under the designation ElectroniK 17 Controller) in circuit 70 such that by means of the air-gas ratio control means 205, the air is kept in constant ratio to the gas supply and the valve 219 is wide open at 1690° F.; at 1695° F. valve 219 is approximately two-thirds open; at 1700° F., valve 219 is one-eighth open. If the temperature in zone two is below 1680° F., the control circuit 70 insures that the feed is shut off at the feed valve 50. A high limit thermocouple 71 has a high limit safety shut-down control and amplifying means C which shuts off the safety shut-off valve 203 in the event the temperature exceeds 1950° F. in the furnace.

Accordingly, the heat treating of metal abrasive shot according to the principles of this invention begins with bringing the furnace up to temperature so that the controls of circuit 70 will maintain the temperature automatically. As the metal particles are fed automatically through the feed valve 50 and arrange themselves into substantially continuous paths over a substantial length of the rotating retort, a discharging of the metal particles from the ports 49 into the quenching bath 80 occurs on a substantially first-in, first-out basis. The conveyor 90 removes the heat treated metal shot from the bath 80 to complete the operation.

For ease of description, the principles of the invention have been set forth in connection with but a single illustrated embodiment thereof. It is not my intention, however, that the illustrated embodiment nor the terminology employed in describing it, be limiting inasmuch as variations may be made without departing from the spirit of the invention. Rather, I desire to be restricted only by the scope of the appended claims.

The invention claimed is:

1. A heat treating furnace for metal particles comprising housing means, heating means mounted on said housing means including separate control means for a preheating zone and a high temperature heat-treatment zone, retort means extending through said housing means and having a smooth cylindrical bore, cap means at either end of said bore substantially closing said retort means, friction drive means imparting rotational movement to said retort means, automatic feed means electrically interconnected with said control means for supplying said retort means with metal particles adjacent one end of the cylindrical bore when said heating means and drive means are in operation, automatic discharge means dispensing said metal particles from said retort adjacent the other end of said cylindrical bore on a substantially first-in, first-out basis into a quenching medium.

2. A heat treating furnace for metal particles comprising a refractory-lined housing means of irregular internal shape, zone controlled heating means controlling the temperature within said housing means, metal retort means extending through said housing means and having a smooth cylindrical bore, cap means secured to either end of said bore substantially closing said retort means, friction drive means imparting rotational movement to said retort means through means mounted on the ends thereof, feed means supplying said retort means with metal particles adjacent one end of said cylindrical bore, spaced apertures in the wall of said retort means dispensing said

metal particles from said retort adjacent the other end of said cylindrical bore on a substantially first-in, first-out basis.

3. The furnace structure of claim 2 in which the friction drive means includes parallel shafts mounted with the ends thereof in support bearings, massive wheels mounted on each end of said shafts adjacent the support bearings, flanges on one pair of adjacent massive wheels on one end of said structure, and in which said friction drive means includes means mounted on the retort ends and which are seated on the wheel surfaces of said massive wheels between said flanges and the wheel surfaces of said second pair of adjacent wheels at the other end of said structure, and means imparting rotational movement to one of said shafts such that said means mounted on said retort ends are frictionally driven by the wheels of said one shaft and the wheels of said other shaft act as supporting idlers.

4. The structure of claim 2 in which an electrical alarm means is provided which is actuated if the controlled zone temperatures drop below their respective desired low limit, if the controlled zone temperatures rise a predetermined

amount above their respective desired operating range, if the retort means stops rotating, or if the heating means is interrupted.

5. The structure of claim 2 in which the zone controlled heating means comprises an electrically controlled air-gas combustion system having a set of burners defining a preheating zone and a different set of burners defining a high temperature heat-treating zone.

6. The air-gas combustion system of claim 5 in which the air-gas ratio to the burners is maintained constant automatically.

References Cited by the Examiner

UNITED STATES PATENTS

1,656,924	1/1928	Smith	266—4 X
2,182,616	12/1939	Juthe	266—5
3,068,091	12/1962	Kirkland	263—32 X

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