SUBJECT ELECTRIC ANNEALING FURNACE - TUBULAR - TYPE #A 56 (With Alterations)

→ The Type #A 56 tubular electric annealing furnace *(with alterations) is standardized as described in this Standardizing Notice.

The furnace is described under the following headings:

1. Heating Tube Box
2. Heating Tube
   (Construction - Installation - Operation)
3. Cooling Chamber
4. Hydrogen Supply and Connections
5. Boats
6. Setting Up the Furnace
7. Method of Operation
   (a) Starting Up
   (b) Operating
   (c) Shutting Down
8. Meters and Voltage Chart

1. HEATING TUBE BOX

The cast iron box 2 measures 21' x 7 1/4" x 7 1/4" outside dimensions not including the bosses. The end caps 5 and 10 are bolted to the bosses as shown in Fig. 1, expansion packing 22 being used at the ends of the heating tube and a thin gasket of asbestos 21 over the end of the boss. The caps should not bear against the ends of the heating tube too much or the tube will break due to its expansion when heated.

The cap 10 has a drilled hole the diameter of which is equal to the inside diameter of the heating tube and forms the entrance to the furnace. A sheet steel cover 15 at the entrance has a 1/4" hole in it to allow the hydrogen to escape and ignite. The water cooler end cap at the rear is tapped to fit the cooling chamber. The cast iron top 3, with the asbestos gasket 20, is held down by three U-shaped top clamps, 16, whose ends extend thru cross pieces 17 on top of the furnace (as shown in Fig. 1) and are provided with nuts and washers.

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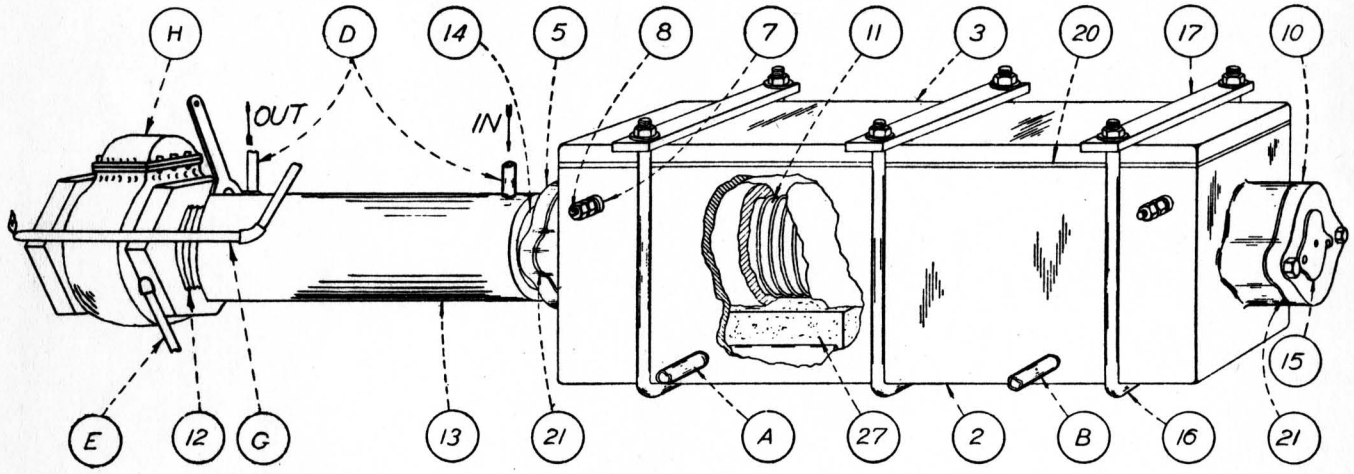

Fig. 1

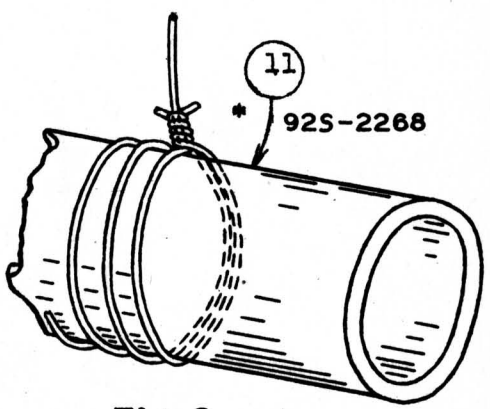

Fig. 2

☆ INDICATES A CHANGE ☆☆ INDICATES AN ADDITION

The tube is supported at the ends by cast iron bushings 4 and at two positions by supports 27 made of fire brick of a size of 2 1/4" x 2 1/2" x 8". Fire brick of this size is known as soap brick. The 2 1/4" dimension is cut down to 1 1/2" to allow the bricks to fit underneath the tube and provide a space above and below the brick for thin layers of insulating material.

→ *After the tube is installed in the box the lead wires should be connected to the inside terminals of the box. These terminals may be insulated from the box with transite slabs and collars cut from 3/16" stock. Terminals should be made of iron bolts and nuts. Brass terminals should not be used. The box should be filled with magnesia, U.S.P. grade. Magnesia as received will shrink after one or more days in a furnace operating above 1200°C and it will be necessary to shut down the furnace, open it and add more magnesia. Magnesia which has been taken from a furnace previously operated should be broken up and used again. The fritted part which must be broken up should be placed close to the alundum tube and unshrunk magnesia should be used in the cooler parts of the packing box, i.e. corners and sides. A furnace which has been packed with previously used magnesia in the above manner does not have to be opened for additional magnesia as the shrinkage is nil.

→ *Approximately 50 pounds of magnesia should be ordered for each new furnace.

→ **New tubes should be heated slowly. The following schedule for heating a new tube should be used:

Time	Wattage Input	Time	Wattage Input
0 first day	100	2 hours	1200
15 min.	200	3 "	1500
30 "	300	4 "	1800
45 "	400	5 "	2100
1 hr.	500	6 "	2400
1 1/4 hrs.	700	7 "	2700
1 1/2 "	900	8 "	3100

→ **The tube should be allowed to operate overnight at 3100 watts with hydrogen flowing thru the heat insulation and the cooling chamber supply valves.

0 second day	3200	3 hours	4400
30 min.	3400	3 1/2 "	4600
1 hr.	3600	4 "	4800
1 1/2 hrs.	3800	4 1/2 "	5000
2 "	4000	5 "	5200
2 1/2 "	4200		

→ ** The tube temperature should be checked with an optical pyrometer after 4800 watts have been applied. The temperature should not be allowed to rise above 1600°C until the tube has operated one or more 8 hour days at 1600°C. If the furnace is to be operated at a temperature under 1600°C it is not necessary to apply 5200 watts. Instead, read the furnace tube at 15 minute intervals and raise or reduce wattage until the desired temperature is attained.

3. COOLING CHAMBER

The cooling chamber consists of a steel inner tube 14, a water jacket 13, and two spacing rings 19 slipped over the tube and supporting the jacket at each end. The chamber is sealed by welding the rings to the tube and jacket. The length of the tube is 16 1/4"; its inside diameter is that of the alundum

(Cont'd. on page 5)

3. COOLING CHAMBER (Cont'd)

tube and both ends are threaded. One end screws into the cap 5 of the furnace and the other end is connected to a lever operated gate valve. Two pieces of 1/4" pipe D in the top of the water jacket provide for the introduction of a stream of cooling water.

→ *When it is desired to open the Lunkenheimer "Handy" quick operating gate valve H at the unloading end of the furnace the hydrogen supply should be increased to prevent an explosion which would be caused by insufficient hydrogen flow.

→ *4. HYDROGEN SUPPLY AND CONNECTIONS

Hydrogen may be supplied from a cylinder thru a pressure reducing valve. The pressure reducing valve should have a left hand thread in the connection for the cylinder nipple. All other threads are right handed. Since the furnaces are operated at approximately atmospheric pressure and are open to the atmosphere no pressure release devices will be needed between the reducing valve and the furnace.

Where hydrogen is furnished thru pipes from a gasometer the cylinder supply and reducing valve are not needed.

5. BOATS

→ *Articles to be annealed are put thru the furnace in boats. Boats are made of 1/16" sheet nickel, or molybdenum, the latter material being used when temperatures are above 1300°C.

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6. SETTING UP THE FURNACE

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→ *A 6 k.v.a. transformer having a 220 volt primary and 220 volt secondary, tapped to give 5 volt steps from 5 volts to 220 volts should be used. The primary and secondary windings should have sufficient capacity for 35 amperes. A plug board should accompany the transformer.

→ NOTE: Existing furnaces for temperatures below 1300°C may in some cases be controlled by Allen Bradley 1000 watt type E2211 resistors. For new or reconstructed furnace equipment, heating tube voltages should be obtained from transformer taps rather than thru the use of resistors.

→ *An optical pyrometer, either the Pyrometer Instrument Co., 50 Howard Street, New York, N. Y. type having a variable screen and constant lamp filament current or a variable filament current type such a s the Leeds & Northrup, Philadelphia, Pa. should be used for determining the heating tube temperature.

→ **After a heating tube has been brought to 1600°C according to the schedule given on a previous page the subsequent heatings from room temperature may be done more rapidly. The following schedule may be used:

Time	Wattage	Time	Wattage
0 min.	500	2 hrs.	2500
15 "	750	2 1/4 hrs.	3000
30 "	1000	2 1/2 "	3500
45 "	1250	2 3/4 "	4000
1 hr.	1500	3 "	4500
1 1/4 hrs.	1750	3 1/4 "	5000
1 3/4 "	2000	3 1/2 "	5200

A tube which has been in service several weeks may require as much as 5500 watts for a temperature of 1600°C.

7. METHOD OF OPERATION

The method of operating the furnace is described under the following headings:

a - Starting Up
b.- Operating
c - Shutting Down

a. Starting Up

1. Start the cooling water which should never become appreciably warmer at the outlet than at the inlet.

2. Regulate the flow of hydrogen so that 50 liters per hour flow thru the box, and 200 liters per hour thru the cooling chamber and tube. It is important that the hydrogen be always flowing when the tube is heated.

3. Five minutes or so after gas has been regulated, during which time the air has been carried out of the tube, light gas at opening in tube cover 15.

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b. Operating

With the furnace heated to a specified temperature, push a loaded boat into the heated zone of the furnace and allow a specified time for annealing; then push the boat into the cooling chamber where it should remain for a specified time to cool or until all danger of oxidization is removed when the parts are exposed to the air. Open gate valve, light gas with pilot light, and pull out boat.

A rod about 50 inches long can be used to push the boat into the furnace. It is convenient to have stops attached to the rod for locating the boat in the furnace and the cooling chamber. A rod with a hook on the end may be used to pull the boat out of the cooling chamber.

*** Indicates an elimination.

b. Operating (Cont'd)

NOTE: While the gate valve is open, air is entering. Should there be a boat load of heated parts in the heating furnace at this time the air which enters may slightly oxidize them, such oxidization being removed by continuation of annealing. For this reason, there should always be an interval of several minutes between the closing of the gate valve and the action of pushing a heated boat into the cooling chamber. The two operations must not be done at the same time.

c. Shutting Down

→ 1. *Open switch and place plugs in jacks which furnish the 500 watt starting power.

2. Allow hydrogen to flow (and burn) until the inside of the tube is black. Hydrogen has no odor and may be a source of danger if left flowing but unlighted. Also allow water to flow. It requires about 1 1/2 hrs. for the furnace to cool sufficiently to permit turning off the hydrogen.

→ 3. **If it is desired to operate furnaces overnight a 5% reduction in voltage input should be made to prevent overheating due to possible line voltage increases.

8. METERS AND VOLTAGE CHART

In addition to equipment described in the present notice there should be included:

1. 1 - 0-40 amp. A.C. ammeter for each furnace
2. 1 - portable 0-220 volt A.C. voltmeter for checking transformer tap voltages
3. 1 - transformer tap voltage chart which will be furnished by the transformer manufacturer.

STANDARDIZING SECTION
ENGINEERING DEPT.