March 9, 1954 P. C. OSTERMAN ET AL 2,671,655

SHUFFLE MUFFLE HEAT TREATING FURNACE

Filed Jan. 10, 1951 2 Sheets-Sheet 1

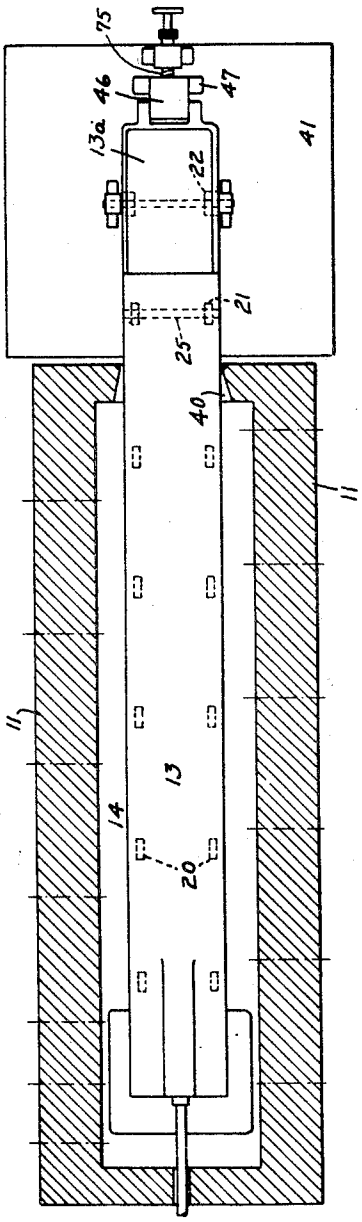


FIG. 2.

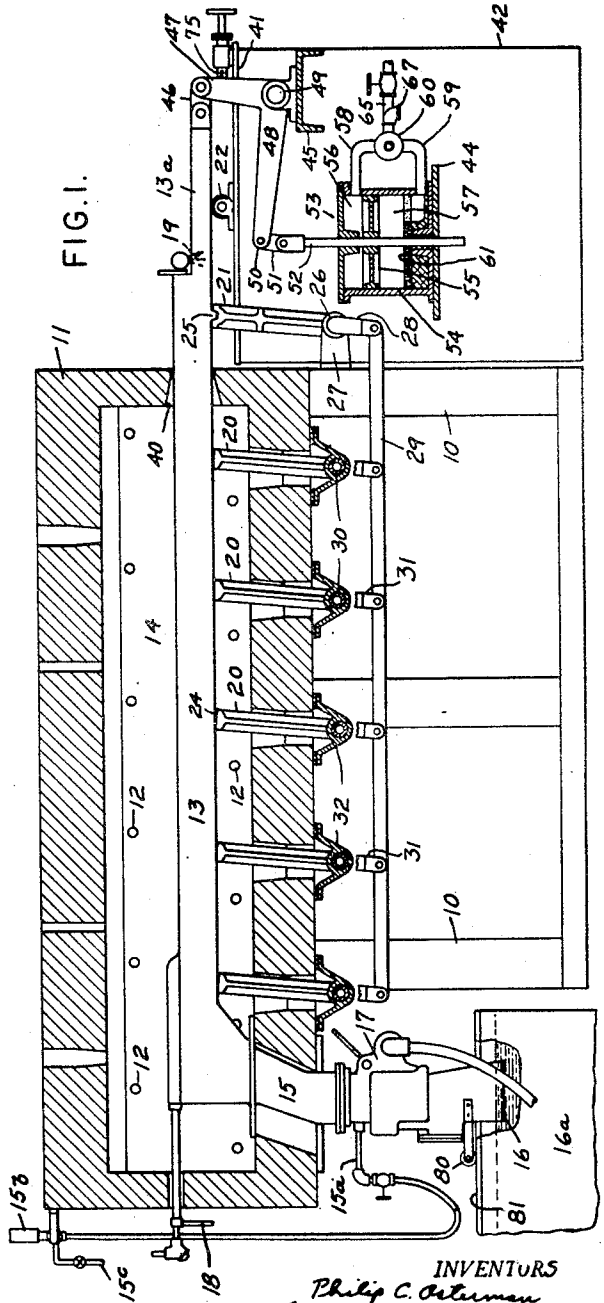


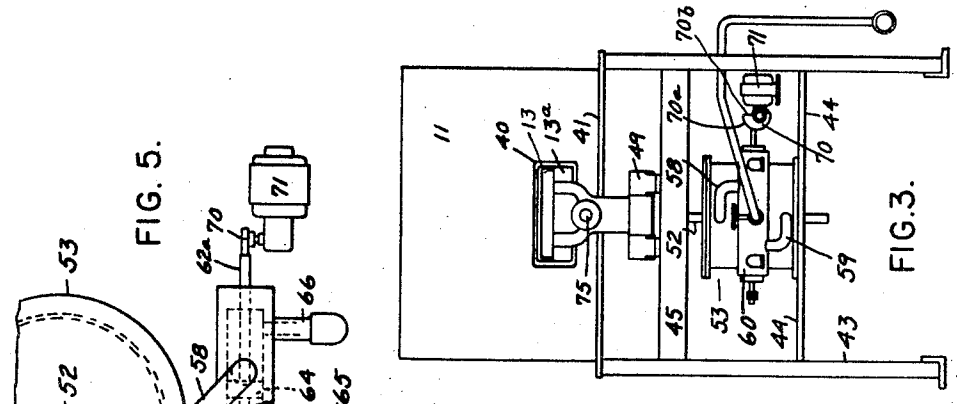
FIG. 1.

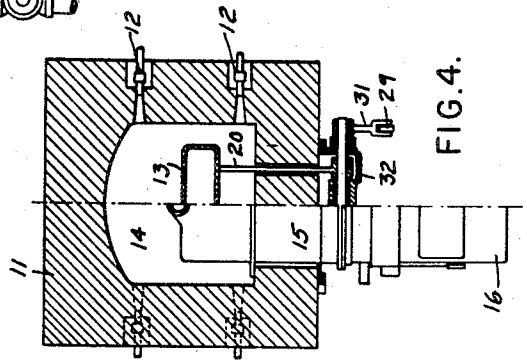
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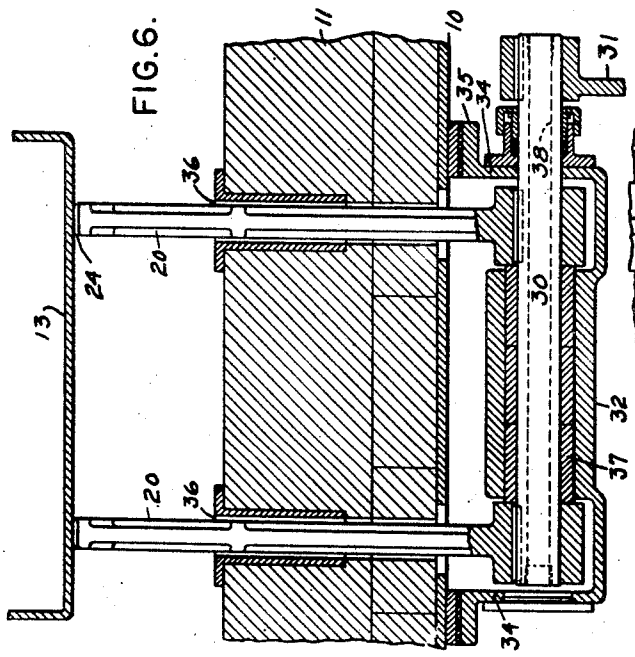
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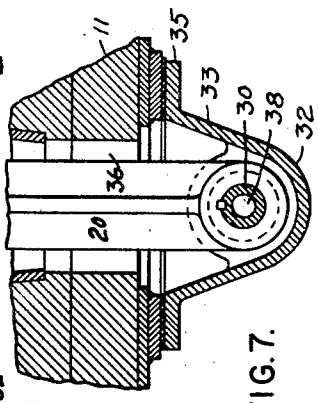
SHUFFLE MUFFLE HEAT TREATING FURNACE

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SHUFFLE MUFFLE HEAT TREATING FURNACE

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3 Claims. (Cl. 263—21)

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The present invention relates to furnaces for heat treating metals and more particularly to furnaces wherein the work may be caused to move through the heating zone while maintained enveloped in a controlled atmosphere.

A primary aim of the invention is the construction of a furnace with means and mechanism arranged automatically to feed the work progressively from the entrance end thereof through the heating regions to the delivery end while simultaneously maintaining the work somewhat in a state of agitation and all the while surrounded with a protective gaseous medium suited to the nature of the process or so that oxidation or discoloration of the work will not take place.

A further aim of the invention is the construction of a combined muffle and work support adapted to be so actuated from the exterior of the furnace as to effect progressive movement of the work therealong.

Still another objective of the invention is to support a movable muffle in a substantially frictionless manner at a plurality of regions along the path traveled by the work to the end of relieving the load on the muffle actuating means and of prolonging the life of the several component parts.

The invention further aims to construct a furnace with a movable muffle supported in such manner that the heating chamber of the furnace is maintained closed to the ingression of external gases, e. g. atmosphere, that ordinarily would react unfavorably on the work or would tend to lower the temperature, and likewise closed to escape therefrom of furnace gases whereby to attain increased furnace efficiency.

Another main objective of the invention is to render available an improved work feeding means that is relatively quiet in operation, which may be disposed at a reasonable distance from the heated portion of the furnace so as to remain uneffected by the heat thereof, that may be constructed of relatively few parts easily to fabricate and assemble, and which may employ for as its primary power, compressed air, at pressures commonly available in industrial plants.

In carrying forward the aims of this invention it is proposed to construct a furnace with a reciprocable muffle similar in some respects to the muffle shown in the patent to A. W. Machlet #2,021,072, but unlike the patent in that, among improved features, the muffle of the present invention is supported at its underside by a plurality of upstanding pivoted arms, the journals of which are disposed below the muffle and preferably below and exteriorly of the furnace proper. By means of an improved journal construction, the apertures in the floor of the furnace through which the supporting arms extend are maintained fully closed. The journals themselves are by the manner of mounting, constantly cooled by the ambient air and are readily accessible for water cooling if necessary.

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The entrance end of the muffle is arranged to extend forwardly out of the heating chamber and provided with a flame curtain across its entrance end through which the work to be treated passes on its way to the heated regions within the furnace. The delivery end of the muffle is equipped with a down spout through which the work may fall by gravity into a quench tank. In the preferred embodiment of the invention, the muffle and its flame curtain, loading tray and down spout are arranged to be reciprocated from its forward end by pneumatic piston and cylinder means whose directions of stroke and the frequencies thereof are controlled by a cam actuated reversing valve, the latter being powered by a small electric motor geared to provide the reciprocatory speed desired.

Other objects and advantages will be in part indicated in the following description and in part rendered apparent therefrom in connection with the annexed drawings.

To enable others skilled in the art so fully to apprehend the underlying features hereof that they may embody the same in the various ways contemplated by this invention, drawings depicting a preferred typical construction have been annexed as a part of this disclosure and, in such drawings, like characters of reference denote corresponding parts throughout all the views, of which:

Figure 1 of the drawings illustrates, partly in section, a heat treating furnace embodying the invention.

Fig. 2 is a plan view, partly in section, of Fig. 1.

Fig. 3 is a front end elevation of the furnace.

Fig. 4 is a rear view of the furnace, shown partly in section in two planes.

Fig. 5 is an enlarged plan view of an air motor, valve and valve actuating means, with portions broken away to clarify the principles envolved.

Figs. 6 and 7 are vertical sectional views of one of the pairs of muffle supports and its mounting.

Referring more particularly to Figs. 1–4, the furnace illustrated comprises a main frame 10, that supports an elongated generally rectangular and hollow furnace 11, the walls of which are

constructed of the usual firebrick and insulating materials as will be understood. A series of burners 12 are positioned at suitable intervals in the side walls and by means of which the hollow interior of the furnace may be heated to the temperature desired to process the work.

A work supporting and conveying muffle 13 is disposed within and substantially the full length of the combustion chamber 14 of the furnace. The forward end of the tube like muffle extends through the front end wall of the furnace and is partially cut away to form a work receiving tray 13a. The delivery end of the tunnel is closed but provided with a discharge tube 15 leading into a quench tank 16a. Customarily the lower end 16 of the discharge tube is submerged in the quench liquid, and to prevent upward splash of the quench medium incident to the falling of the workpieces thereinto the tube is provided with fluid cascade mechanism indicated at 17. Line 18 indicates a gas line by which a gaseous medium may be introduced into the muffle for protecting the work, treating, or flushing purposes. Excess gases escaping from the entrance end of the tunnel are burned at the flame curtain 19 provided. A fume exhausting line 15a connects with the interior of the chute 15 and leads to a burner 15b. Combustion air, and fuel if desired, is supplied to the burner 15b by a line 15c. By this construction fumes rising from the quench medium are drawn off and burned and hence do not enter the muffle 13.

As illustrated in Figs. 3, 4, and 6, the muffle 13 is hollow and generally rectangular in cross-section. Its underside rests upon spaced supports 20, 21, and 22. Supports 20 and 21 are in pairs and have their upper ends curved as at 24, with the center of the radius at the axis of the shafts 30. The pair of supports 21, at the entrance end of the muffle, are also notched at their upper ends to interlock with a rib 25 formed upon the underside of the muffle 13. The lower ends of the supports 21 are secured to a rock shaft 26 journaled in bearing brackets 27 mounted securely to the main frame 10. The outer end of the rock shaft 26 carries a lever 28 that has a pivotal connection with a long link 29. Link 29 extends under the furnace and is pivotally connected with each of rock shafts 30 through the medium of similar levers 31.

Each of the rock shafts 30, in the instant disclosure, there being five in all, are journaled in bearing brackets 32. The bearing brackets are each constructed to cradle a pair of supports 20, and each has closed side and end walls 33 and 34 respectively, with their upper margins flanged as at 35. The flange 35 extends completely around the journal bracket and is securely fastened to the underside of the furnace structure 11. Within the margins of the flange suitable openings 36 are provided in the lower wall of the furnace through which the levers 28 project, the lower end of each lever being keyed or otherwise secured to an associated rock shaft 30. Numeral 37 indicates bearing elements in the brackets in which each rock shaft may oscillate with ease. If, due to the maintenance of relatively high furnace temperatures, the rock shafts heat up unduly, they may be cooled by passing a cooling agent, e. g. water, through their interiors which are drilled out as at 38 for that purpose.

In accordance with this invention the entrance end of the muffle projects through an opening 40 in the furnace and overlays the top 41 of supplementary frame structure 42. The frame 42 comprises leg elements 43, a shelf 44 and cross brace 45, and carries on its top 41 the support 22 which in this instance is in the form of a pair of anti-friction rollers.

The extreme forward end of the muffle is pivotally connected to a short link member 46, which in turn is connected to one arm 47 of a bell crank lever 48. Lever 48 is pivotally journaled in a bearing block 49 securely fastened to cross brace 45. The other arm 50 of the lever 48 is relatively long and massive and is pivotally connected with a short link 51 that in turn pivotally connects with the upper end of a piston rod 52. The piston rod projects from the upper end of an air motor 53 that is mounted on the shelf 44.

The motor 53 includes a cylinder member 54, and a cooperating piston 55 that is fastened to the piston rod 52. Above and below the piston, air chambers 56 and 57 respectively are formed in the cylinder, each chamber being in communication with an air line 58 or 59 leading to a control valve 60. Inside the cylinder at the underside of the piston a cushion 61 is installed to absorb the shock and noise as the piston reaches that end of its stroke.

The control valve 60, is of the reversing type having a valve piston member 62 reciprocably mounted therein. The piston is formed with two enlarged valve portions 63 and 64 spaced from one another so as to divide the valve cylinder into three chambers. The center chamber may be regarded as a pressure chamber which constantly communicates with a compressed air line 65, and alternately with cylinder lines 58 and 59. The end chambers constantly communicate with exhaust lines 66 and 67, and each in alternation with the cylinder lines 58 and 59 as the valve piston is shifted from one of its extreme positions in the cylinder 60 to its other extreme position. The core portion 62a of the valve piston is arranged to extend through one end of the valve body and normally is urged by a compression spring 68, against the face of a hammer cam 70. The cam is in the form of a spiral having an ascending portion 70a, an abrupt descending portion 70b, and is mounted upon the output shaft of a power transmission herein illustrated as geared motor 71, though other forms of drive, such as a variable speed drive, may be employed.

When the motor switch (not shown) is closed, the hammer cam 70 is caused to revolve whereby the piston 62 is moved relatively slowly to the left (Figs. 3 and 5) and then quickly to the right, in alternation and continuously. When the valve piston is in the position shown in Fig. 5, compressed air from line 65 is directed through the valve to line 59 and reacts against the underside of the motor piston and the latter moves upwardly. Through the linkage and connections 52, 51, 50, 48, 47, and 46, the muffle is withdrawn from the furnace a limited distance. When the air valve is shifted to the right in Fig. 5, pressure air is directed to the upper side of the motor piston and the latter moves downwardly. Through the linkages mentioned, the muffle is thereby caused to move into the furnace a limited distance. When the reversing valve is in either of its effective positions, air exhausted from the forward side of the motor piston is expelled through one of the end chambers of the valve and the associated exhaust line 66 or 67, as will be understood.

In the position of the parts illustrated in Figs.

1 and 3, the muffle 13 has been withdrawn and is at rest against the stop 75, the piston 55 of the air motor is in its upper limited position and the valve is still moving to the left and continues so to move until the line 59 leading to the bottom of the air cylinder is wide open. As soon as the hammer cam 70 revolves sufficiently to let the valve piston move past or down the steep decline 70b, the spring 68 shifts the valve quickly to the right. This movement opens the lower end of the cylinder to exhaust and the upper end quickly to pressure from the line 65. Through the linkages referred to, the muffle 13 is caused to move forward into the furnace rather quickly, and the workpieces thereon are also carried forward, the movement in the forward direction being assisted by the weight of the arm 50, piston rod 52 and the piston 55. As the muffle moves forward, the workpieces gather momentum and as they are not positively restrained, they are caused to slide a short distance further along the muffle when the latter is abruptly stopped by reason of the piston 55 of the air motor engaging the bumper 61. Immediately thereafter, the gradual incline 70a of the hammer cam begins to move the valve slowly in the opposite direction and slowly cracks the line 59 leading to the underside of the piston 55, to air pressure. The relatively slow opening of the valve to the underside of the air piston causes the piston to rise slowly and thus to impart a relatively slow retract movement to the muffle. The workpieces thereon, which previously had slid forward hold their new positions and move back with the muffle. As the muffle is brought to a stop against the abutment 75, the workpieces, which have not gathered sufficient momentum to slide, retain their positions on and relative to the muffle floor. The parts are so related and coordinated that on completion of the retracting stroke of the muffle, as determined by the stop 75, the valve has still some distance to travel before line 59 is fully opened. In consequence of this relation the piston of the air motor, and also the muffle, never attain the speed on the retracting stroke that they attain on the forward stroke, with the result that the workpieces slide forward at the end of the forward stroke and hold their positions on the muffle at the end of the retracting stroke. The repeated cyclic movement of the muffle thus causes the work to advance step-by-step through the muffle. With the muffle heated to a given temperature the rate of progress of the work through the muffle may be controlled by varying the stroke imparted to the muffle and the rapidity thereof with due regard to the mass of the individual pieces being processed. On a run of workpieces ⅜ round by 2 inches long, ten valve cycles per minute gave a desirable feeding rate through the muffle.

As indicated in Fig. 1, outward movement of the muffle is limited by the adjustable screw stop 75, and the inward movement of the muffle is limited by the motor piston 55 engaging the shock absorber 61, the former providing a simple means for varying the stroke of reciprocation of the muffle, and the latter a silencer at the end of the forward stroke.

As the muffle is reciprocated, the rib 25 on the underside thereof being interlocked with rocker arms 21, causes the arms 21 to oscillate in synchronism. The arms 21 are, as hereinabove explained, operatively connected with each of the pairs of rocker arms 20, whereby the latter are also power operated. The upper curved load bearing ends 24 are thus caused to move in unison and partake of a rolling motion with the muffle without actually shifting, hence there is no wear on the arms or muffle and the latter can be reciprocated with a minimum effort. It will be further observed that with this character of support, the muffle may be anchored at one end, preferably the loading end, as by the lever 47 and any elongation or contraction of the muffle, incident to temperature changes, may freely take place on the arms 20.

Inasmuch as the inner end of the muffle overhangs the last pair of rocker arms and carries the weight of the discharge chute and apparatus connected therewith, straining or possible sagging may occur at high furnace heats, and to avoid such results, it is proposed to support the weight of the chute upon rollers 80 attached to the sides. The rollers 80 bear upon a track 81, which may be mounted upon the quench tank 16a or be a part of a bracket secured to the main frame 10.

Without further analysis, the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various utilizations by retaining one or more of the features that, from the standpoint of the prior art, fairly constitute essential characteristics of either the generic or specific aspects of this invention and, therefore, such adaptations should be, and are intended to be, comprehended within the meaning and range of equivalency of the following claims:

Having thus revealed this invention, we claim as new and desire to secure the following combinations and elements, or equivalents thereof, by Letters Patent of the United States:

1. A work treating machine combining a furnace having an elongated heating chamber therein defined by integrally connected upper, lower, side and end walls with a work receiving opening in one of the end walls, an elongated work treating muffle mounted for reciprocation in a linear path within the heating chamber, said muffle having a work-entrance end projecting through the said opening in one of the end walls, means for supporting the muffle for reciprocation within the heating chamber of the furnace comprising a plurality of longitudinally spaced muffle-supporting arm members pivotally connected to the exterior surface of the lower wall of the furnace and projecting upwardly through correspondingly positioned openings provided in the said lower wall, said arm members having end portions extending into the furnace chamber in abutting relation with the muffle for supporting the latter, each of said arm members having an end face upon which the muffle rests for supporting the weight of the muffle shaped in the form of a segment of a cylinder having a radius equal to the radial length of the arm members and said end face on each arm member having a circular length at least as long as the linear stroke imparted to the muffle, means connected with the projecting work-entrance end of the muffle for reciprocating the muffle through a given distance, and linkage means operatively connected with said projecting end of the muffle and with said pivotal arm members at points exteriorly of the furnace for imparting an oscillatory movement to the muffle supporting arm members thereby to cause their respective segmental end faces to move through a circular distance equal to the linear distance the muffle is reciprocated so that irrespective of changes in muffle length incident to changes in temperature and the resulting changes in the positions of contact with the end faces of said arm members

the reciprocating forces are applied to the muffle at a plurality of points lengthwise thereof, said linkage means including a two-armed lever movable about a fixed pivot and having one of its arms connected with the muffle and its other arm connected with said first named muffle-supporting arms, said two arms being relatively proportioned to effect movement of the muffle-supporting arms synchronously with the linear reciprocations of the muffle.

2. The combination of claim 1 in which said arm members spaced longitudinally of the furnace are arranged in pairs and each pair being secured on a common rock-shaft and in which the said other arm of the said two-armed lever operatively connects with the rock-shaft of each pair of arms for oscillating the arms of each pair in unison.

3. The combination of claim 1 in which the pivoted ends of the supporting arms are journaled in flanged housings, portions of which surround and form closures for the corresponding arm-

openings in the lower wall of the furnace to exclude surrounding air from the heating chamber of the furnace.

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