US007514035B2

(12) **United States Patent**
Jones

(10) **Patent No.: US 7,514,035 B2**
(45) **Date of Patent: Apr. 7, 2009**

(54) **VERSATILE HIGH VELOCITY INTEGRAL VACUUM FURNACE**

(76) Inventor: **William R. Jones**, P.O. Box 205,

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 320 days.

(21) Appl. No.: **11/235,739**

(22) Filed: **Sep. 26, 2005**

(65) **Prior Publication Data**

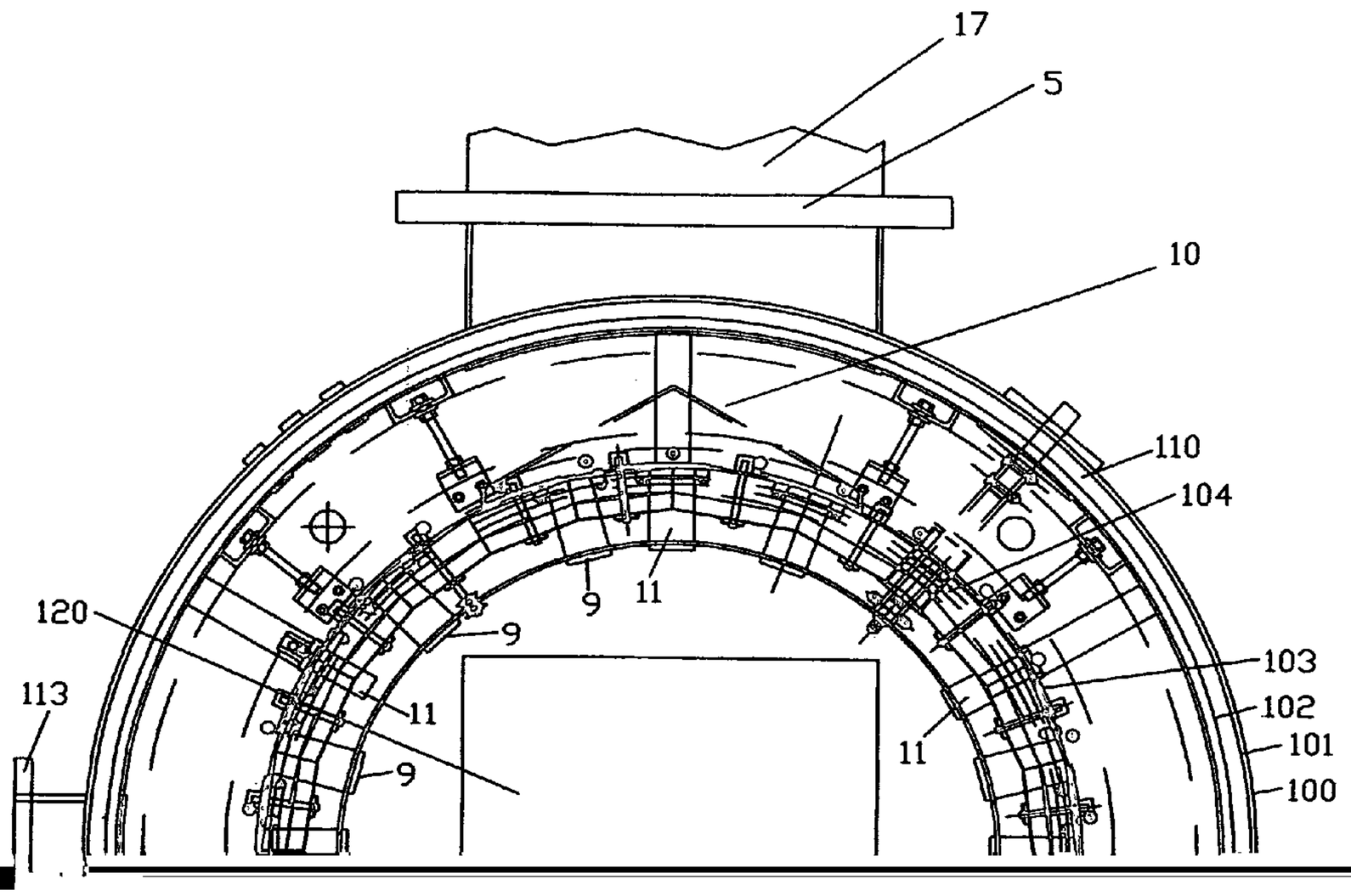
US 2007/0069433 A1 Mar. 29, 2007

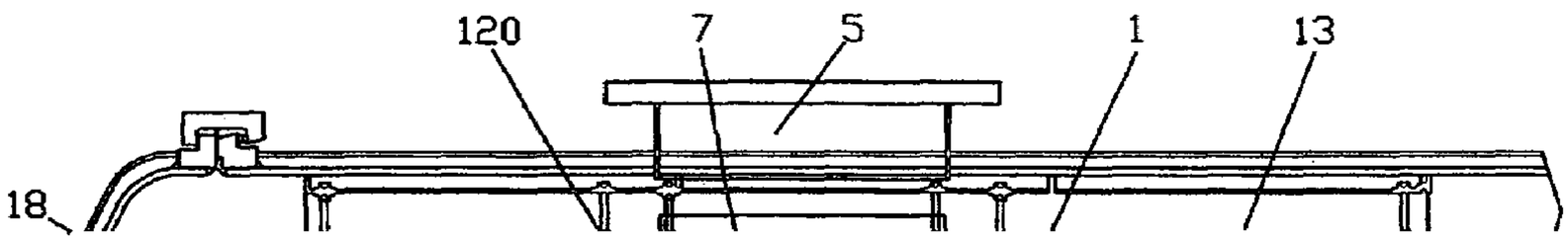
5,267,257	A *	11/1993	Jhawar et al.	373/110
5,348,593	A *	9/1994	Bowe et al.	148/208
5,702,540	A	12/1997	Kubota	
6,021,155	A	2/2000	Jones	
6,187,111	B1	2/2001	Waka et al.	
7,084,068	B2 *	8/2006	Suguro et al.	438/708
2003/0168125	A1	9/2003	Goldsteinas et al.	
2004/0007565	A1 *	1/2004	Moller	219/400
2005/0046095	A1 *	3/2005	Shoemaker	266/250
2007/0068601	A1	3/2007	Jones et al.	

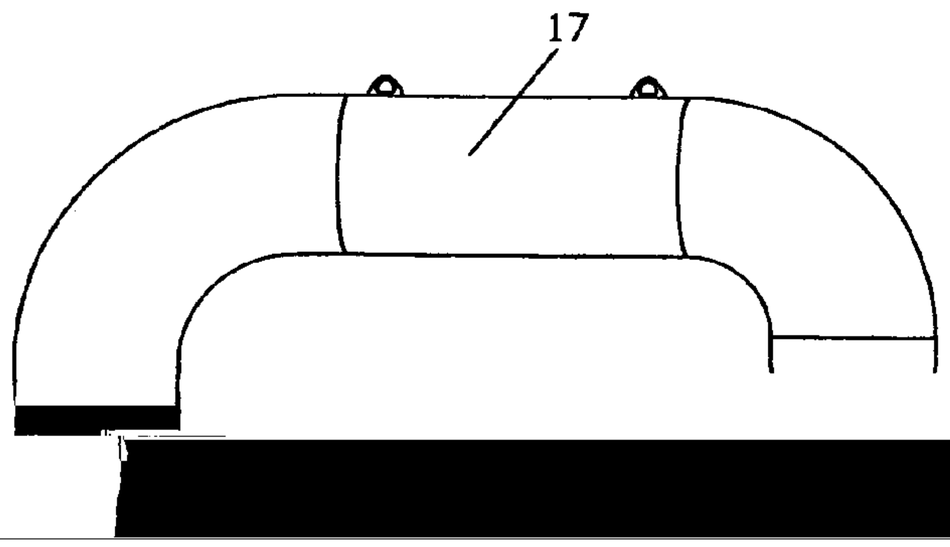
OTHER PUBLICATIONS

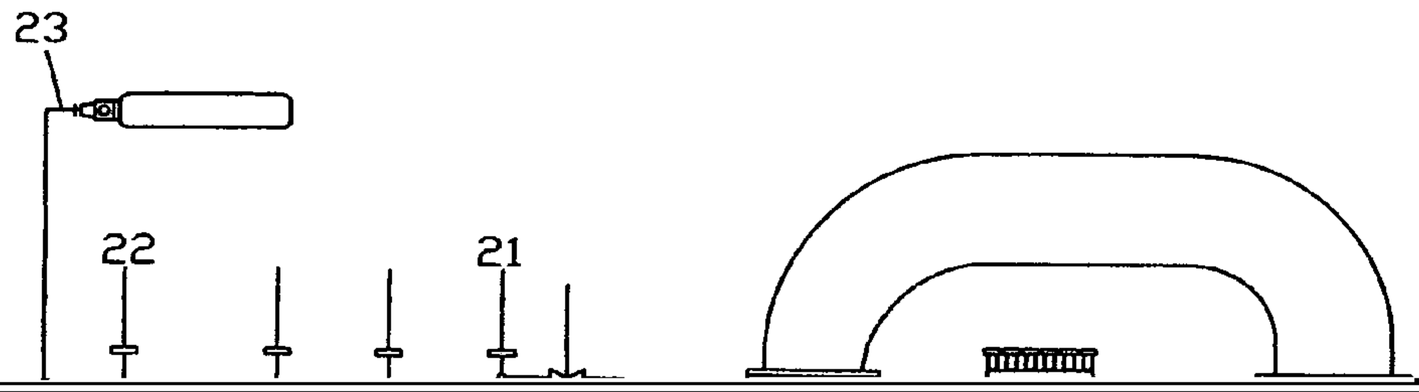
Brignoni et al., "Effects of nozzle-inlet chamfering on pressure drop and heat transfer in confined air jet impingement," International Journal of Heat and Mass Transfer 43 (2000) 1133-1139.*

(51) **Int. Cl.**


17
5
10
110
104
9
11
120
9
103
113
11
102
11
9
101
100


120
7
5
1
13
18


17


23
22
21

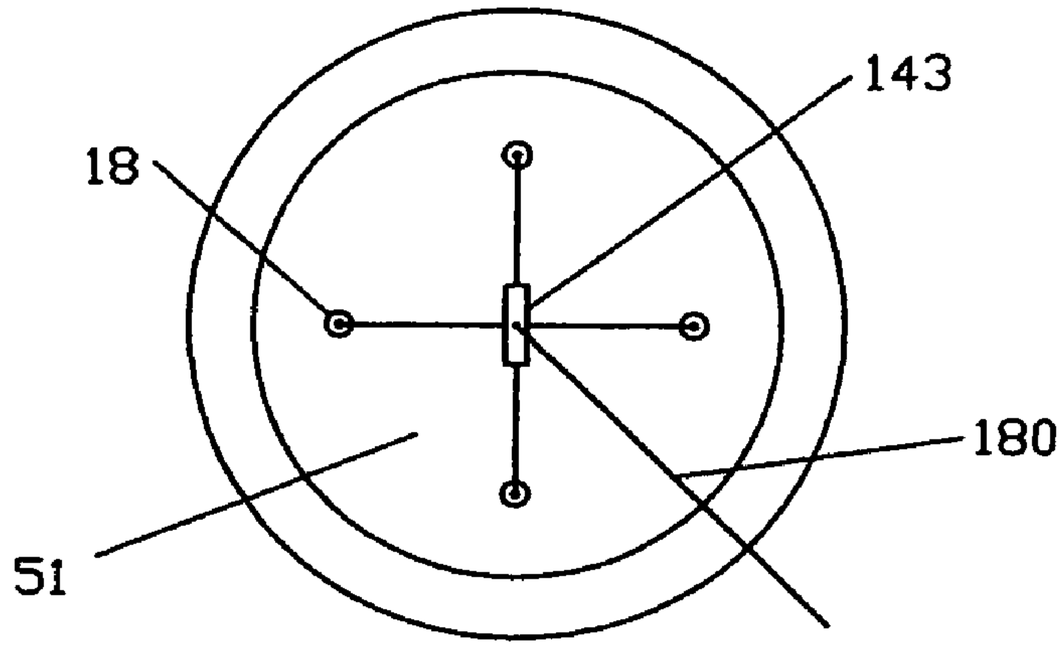


FIG. 5A

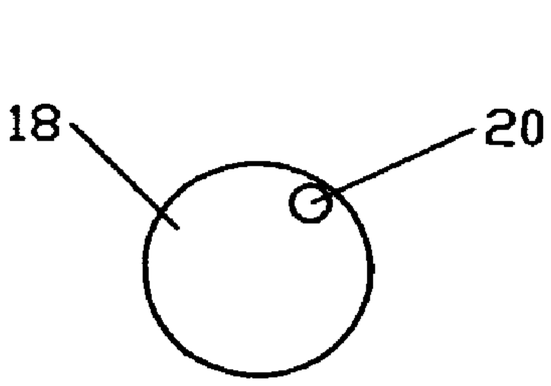


FIG. 5B

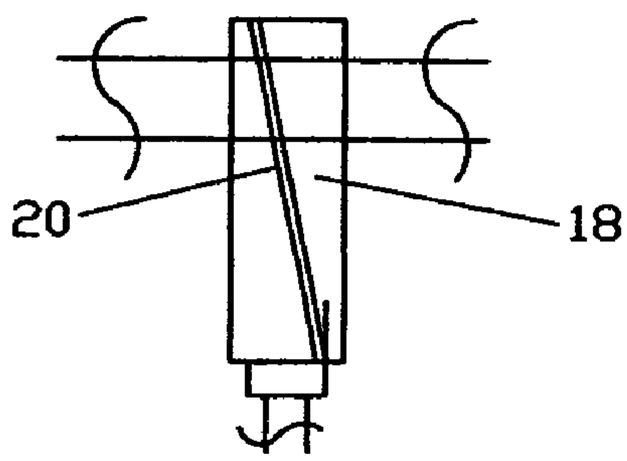


FIG. 5C

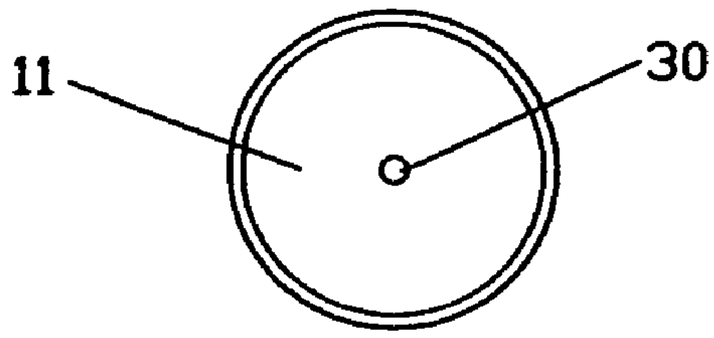


FIG. 6A

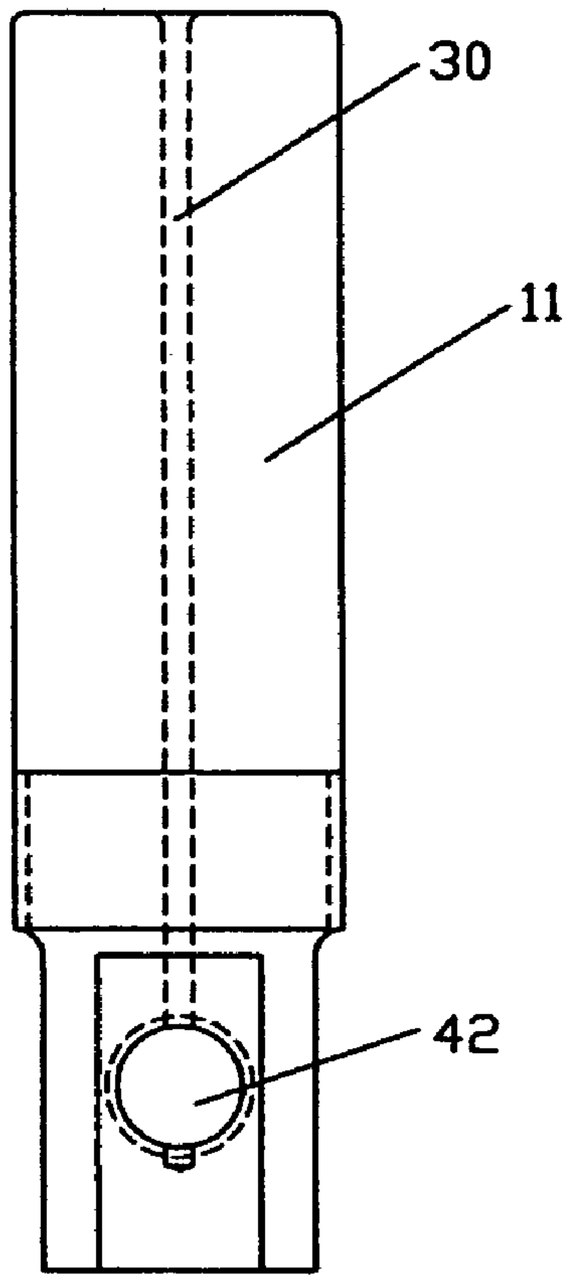


FIG. 6B

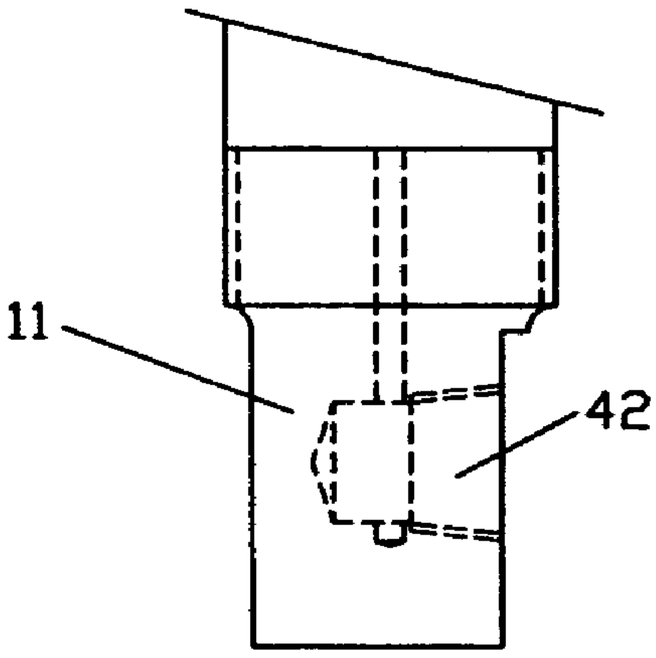


FIG. 6C

VERSATILE HIGH VELOCITY INTEGRAL VACUUM FURNACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to low pressure carburization and other heat treating processes applied to metal alloy parts

shape having a substantially circular internal cross-section. Such a furnace is closed at its forward end by a releasable door, regularly with hinges so that the door swings out of the way for loading and unloading the furnace. The furnace doors have vacuum seals when closed to support the vacuum capability of the furnace. Also the doors regularly have insulation placed and formed to mate with insulation lining of the circular cross section furnace walls. Although the furnace of this

William R. Jones et. al. entitled "Process For Heat Treating Steel Alloys" which is incorporated by reference in its entirety.

BRIEF SUMMARY OF THE INVENTION

Applicants have found that a carburizing process including

FIG. **6**B. FIG. **6**D is a cross sectional view along line Z-Z of carburizing gas nozzle **11** connection.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

A front, cross section view (looking toward the door end) of high temperature, vacuum furnace **100**, is depicted in per-

1 wherein the diameter of duct **17** is significantly longer than 90 percent of the width or height of work zone **120**. In another important embodiment of the invention, for high volume transport of the quenching gas into the furnace, the perpen-

The carburizing gas tube connection **42** (see FIG. **6**) furnishing carburizing gas to the jet is at a 90 degree angle in order to reduce or block heat. Carburizing gas nozzles **11** are fed through smaller diameter tubing, desirably stainless steel tub-

from the supply source into the furnace desirably is at least as

highly purified hydrogen or acetylene outside furnace **100**

mity within the furnace of 427 to 93 degrees C. +/−5.6 C (800 to 200 degrees F. +/−10 F). The system is designed to operate in conjunction with a roughing pump (commercially available). In the heating mode of the furnace, reflective heat radiation baffle 8 reflects heat back to the furnace hot zone and

purest grade commercially available. Impurities found in lower grade gases, according to the present invention have been found to contribute to soot formation and product contamination. Also, before each carburizing run all gas feed

To further improve carburizing efficiency the design of carburizing gas nozzles **18** shown in FIG. **5**A and their arrangement within the autoclave door desirably fit in a uniform arrangement at 12:00, 3:00, 6:00, and 9:00 as on the face of a clock. Nozzles **18** are designed as graphite threaded units for ease of replacement and freedom from clogging. Alterna-

ber of a heat treating vacuum furnace having low vacuum capability, high pressure capability, and very high gas-circulating capability), with gas transport lines for providing gas to and drawing gas from said chamber, surfaces of steel alloy work pieces, by:

(a) drawing a very low pressure vacuum to evacuate gas

als. The gas mixtures, which are delivered from stainless steel

(b) allowing hydrogen to flow through a gas line into the

the diameter of said duct is larger than approximately 70% to 90% of the shortest work zone dimension.

2. A vacuum carburizing furnace in accordance with claim

said plurality of centered chamfered jet tube carburizing nozzles are located evenly throughout said cylindrical cham

8. A vacuum carburizing furnace in accordance with claim **1** wherein said access door contains approximately 8 high velocity gas quench nozzles evenly distributed throughout

9. A vacuum carburizing furnace in accordance with claim