RCA Radiotron Division
RCA MANUFACTURING COMPANY, INC.
STANDARDIZING SECTION
RESEARCH AND ENGINEERING DEPT.
EEE

STANDARDIZING NOTICE 34-38-5A

SUBJECT CONTINUOUS FIRING IN ATMOSPHERE OF PARTIALLY COMBUSTED CITY GAS

SUPERSEDED DATE

Supersedes former 34-10-5 & 5 and 34-12-2.

By partially burning city gas (water gas) in the ratio of 2-3 volumes of air to 1 volume of gas, a reducing gas composed of hydrogen, carbon monoxide, methane, carbon dioxide, nitrogen, and water vapor is formed. This partially combusted gas is much less expensive than pure hydrogen and is particularly adaptable as a reducing atmosphere in continuous firing furnaces such as are included under Model No. 780-Y.

In addition the furnace may be used as an annealer to relieve strains in region of glass to metal seals. In latter case as well as in oxidizing nickel parts, the gas is either shut-off or by-passed. Chrome iron parts may be oxidized in above reducing atmosphere.

1. EQUIPMENT

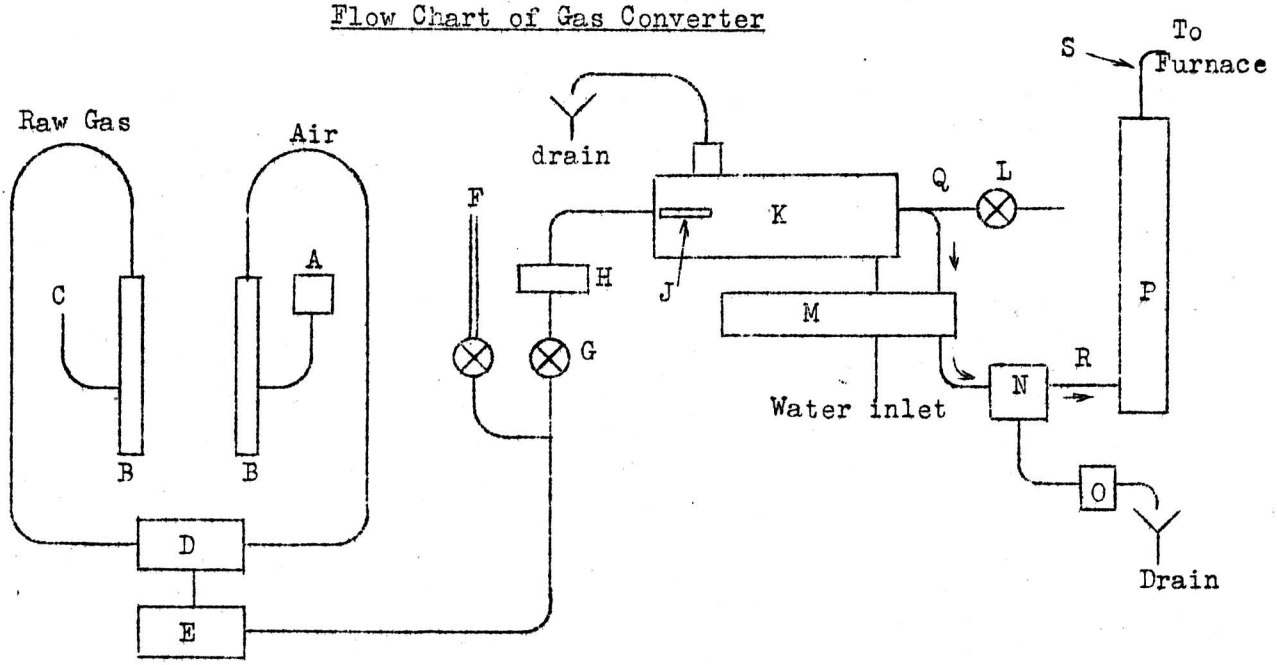
Continuous Firing Furnace, Model No. 780-Y, consisting of furnace and gas converter along with compressor condenser, purifier, electrical equipment, etc. Under this model are included (1) the Electric Furnace Co. 8" and 12" furnaces and (2) the General Electric Co. 8" furnace, where dimension indicates the width of the heat resistant woven carrier belt in the furnace. For details or specific information other than that given here, refer to Equipment Dept.

Furnaces are electrically heated with cast grid heating elements in the Electric Furnace Co. furnaces and with ribbon elements in the G.E. furnace mounted inside the heating chamber along the walls and ceiling and exposed to the partially burned gas atmosphere.

Furnace Ratings

Electric Furnace Co. furnaces	1115°C	8" - 40KW at 220 V. 12" - 75KW at 220 V.
General electric Co. furnace	1176°C	8" - 41KW at 55 V.

Flow Chart of Gas Converter



☆ INDICATES A CHANGE ☆☆ INDICATES AN ADDITION

Flow Chart of Gas Converter (Cont'd)

A. Air intake with filter
B. Flow gauges
C. Gas intake
D. Proportioning mixer
E. Compressor
F. Lighting torch
G. Volume control valve
H. Fire check
J. Burner
K. Combustion chamber (water jacketed)
L. Exhaust valve
M. Surface cooler
N. Water separator
O. Trap
P. H_2S removal tank
Q. Processed gas containing H_2O & H_2S.
R. Processed gas containing H_2S (water partially removed)
S. Processed gas

Furnace temperature is controlled with Leeds & Northrup recording potentiometer equipment. Temperature regulation is affected by operating temperature, belt speed, load, and the control setting. Regulation probably better than average is represented by the temperature values in the second column below.

Operating Temperature	Regulation
400°C	± 20°C (400°C is below firing temperature normally used)
800°C	± 15°C
1100°C & over	± 10°C

Note: When furnaces operate idle the temperature spread is about 50% of above values. (Temperature spread of General Electric 8" furnace when operating idle is about ±6-7°C.)

Trays - For firing parts which are too small or otherwise unsuitable for placing directly on belt, trays of sheet metal or wire mesh may be use. For example, trays of 1/16" sheet nickel may be of a size such as 6-1/2" (width) x 10-1/2" (length) x 1-1/2" (height)(overall dimensions).

2. FIRING SCHEDULES

These are carried as a matter of record. Time and temperature data are representative of average conditions. For specific firing time and temperature for any part refer to construction data notices.

Operation & Parts	Furnace Belt Size (Inches)	Belt Speed (Ft/Min.)	Firing Time (Min.)	Firing Temp. (°C)	"Refer. Note"
Cleaning - Metal Bulbs	8	1.0	7	1120-1130	A
Metal Bulbs	12	1.0	9	1120-1130	A
Misc.Iron Parts	12	0.9	10	1000	B
Ni.or Ni.Pl. Parts	12	1.8	5	1000	B
Firing - Misc. Carb. Parts	12	0.9	10	800	B
Brazing - Power Tube Cu Parts	8	1.0	7	1120-1130	B

2. FIRING SCHEDULES (Cont'd)

Operation & Parts	Furnace Belt Size (Inches)	Belt Speed (Ft/Min.)	Firing Time (Min.)	Firing Temp. (°C)	"Refer. Note"
Clean & Anneal - Miniature stems	8	1.0	7	495-510	B
Oxidize & Clean - FMT10A3 Metal Bulb Assly.	8	1.0	7	1120-1130	B
Annealing- Metal to #8 Lime Glass seal	8	1.0	7	500-520	C

A. Load bulbs so that face of flange does not come in contact with belt.
B. Load small parts into trays before placing on belt.
C. Cooling Water Control - Restrict flow of water to first cooling chamber to raise temperature of water to boiling point. Operate second cooling chamber with water jacket filled with water but with no water flowing.

3. PREPARATION OF REDUCING ATMOSPHERE

A. Mixing Gas & Air

Prior to being partially burned in a combustion chamber, the city gas must be mixed with air in ratio of 2-3 volumes of air to 1 volume of gas. This is done by a pump operated at such a speed as is required to continuously deliver required quantity of gas and air mixture to combustion chamber and eventually to furnace proper. Air at desired rate of flow is drawn thru (1) a filter chamber, filled with material such as cotton, (2) thru a Rotometer flow gauge, (3) thru an orifice, of a size determined by the quantity of air required, and (4) mixed with the gas in the intake line to the pump. The gas, before it unites with the air, flows thru a Rotometer flow gauge and an adjustable orifice with a micrometer screw. Pump speed, orifice sizes or openings, and pressures within system, must be such that Rotometer flow gauges will register proper rates of flow in their correct ratio, 2-3(air): 1(gas). Combusted gas is maintained under about 1 psi. pressure, that is, up to valves where gas is admitted to furnaces. (The valve to General Electric 8" furnace is used wide open, and but little back pressure develops.

B. Combustion of Gas - Starting Up

1. Electric Furnace Co. Furnace

Having valves in line between combustion chamber and furnace set for normal operation, remove sight glass fitting from near top end of cylindrical combustion chamber. Start pump, admitting only gas at first and ignite gas in chamber with a lighted taper or with a flame from a small pipe. Admit air gradually until mixture will remain lighted, replace sight glass, and admit full flow of air. If the correct mixture of gas and air is used the temperature in combustion chamber should remain below that at which pipes in top end may become overheated and burned.

3. PREPARATION OF REDUCING ATMOSPHERE (Cont'd)

B. Combustion of Gas - Starting Up (Cont'd)

1. Electric Furnace Co. Furnace (Cont'd)

The partially combusted gas leaves combustion chamber thru an outlet connected to a safety valve and a series of condenser pipes in a narrow tank of water, the gas entering at top and leaving at bottom of tank. The temperature of cooling water in tank may be kept cool or quite warm and is not critical. Moisture which condenses out of the gas, drains away thru a trap at end of condenser. The safety valve referred to consists of a gasket of .003" sheet aluminum clamped between two side (8") flanges to leave one side of gasket 4" in diameter exposed to air. After leaving condenser the gas may be passed directly to furnace or it may first be passed thru a purifier to remove small carbon particles and hydrogen sulphide (H_2S). Outlets in the system allow checks to be made on gas pressure after combustion and permit samples of gas to be taken for analysis. Analysis for constituents (H_2, CO, CO_2, N_2, CH_3, and H_2O) of gas may be checked by the laboratory; or a specific gravity check may be made on gas with a Schilling specific gravity bottle.

2. General Electric Co. Furnace

Start combustion of gas as follows: 1 - Close gas outlet valves on lines leading from combustion chamber and open latter to air by means of a valve on a blow pipe projecting horizontally from end of chamber. 2 - Operate pump to give a mixture of 300 cu.ft. of air and 100 cu.ft. of gas per hr. 3 - Immediately ignite mixture at end of pipe. 4 - Hold air flow at 300 cu.ft. per hr. and reduce gas flow to 83 cu.ft. per hr. This will cause flame to pull in and ignite gas inside of combustion chamber. 5 - Allow gas to burn about 15 minutes until inside of combustion chamber becomes red hot. 6 - Open valves to permit normal flow of gas in lines and close valve on blow pipe. 7 - Adjust air and gas to obtain desired volume of each in ratio of 2-3 to 1, respectively.

4. SULPHUR REMOVAL

When it is necessary to use sulphur-free gas as a reducing atmosphere in a furnace, the combusted gas leaving condenser must be forced thru two towers in series, the gas passing from bottom to top of towers in both instances.

The charge for the first tower, or water scrubber, consists of granulated pea-size limestone. As gas passes upward thru limestone, water trickles downward at rate of about 20 gal. per hr. (in the 1000 cu.ft. size scrubber) and drains away thru a trap. Free particles such as carbon are removed from the gas in this tower. The limestone does not deteriorate and should last about five years without need of replacement.

The second tower for removing hydrogen sulphide must be filled with wood chips impregnated with iron oxide (F_2O_3). This material may be obtained under trade name of "Lux". Lux chips deteriorate and will require replacement in about 6 months. This material dries out and should not be stocked for a long period of time. About two weeks should be allowed for ordering Lux, before it is to be used.

4. SULPHUR REMOVAL (Cont'd)

As gas passes through iron oxide treated chips, any hydrogen sulphide (H_2S) present in gas is converted into iron sulphide (FeS) and water vapor (H_2O). Tests for sulphur content in gas should be made periodically to note if there is any increase in sulphur and consequently need for renewal of Lux. To test for presence of H_2S, allow gas to impinge on a filter paper soaked in 10% lead acetate solution. If filter paper turns brown, presence of H_2S is indicated. Note: With the G.E. furnace unit, no carbon removal tower is used.

5. FIRING OPERATION

a. Pump air and gas to combustion chamber in ration of 2-3 to 1. Minimum quantities of air and gas mixtures used before combustion, for 8" and 12" furnaces, are about 565 and 990 cu.ft., respectively. Combusted gas enters furnace on opposite sides of connection between furnace and cooling chamber.

(For General Electric 8" furnace the inlet for combusted gas is near top on one side of cooling chamber extension, close to exit end of cooling chamber.)

Due to conversion of hydrogen in gas to water vapor during combustion, the volume of gas leaving combustion chamber is less than that of mixture of gases which enter combustion chamber.

b. Set temperature control at required value and apply heating current.

c. Adjust travel of belt to required speed. Partial calibrations of speed regulators are: (Periodic calibrations should be made due to wear of belt.)

Regulator Setting	Belt Speed 8" Furnace Ft./min.	12" Furnace Ft./min.
0.	2.73	1.54
0.5	2.00	1.03
1.	1.50	0.71
1.5	1.13	0.58
2.	0.90	0.41
2.5	0.66	0.32
3.	0.47	0.24

d. Load parts close together on belt to completely cover it; or load small parts into 6-1/2" x 10-1/2" nickel trays and place trays end to end on belt.
e. Lower furnace gate to leave just enough opening for parts on belt to pass under. This retards back draft. Gas on escaping from this opening will burn with a blue flame.
f. Regulate cooling chamber water to a temperature such that moisture in gas passing out through cooling chamber will not condense on inside walls. The parts on leaving belt at exit end should be warm enough to prevent condensation. Depending on requirements, as specified in firing schedules, it may be necessary to turn off cooling water completely or restrict its flow to keep it at boiling point.
g. Adjust baffle curtain at exit end of cooling chamber so that space above parts will be closed as effectively as possible against back drafts.