GTW Series
Flat &Bending Glass Tempering Furnace

Operating Manual

(Read This Manual Before Operating)

Qinhuangdao Tucheng Glass Technology Co. Ltd

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We would like to extend our appreciation for your selection of Glass Tempering Furnace of Tucheng Company.

Carefully read this Manual and know about its content to ensure correct operation and maintenance. If there is something you need not involving or something you are not clear you are always welcomed to contact our After Sales Service Department, we will show our utmost to satisfy you.

Kindly keep these manuals or references well in case you need to consult something.

Ⅰ. Precaution

1. Before using this equipment, the operator shall read this User's Manual on perusal, make sure to understand the following caution signs completely and comply with them strictly.

2. Only those personnel who're well trained and qualified are permitted to operate this equipment.
3. Non-professional maintenance personnel shall not install, test run or take

down any mechanical or electric equipment, otherwise it'll broad the problem or cause personnel injury and breakage of equipment.

4. Unauthorized personnel shall not open the protective door/cover to avoid personnel injury and breakage of equipment.

Ⅱ. Equipment application

This non-standard equipment, which is a kind of glass deep processing mechanism, is used for producing tempered glass. By using this equipment, different variety of glass like clear float glass, body tinted float glass, single screen print glass, online coated glass and online Low-E glass can be tempered.

Ⅲ.Environmental and power supply requirement as well as total weight of equipment

1. Special blower room is to be set.
2. Ambient temperature -5^{o} C ~ 40^{o} C
   Relative humidity 40^{o} C—50 %; 20^{o} C—90 %
   Altitude lower than 1000m is normal for running
3. Power supply requirement and total weight of equipment
   This kind of equipment requires a 3-phase-5-line AC power supply of 380V and total installed power of it is 227Kw~3250Kw. Total weight ranges from 16.5t to 115t.
   The actual total power and total weight are various by different model of furnace.

Ⅳ. Main technical specification of GTW series flat & longitudinal bending glass tempering equipment

Model	Max. Size for Flat Glass	Max. Size for Bending Glass	Thickness
	mm	mm	mm
GTW0608H	600×1000	600× $\overset{\frown}{800}$	4~10

GTW0708H	700×800	700× $\overset{\frown}{800}$	4~10
GTW1008H	1000×800	1000× $\overset{\frown}{800}$	4~10
GTW1210H	1200×1000	1200×$\overset{\frown}{1000}$	4~10
GTW1612H	1600×1200	1600× $\overset{\frown}{1200}$	4~12
GTW2415H	2440×1500	2440× $\overset{\frown}{1500}$	4~12
GTW3621H	3660×2150	2150× $\overset{\frown}{1500}$	4~12
GTW3624H	3660×2440	2440× $\overset{\frown}{1500}$	4~12
GTW5024H	5000×2440	2440× $\overset{\frown}{1500}$	4~12
GTW6024H	6000×2440	2440× $\overset{\frown}{1500}$	4~12
GTW8024H	8000×2440	2440× $\overset{\frown}{1500}$	4~12

Bow shape deformation of flat tempered glass: ≤0.3%
Wave shape deformation of flat tempered glass: ≤0.2%
Bow shape deformation of bending tempered glass: <0.5%
Wave shape deformation of bending tempered glass: <0.3%
Length of straight section of arch edge: <50mm

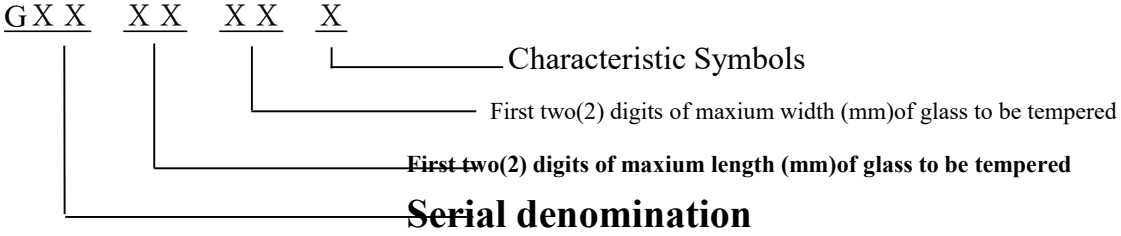
Ⅴ. Principia of denomination for types of glass tempering equipment

Glass tempering equipment produced by Tucheng is of non-standard equipment, the principle of denomination for its serial types stipulated for by Tucheng itself.

1. Name of Model
   (1) Flat Glass Tempering Equipment: GT
   (2) Bending Glass Tempering Equipment GW
   (3) Flat and Bending Combined Glass Tempering Equipment: GTW
2. Symbols
   (1) “H” Lateral bending

(2) “Z”	Longitudinal bending
(3) “L”	Continuous heating
(4) “B”	for Thin Glass
(5) “S”	Double heating room
(6) “D”	Convective heating

3. Significations and Example of the Symbols



For Example：GTW5024H

It represents that a flat and bending combined glass tempering equipment with maximum length (mm) and maximum width of glass to be tempered are respectively 5,000mm and 2,440mm.

4. Code for Drawings of every major component with the plant

00: General Drawing	05: Quenching Frame & Quenching
01: Loading Section	06: Air Supplying System
02: Electric Heating Furnace	07: Pneumatic System
03: Roller Table for Quenching	08: Electric Drawings
04: Unloading Section	

Ⅵ. Statement of equipment running noise

This glass tempering furnace is a kind of non-continuous running equipment. It has loud noise when working, which is mainly from blower room (caused by motor and blower) as well as nozzle of windscreen.

When customer requires to lower noise, which is written in contract, we may supply the blower room construction drawing, designed according to which blower noise will be reduced. Another way that is recommended is to set the whole blower room under ground. For the windscreen section, we may set sound absorption device to reduce noise. The Max working noise will be less than 85 dB.

If a worker enters blower room when equipment is in operation, he’s

required to wear ear protective cover.

Ⅶ. Equipment constitution, structure and working principle of GTW series flat and longitudinal glass tempering equipment

1. Constitution

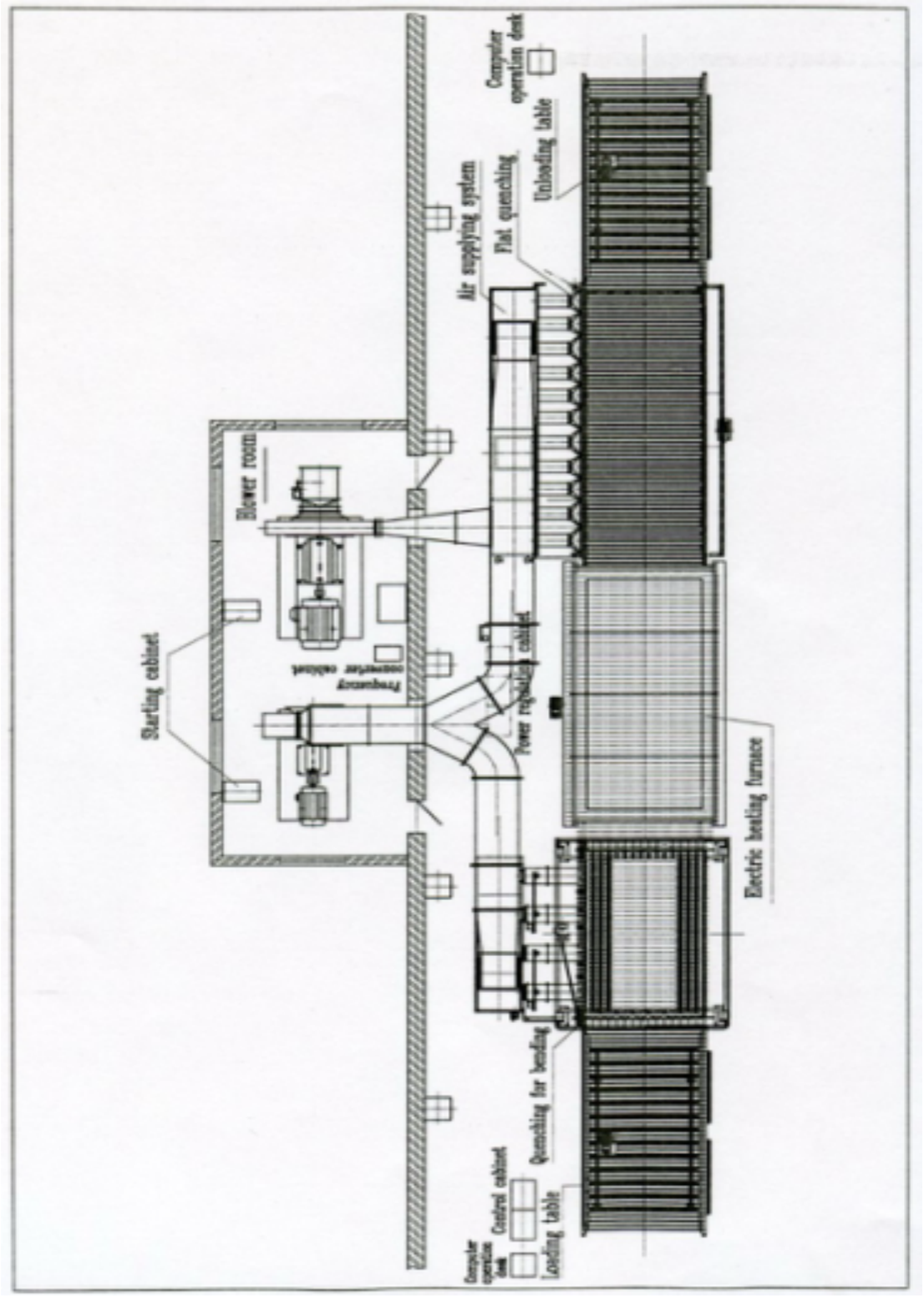


Fig. 1: Equipment constitution

As what is shown in Fig. 1, equipment of GTW Series flat and longitudinal bending glass tempering plant mainly consists of the following parts:

1) Loading roller table
2) Longitudinal bending windscreen
3) Electric heating furnace
4) High pressure section of flat tempering
5) Low pressure section of flat tempering
6) Unloading roller table
7) Air cooling system
8) Control system

2. Function, structure and working principle

1) Loading roller table

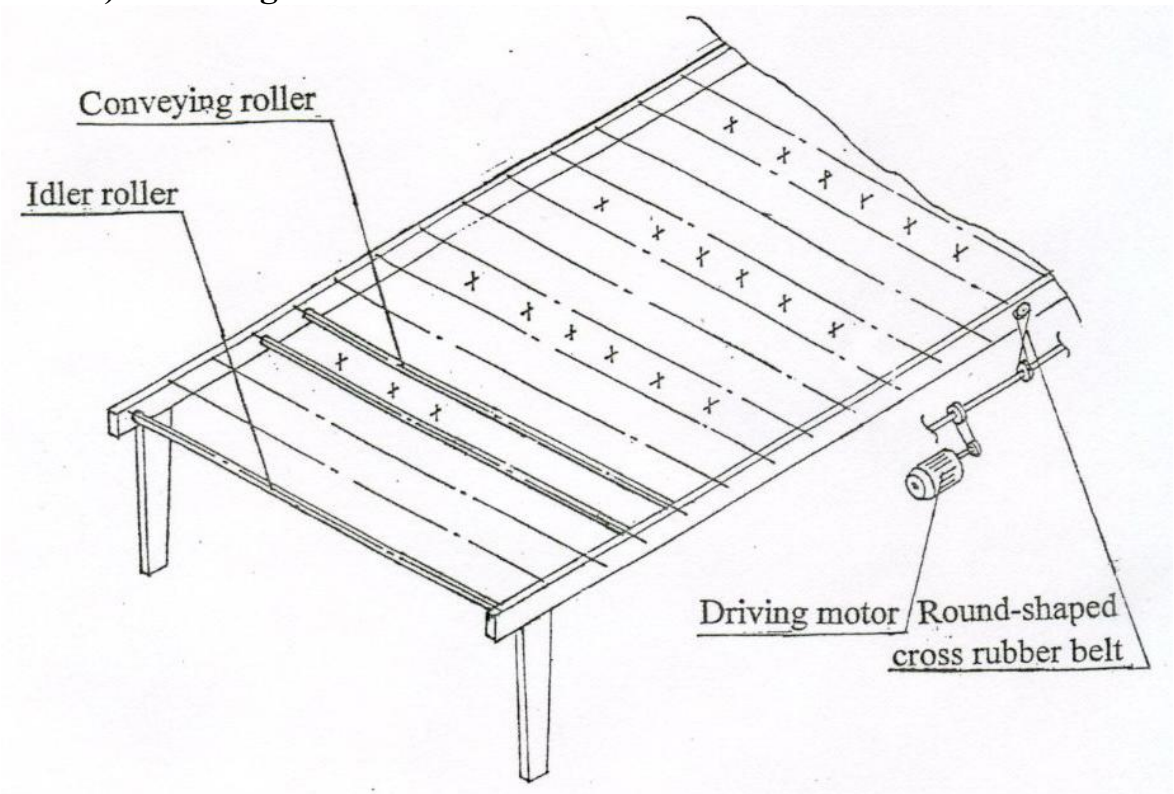


Fig. 2: Loading roller table

As what is shown in Fig. 2, the loading roller table consists of welded steel frame, follow roller, conveying roller, electric accessories and transmission parts by using bushing rubber roller so as to prevent the glass being scratched during transport. The roller conveyer is individually driven by a frequency converter achieving both dot-forward and step-forward as well

as synchronization with the roller conveyer of the heating furnace. The loading roller table is equipped with encoder(s) and product's length detecting device in order to realize process control of the entire system. As for the large-scale glass tempering equipment, the customer can select a manually controlled up and down ball table device so that the glass of jumbo size can be facilitated loaded from side end.

2) Heating furnace

Heating is an important step during the process of glass tempering. Glass heating inside the furnace has to be uniform and be fleetly heated to the temperature suitable for tempering.

a. Structure

Notice: During the process of furnace body lifting/dropping, personnel must be set at the angle column, where spiral-lifting is implemented, to observe the working state. All the spiral-lifting shall keep a uniform lifting/dropping speed. In case speed of an individual column doesn't conform to the others, the movement must be stopped at once to find out the reason and cope with it properly so as to avoid blocking lifting mechanism.

The heating furnace body is divided into two parts and welded with profiled bar and steel plate of solid structure. Its upper part can be raised with a spiral-lifting device in order to facilitate maintenance and furnace cleaning. It is equipped with an individual pneumatic door of insulation materials at the either side which opens only when loading and unloading glass while it closes all along during the process that the glass is heated by means of reciprocating so as to prevent any heat loss. The furnace body is insulated with alumina silicate of high efficiency. There is roller conveyer of ceramic (or quartz) with very low thermal expansion inside the furnace. The SO_2 device is installed at the lower part. The whole plant adopts structure of module in order to facilitate transporting and handling. In

mean while, the furnace body can be enlarged so that it can meet the increasing requirement for production capacity. There is furnace cover installed at its top so as to prevent any dust as well as for decoration.

Structure and Transmission of the heating furnace are as shown in Fig.3.

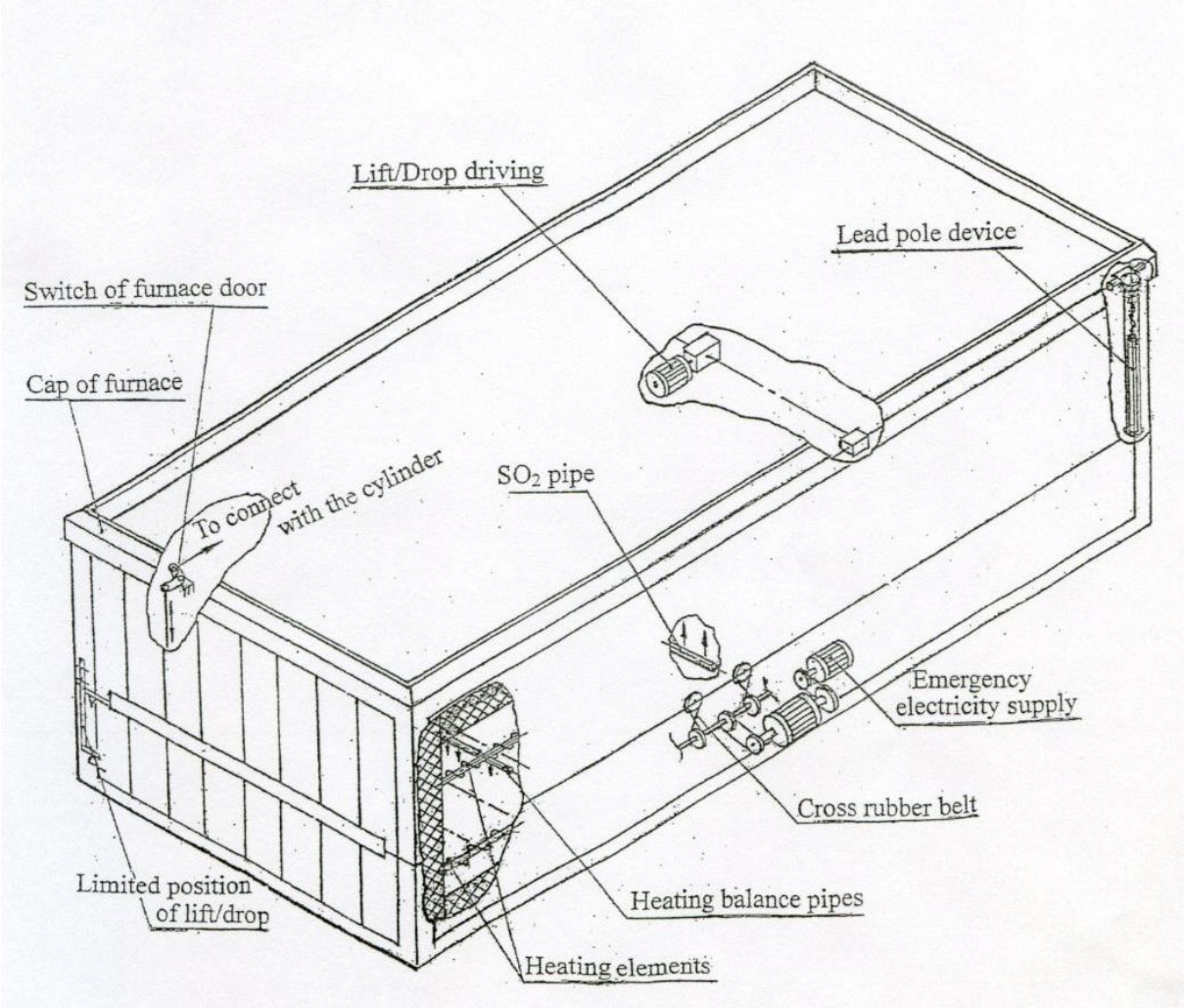


Fig. 3: Heating furnace

b. Transmission and conveying

The basic requirement for transmission is to ensure that all the roller conveyer runs synchronously and stable without any flopping and vibrating.

The transmission of the heating furnace is by means of round perpendicular rubber. Apart from continuous heating type, roller conveyer of the glass tempering equipment of all the rest types are all by means of reciprocating with reciprocating cycle regulated automatically by the controlled system as per length and thickness of the glass. It will take longer time for thicker glass heating since it needs frequent reciprocating, and vice versa. Since the glass directly contacts the ceramic or quartz roller inside the furnace, requirement for its surface quality is very strict, i.e.: the surface must be even and straight as well as smooth with tolerance of outside diameter for each roller no more than ±0.5mm.

c. Heating and temperature control

There are heating elements and temperature detecting component installed inside the furnace. Normally the glass is radiant heated by using heating elements made up of heat resistant metal alloy (FeCrAl or CrNi2080) rewound around a special ceramic pipe. The most important thing is how to keep the entire surface of the heated glass in uniformity rather than to just enable the temperature reaching the required value, otherwise glass is broken during process of quenching. Therefore, the heating elements have to be reasonably distributed according to the zones. Based on the conditions of glass loading and temperature settings, the computer controls the on and/or off of the heating elements for any heating zones so as to keep the furnace temperature homogeneous.

In order to improve distribution of temperature inside the furnace and to keep the glass being heated more homogeneously, add one set of thermal equilibrium forced convection system according to the feature of the Low-E coated glass, which surface coating can easily reflect the heat .

d. SO_2 gas device

SO_2 gas device consists of gas storage tank, pressure regulating valve, flowrate meter and valves as well as piping etc. The purpose of using SO_2 gas is to have a function of lubricate and protect the lower surface of the glass. If the roller was not cleaned thoroughly after carrying out the

furnace cleaning, some obvious roller marks would be generated on the lower surface of the glass during production. At this time, a proper quantity of SO_2 gas can supplied. Just as the roller marks disappear, switch off the valve or it would enable the glass bluish affecting its optical property.

3) Quenching roller table and flat & longitudinal windscreen

The dominant difference between structure of flat glass tempering furnace and bending one lies in that whether the windscreen deforms while other parts are the same or of little difference. Following introduced structure & transmission of quenching table and flat windscreen as well as working principle of bending windscreen briefly.

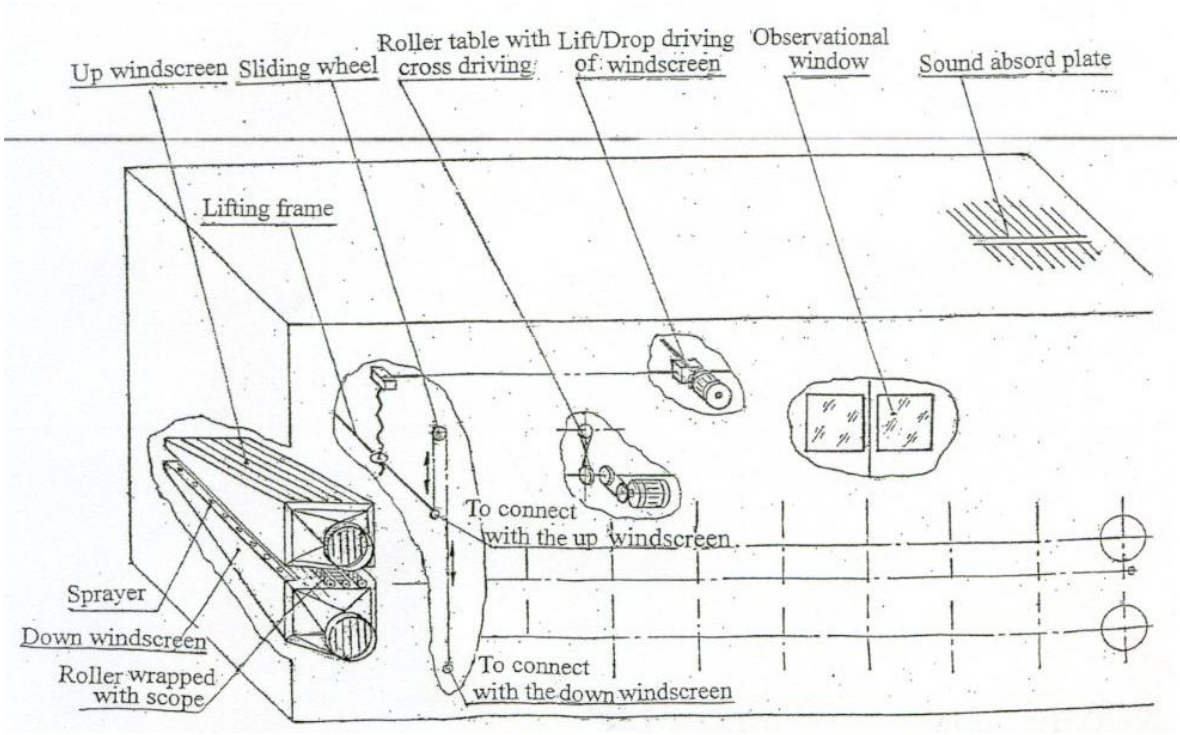


Fig. 4: Quenching roller table and flat windscreen

a. Quenching roller table and flat windscreen

As it is shown in Fig. 4, the frame of quenching table is made up of welded

with profiled steel with a windscreen lifting & going down frame and up & down combination windscreen with nuzzles installed. Opening and/or closing of the windscreen is accomplished with a motor gear (or electrical actuating mechanism or feed screw nut) by means of chain belt transmission. The distance of opening and/or closing (lifting and/or falling down) is automatically adjusted with a computer as per different thickness of the glass (there are two ways of adjustment of weight counterbalance and individual up and/or down windscreen adjusting, the Figure shown is adjustment of the weight counterbalance). There are many ways of transmission, for instance, gear drive, sprocket drive, round type tape drive and so forth. The roller conveyer is of assembly with rope/wire winding, direction of spiral of fabric rope/wire enwinding on the adjacent rollers is opposite each other so as to keep the movement of glass reciprocating in a way of no deflection. The rope/wire enwinding roller contacts the glass by means of punctate contact to ensure the glass is not scratched. In the mean while, because of the spacing interstice between the fabric rope/wire spiral, the areas of the favorable air circulating for the cooling of the lower surface of the glass is thus increased, hence, effect of glass tempering is improved. There is a shield installed in the driving system for the windscreen to avoid any damage when there is breakage with the glass in the windscreen. The entire quenching system is by means of close structure with a observation window installed in front of the outer frame to facilitate observing the status of glass running and any breakage during the process of tempering.

b. Lateral bending windscreen

The bending mechanism, bending lifting mechanism and strip shaped windscreen, taper frictional wheel and air supplying pipe of both upper and lower windscreens are basic same. The main differences between them are: the entire upper windscreen can be lifted and dropped so as to realize the arc adjustment by means of the top screw on the top of speed-adjusting arc plate. The median axis of lower windscreen are fixed to windscreen frame, the arc of low windscreen is adjusted by means of realization of following process: Input Pulse---Arc Adjusting Motor----Arc Changing

Motor---Control the position of the slide sleeve.

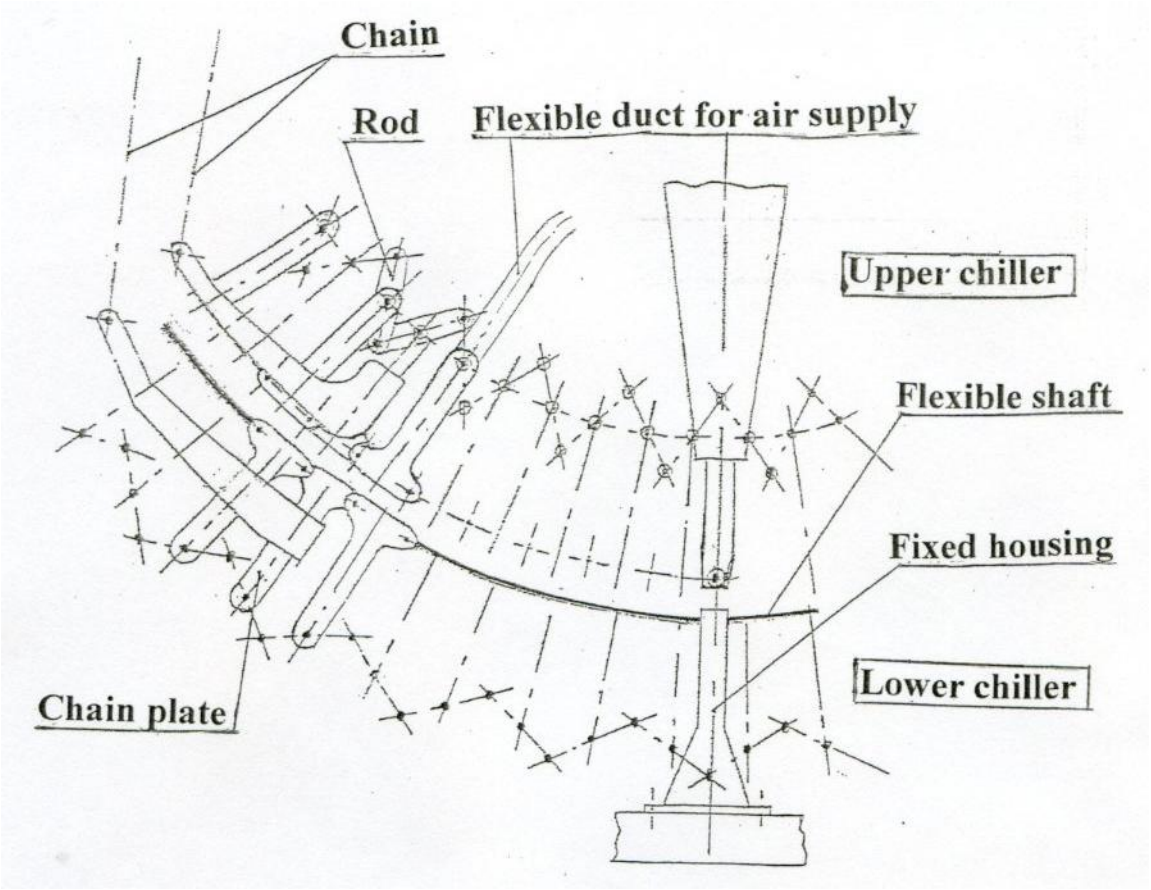


Fig.5: Bending windscreen

As what is shown in Fig 5, the bending mechanism of upper and lower windscreen is composed of some T shaped chain plates, which of the tail hinged each other by forelock and. A connection spot fixed on the middle of the lower windscreen. When the bending lifting chains of chiller are loose, each soft shaft is flattened automatically, and all the upper generatrix of the soft shaft is in the same level, at this time, the glass sheet can go through freely. During lifting bending process, the lifting mechanism upwardly drive the T shaped chain. With the process of drawing of the number four T shaped at the other side upwardly, the chain plate and the rod deflect accordingly to become the single curvature of the upper generatrix of the soft shaft. The more movement of the chain going it is, the smaller of the curvature it is. The process of the deformation of the upper striped windscreen is as the same as that of lower windscreen.

4) Unloading roller table

The function and structure is as the same as that of the loading roller table with the lifting/dropping ball table and side roller to facilitate unloading the glass with jumbo size from the side end.

5) Air cooling system

The air cooling system is composed of air blower, pressure regulating valve, air distribution room and piping line etc. The blower consists of motor, bearing seat and centrifugal blower fan and they firmly fixed on a steel frame which is mounted on a base frusta. The air cooling system usually includes high and low pressure blowers and each one connected respectively to the intake of the air distribution room (it is called static pressure cabinet as well) through the piping line and pressure regulating valve. The air pressure and air current are balanced and homogenized in the air distribution room. The outlet of the air distribution room is connected to the air incoming piping of up and down windscreen through a flexible tube so as to insulate the violent vibration caused by the air blowers. The thicker the glass is, the more slow the cooling speed is, and the less the air pressure of quenching required is. In view of the above, when producing glass with thickness of 6mm, only the low pressure air blower is needed for operation, and the glass is tempered and cooled at the low pressure section; But when producing glass with thickness smaller than 5mm, all the high and low air blowers are required for operation. The air valve of high pressure section is closed after the glass passing the high pressure tempering section thoroughly, and the tempered the glass continue to cool down at the low pressure section.Openings of pressure valve of the piping and outlet of the air distribution room can be automatically regulated as per parameters of air pressure defined with the computer.

6) Other facility/apparatus

There are a pony battery of 24V and a D. C. motor equipped with the

driving system of the heating furnace body for discharging the hot glass from the furnace when there is failure with the driving mechanism to avoid any damage with the quartz/ceramic rollers due to over hot.

7) Control system

The control system of GTW series flat & bending glass tempering furnace plant is composed of operating desk, control cabinet, power regulating cabinet, starter cabinet for bowers and sensor, switch, encoder and so forth. Each motion/procedure during the production is accomplished with a programmable controller, spot detecting elements and actuating mechanism. As what is shown in Fig. 6, temperature, time and air pressure as well as parameters for roller conveyer at each section are dynamically displayed on display.

Caution:

Safety Instructions:

1). Non professional personnel is not allowed to touch any locations or components apart from switch-handle in every cabinet, otherwise, it may cause an accident of getting an electric shock or short-circuited.

2). During running of the plant, it is prohibited to connect any other electrical appliance, such as electrical fan, drilling machine and hand grinding wheel etc. to the power supply for the control system, otherwise, it may cause occurrence of interference or cause break-down with the control system, as a result, it may cause a big loss to production.

3). Switch off power supply for computer, module and control system before carrying out electric welding with the glass tempering equipment. In the meanwhile, the ground leas of the electric welding machine has to be soldered on the parts to be welded, otherwise the computer may got burnt causing the electric wire on fire.

4). Effective portable fire extinguisher of CO_2 and dry powder type or

ammonia phosphate and pressure stored type has to be equipped adjacent to the equipment so as to avoid any loss to the production.

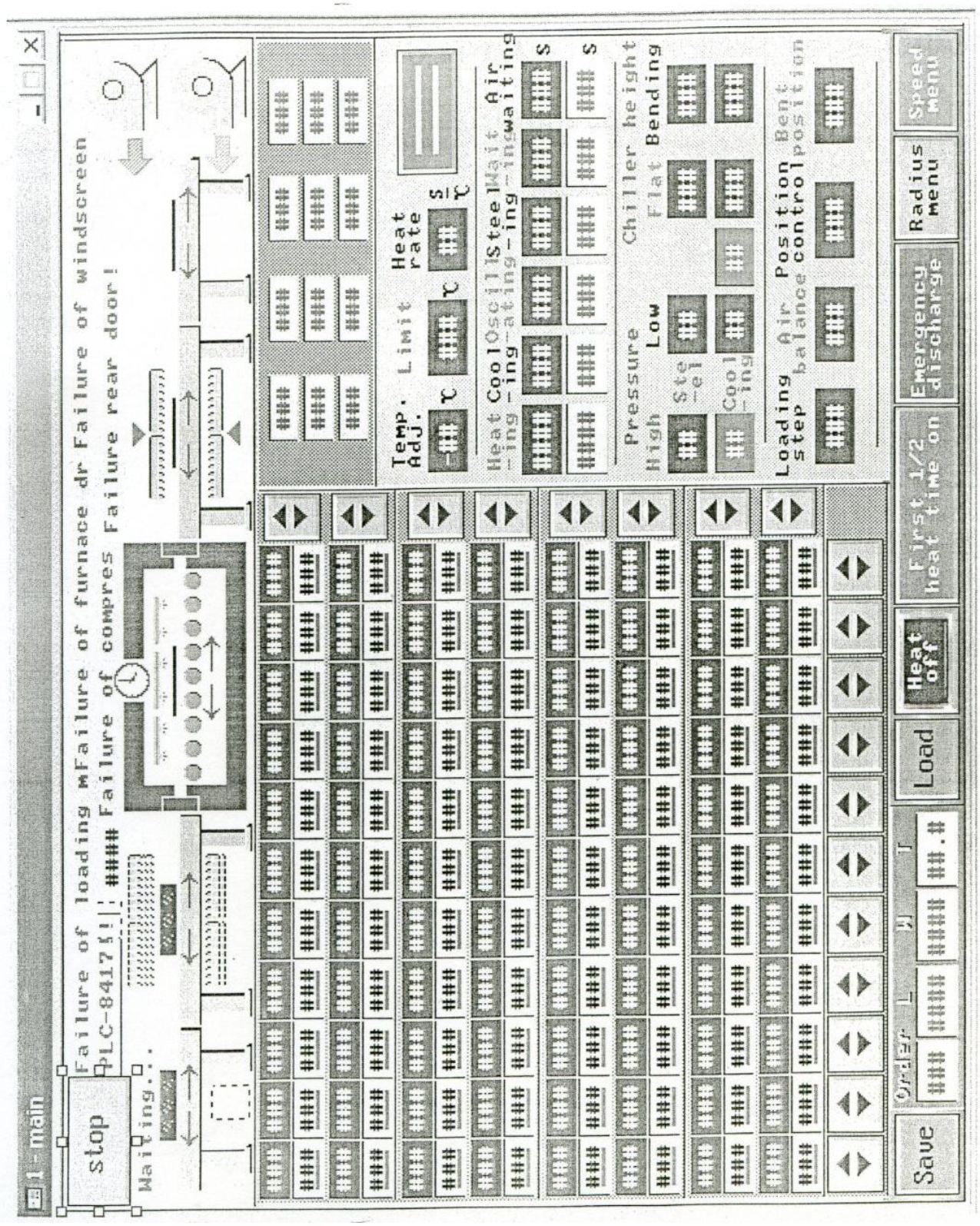


Fig.6: Operating desk (main picture)

The main controlling functions are as below:

a. Temperature adjustment inside the furnace;

b. Production control as per time mode;

c. Modifying and screen displaying of setting value and detecting value;

d. Glass loading (unloading) stepping and dot moving forward;

e. Storage, invoking and modifying as well as switching over with up to 150 orders in the menu;

f. Automatic length and breadth measuring;

g. Automatic adjustment for distance of reciprocating in the entire path;

h. Electricity failure protection;

i. Display of malfunction and phonetic alarm;

j. Furnace waiting time adjustment

The operating desk is by means of computer with human-to-machine interface, colour liquid crystal display (LCD).

There are many displaying zones of running status, display of malfunction, furnace temperature divisions display and parameters of the windscreen display as well as various function controls equipped to facilitate the operation with intuitionistic display.

The radiant heating element of the heating furnace is installed according to divisions and zones both longitudinally and laterally. On and Off of Some heating elements in the heating zones are controlled by the computer according to the set glass heating temperature so as to keep the distribution of the temperature more precisely and reasonably. There are many ways to start up the quenching blowers like frequency converter, soft starting up or Y and/or delta connection etc. for customers to select. Setting of parameters for temperature rising discretionarily in 72 hours of stop-production is equipped on the operating desk, in return for this, the production can be restarted immediately after the operator arriving at the spot without waiting for several hours for temperature rising, time and labors are thus saved.

The programmable controllers and all the frequency converters, sensors, photoelectric switches as well as photoelectric encoders are from Japanese Mitsubishi, Fuji, Omron and other famous brands with advance technology and stable performance as well as reliable service. The motion/movement of each section of roller conveyer are all collocation of advanced round orthogonal adhesive tape, driven by individual motor, speed regulation

with frequency converter, with function of automatic switching over realizing fully asynchrony, partial synchrony and fully synchrony.

8) Specification and data

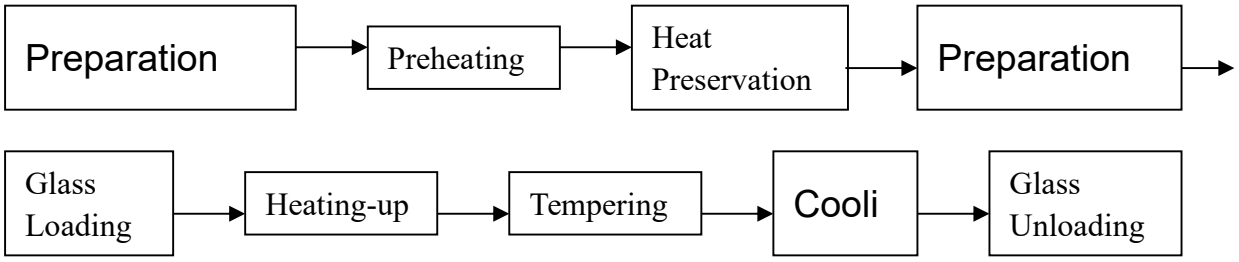
Quality standard of tempered glass:《GB 15763.2-2005》《ECE R43-2000》
Thickness of the glass: 4 ~ 19mm
Minimum size of the glass: 300mm×100mm
Minimum distance between two glasses: 50mm
Actual power consumption: ≤60% of installed power
Rate of finished product: >95%
Time for heating up (from ambient temperature up to 700℃):
3 ~ 4 hours

Ⅷ. Equipment Installation, Commissioning and Operation Training

Installation, commissioning of this equipment is executed in accordance with relative regulation on customer's site by the personnel dispatched from Tucheng Company. After all the running condition meets requirement of drawing, technical document and contract, the customer is requested to sign the acceptance document.

Regarding training of equipment operator and maintenance personnel, it can be realized either on the customer's site or at Tucheng Company subject to the stipulations of contract.

Ⅸ. Equipment Operation Flow



Ⅹ. Electric control of equipment

This part is regarding electric control cabinet of equipment, outline drawing and arrangement plan of power supply cabinet as well as circuit drawing, terminal connection drawing from outside and electric control cabinet to other else equipment as well as apparatus list. See Part 08 of

Equipment Drawing, i.e. Electric Drawing for more information of a specified type of equipment.

Ⅺ. Drawing of equipment base

See Part 00B of Equipment Drawing, i.e. Installation Base Drawing for more information of a specified type of equipment.

Ⅻ. Preparation before preheating furnace

Before preheating, relevant facility shall be seriously checked and tested in order to avoid malfunction or loss when preheating.

1. **Standby DC system checking**

   Turn on the DC switch on controlling desk and press Emergency Stop button & DC button at the discharging door of furnace. Ensure motors of furnace body, windscreen and unloading roller table run normally.

2. **Air compressor checking**

   Switch on its power supply, compressor is supposed to work normally and stop automatically when pressure reaches set value (less than 1Mpa). When pressure decreases to 0.4Mpa, it shall be able to be restarted.

3. **Start-up of the Computer**

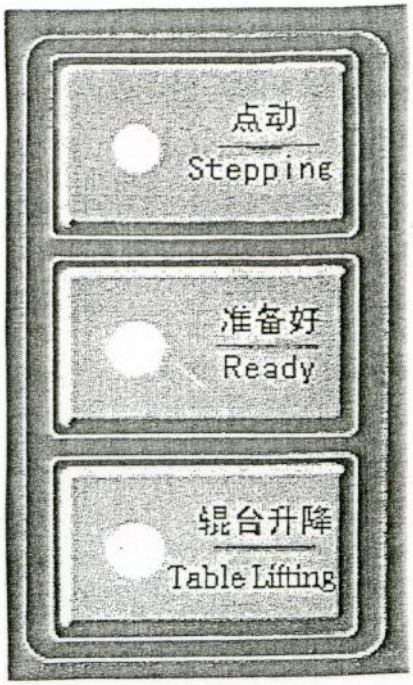
   Turn on the switch of power supply for control system and put through the power supply for UPS (it realizes functions of voltage stabilizing and timing power supplying after electricity is power off or with failure). Call the parameters of Order No. 0 for empty test-run and heating up before the operational menu/window is displayed on the screen of the computer.

4. **Parameter checking**

   Press Running button on computer screen. Set parameters of heating time as 60s, blowing time as 40s and oscillating time as 30s. Observe and make sure that displaying of parameter of temperature and time is normal.

5. Running checking

Security requirement: When the equipment is running, windscreen will open and close automatically quite often. Therefore, it's forbidden to stretch out hands or metal in or it may cause human or equipment damage.



Press Ready button on loading roller table (see chart on the right). After equipment comes into testing-run mode, check running state like tension of rubber belt and chain, running of transmission belt and movement of valve cylinder & furnace door cylinder as well as lifting-bending of bending windscreen, lifting/dropping of upper windscreen, flattening of lower windscreen and bending curvature etc.

6. Open/Close checking

Change open/close of windscreen and opening of valve to check relevant movement. In case abnormal phenomenon occurs, causes shall be found out at once and relevant remedy measures shall be taken. After every parts work normally, the furnace can be preheated then.

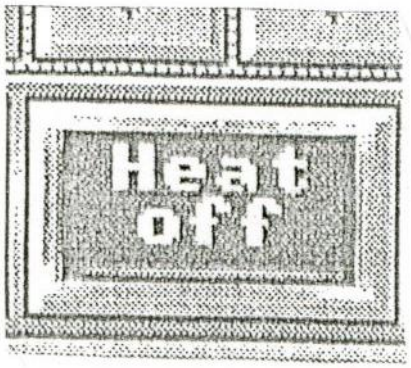
XIII. Operation of preheating furnace

Security requirement

1) When switching on main power supply, it's forbidden to work on top of furnace or at bottom. Otherwise electric shocking accident may occur.

2) Protective cover of ditch for heating chamber must be locked. Unauthorized personnel mustn't open it and enter the ditch, otherwise electric shocking accident may occur.

1. Switch on all main electric heating switch of lower heating control cabinet. Switch on trigger power supply (caution to avoid electric shocking). Set heating up velocity and top limit of heating up on computer display (heating up velocity is usually 12~20s/ºC while top limit is usually 700~730ºC, subject to actual glass state). When all the parameters are correctly set press **Preheating button** on touch screen (see chart on the right) and preheating starts automatically.



2. Pay attention to the temperature variation of different zones. If preheating velocity of most zones doesn't keep up with set value, the set value shall be lowered accordingly. If an individual zone doesn't keep up with set value or heats up more rapidly, heating up shall be stopped and restarted only after finding out malfunction and solving problem. If heating up by force at this time, heating elements will be damaged and affect normal production.

3. During process of preheating, running state of transmission parts and ceramic rollers shall be observed. In case abnormal state like running stop occurs, preheating shall not continue until problem is solved.

4. When temperature reaches top limit, heating velocity will lower to zero which is controlled by computer automatically and the system comes into temperature preserving state, continuing 30~60 minutes, which ensures a homogenous temperature inside heating furnace. In case temperature difference is too much, the set temperature parameter shall be micro adjusted to make temperature difference inside no more than 5ºC.

ⅩⅣ. Preparation before production

1. After temperature holding for at least half an hour, turn on **Ready**

switch on the loading table under Order No. 0, the plant now goes into free running. If everything goes normally, the required order can be called in.

2. After the new order is called in, opening of windscreen and valve shall automatically get to set value and temperature of each heating zone will be automatically adjusted according to new order. This regulating process takes approximately 10 minutes.

3. Parameter setting: if no order available, parameter setting is thus needed. Refer to Clause ⅩⅨ. Set parameter shall be saved to relative order.

4. Start relative blower according to glass thickness and observe the air pressure gauge when switch on air valve to see whether air pressure setting is proper. See Clause ⅩⅨ, Article 8 for detailed air pressure value. After that the equipment comes into normal production mode.

Notice:

1) When starting blower, make sure that the air valve is closed.
2) When blower is running, NO personnel is allowed to stand near air inlet. Or it will cause a severe damage with negative pressure under a sudden open of air valve.

ⅩⅤ. Operation of production

1. Loading

1) Points to be paid attention to when loading glass sheet:

a). The glass sheet must be edge-grinded and washed with qualified apparent inspection, without any scathes.

b). Glasses with different thickness and colours cannot be loaded in a same batch.

c). For coated, decorated and figured glasses, always put the polished (or smooth) and clean side down.

d). Properly load the glasses as per the requirement for glass loading (see “forms of loading and its effect on glass temperature, Chapter IV, P3, Performance of Technological Process” of Tucheng Glass). Keep specification and loading rate of glass for each furnace as homology

(same) as possible, spacing of glass should be alternatively staggered.

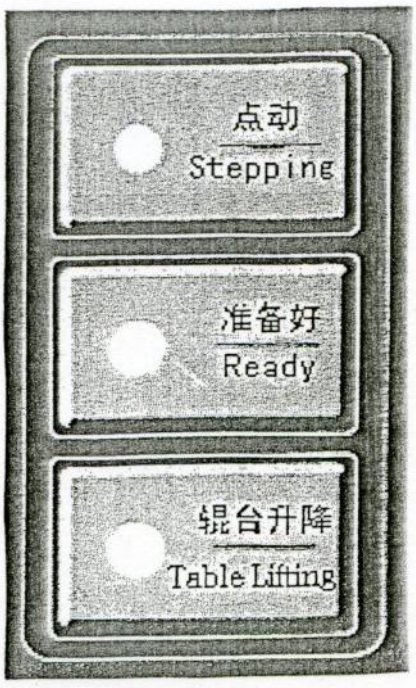
e). Carefully handle the glass when loading. Never strongly pull glass against the running direction of the roller conveyer and/or erect glass to keep glass touch the roller conveyer by single edge so as to prevent the glass damage the roller.

f). Stamp and/or print the marks or pattern for tempering or trade marks in the specified location as per the requirements of the product or customer's by means of reflex printing.

2) Operation of loading

Set the glass on the foreside of the loading roller table in order first when loading. After setting glass well, press **Stepping-in-Ready** button to make glass progress forward a stepping length. Then, continue to put glass on the foreside of the loading roller table. Beware of the space between two glass no less than 30mm; distance between outer edge of the glass and furnace inside wall no less than 50mm. Summation of total glass putting (or setting) length and putting width can no exceed the length of the windscreen.

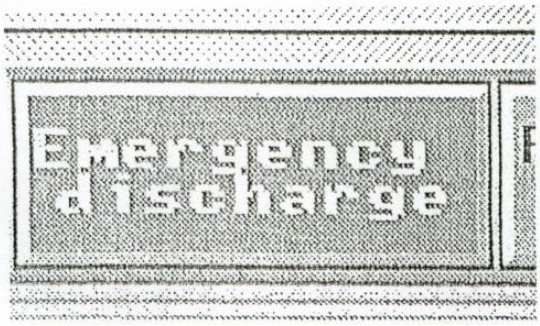
After completing glass loading, Press **Ready** button (See chart on the right), and the button is on: If there is no glass in the furnace, the glass on the loading roller table enters into the furnace immediately and if there is glass in, the glass on the loading roller table automatically enters the furnace when the glass in the furnace discharged and after some furnace-waiting time. If you change your mind not to let the glass goes into the furnace or put off entering during this period of time, press **Ready** button again, the indicator is then off, and the glass will not enter into the furnace automatically.



2. Heating

1) After glass entering heating furnace, it heats up automatically in each heating zone according to the orders and condition of glass setting. Pay close attention to observe temperature changes in each zone and space in the furnace. non-homogeneity in temperature/heating is found, becomingly adjust the setting temperature of relevant zone, and the heating time can be altered at any time.

If you need to discharge the glass from the furnace, press **Emergency** discharge button (See the chart on the right).



2) Time for glass heating is calculated based on 40 seconds per mm glass thickness. It can be befittingly adjusted pursuant to transmittance, edge-grinding and loading rate of the glass: For rolled glass, it should be calculated in terms of maximum thickness; For glass with round holes and/or trough and coatings, also for heat reflective glass, heating time is advisably prolonged; For heat-absorption glass, heating time is advisably shortened.

3) During progress of heating up, door of the furnace can be duly opened for observation. If broken, or chipped and cracked glass, and/or other thunderbolt is found, press **Failure-in-furnace** button on operating box for the windscreen. After the glass is automatically discharged, press this button again, the plant is now ready for production (furnace-waiting condition).

4) When the plant is ready for production after furnace or roller cleaning, some SO_2 gas should supplied into the furnace generally for the first several batches so as to enable SO_2 reacting with Na^+ (sodium ion) for form a layer of film of sodium sulfate. As a result, it “lubricates” and protects the surface of the roller, prevent glass from the roller marks

or scratches on the lower surface. SO_2 gas supplying should be switched off immediately after SO_2 has been used for several batches, or the surface of the glass would become bluish with “white frost”.

3. **Discharge from the furnace**

When hearing the sound of glass discharging from the furnace, operator should stands the place near the furnace door to observe glass discharging from the furnace. When problems of the glass being locked and/or uncompleted discharge etc. are found, press **Failure-in-furnace** button or manually take out the glass. (Refer to term 18 clause 4 and 5) When the furnace rear door alarm ringing, open the rear furnace door until the glass is discharged thoroughly and stop loading for the next furnace. When the “windscreen transmission failure” alarm ringing, the rollers inside the furnace stop running automatically, at this time, the glass must be taken out manually.

4. **Windscreen**

After the glass enters the windscreen completely (Note: When producing bending tempered glass, upper windscreen deforms with a set curvature previously while lower windscreen is of flat status. And the lower windscreen deforms with the set curvature when hot glass arrives at the position of lifting-bending.), the upper and lower windscreen automatically close, glass is rapidly and uniformly cooled down within 40 to 60 seconds. Then cool down the glass gradually the temperature of unloading (about 45℃). During cooling down of rapidity, operator should examine the glass through observing hole. If broken or chipped and/or cracked glass is found, immediately press **Windscreen Failure** button on operating desk of the windscreen so as to enable the windscreen roller conveyer stops oscillating in advance and to prevent the roller rope from damaged by fragile glass (or cullet). After completion of cooling down, the windscreen initiates automatically, in the meanwhile, the unloading roller table is running synchronously. After glass has been unloaded, the cullet may fall down on to the lower windscreen, at this time, press **Oscillating** button on windscreen operating desk to make the lower windscreen oscillating until all the cullet are discharged thoroughly. Press

in sequence the **Windscreen open & close** button two times to make the windscreen returns to the working position (Note: If the windscreen didn't return to the working position, when the next furnace of glass discharged from the furnace, the windscreen will drop automatically).

Besides, when entire broken glass is found, press the **Windscreen failure** button in order to make the windscreen roller table stop oscillating in advance. Press the button again, then air blowing stops ahead of time and discharges. The process of the following operation is the same as the above.

After completion of automatic unloading, if there is glass remained in which is not removed, press the **Windscreen transmission** button until the glass is discharged from the windscreen roller table completely. Bear in mind never loosen (or unfasten) the Windscreen Transmission button or it will affect the normal operation of the next batch.

Notice: When implementing operation of heating, discharge from the furnace and windscreen, press relative buttons on flat windscreen operation box or bending one respectively in accordance with production of flat tempered glass or bending.

5. Unloading

Cautions:

a). It is required to take glass one by one from the unloading roller table. Never take glass with more than two pieces of glass by means of one put on the other in order to avoid any collision and/or scratching the surface of the glass.

b). Promptly inspect the apparent quality of the finished glass. If problems of crooked, deformed and some defects with the surface etc. are found with the glass, and should be reported to the responsible person.

Operation of unloading

After completion of cooling down, glass enters unloading roller table automatically. When the glass reaches the detecting switch, the unloading roller table stops running automatically (but it does not stop when failure

discharge and/or manual discharge). After previous batch of glass is unloaded, the subsequent glass moves to the detecting switch and stops until all the glass is unloaded without pressing any buttons. When the glass is in jumbo size and its foreside has to be put out of unloading roller table, press the **Unloading stepping** button until the glass reaches to the place where it is easy to be unloaded, then let go hold of **Unloading stepping** button, take away the glass. At this time, the subsequent glass remains staying at the detecting switch until all the glass is unloaded.

For tempering equipment with unloading rise-and-fall spherical table, when press **Rise-and-fall** button to lift the table, the roller conveyer stops running automatically. When the rise-and-fall spherical table lowers down, the roller conveyer also stops running. If it is necessary to enable the roller conveyer running, just press **Unloading stepping** button.

Note: If forget lowering down the rise-and-fall spherical table, when blowing air to the next furnace of glass is ended, the rise-and-fall spherical table will be decent by itself.

ⅩⅥ. Quitting operation

Cautions

1): Before stop furnace running, examine and ensure there is no glass in the furnace and windscreen.

a. Stop blower's running.
b. Turn off heating switch on the screen of the computer.
c. Turn off trigger switch for power supply and operating switch on operating desk.
d. Turn off main switch inside power regulation cabinet.

2): It is not allowed to turn off D.C. switch and other switches which were not mentioned here.

If it is necessary to drive temperature down fleetly, open the vent on top of heating furnace. In the meanwhile, the electrical fan of floor type can be used to blow air at the place of front door to bring temperature down. While temperature down to below 300℃, switches for overall control power and D. C. power can be turned off. Stop furnace roller running and

switch off UPS power supply.

ⅩⅦ. Furnace cleaning operation

When production running for one month in progression or when tempered glass with serious roller wound and/or pockmark is found, it is time for carrying out furnace cleaning with procedure as below:

1. Press the **Furnace-body-rise button** when furnace temperature touches down the ambient (room) temperature to enable the upper furnace body rise up (with rising height less than 600mm).
2. Pave a layer of plastic film and put up wood plates on the rack stand at the either end of the furnace, clean the radiation plate on the top of the furnace up by using of steel wire brush. Then remove the plastic film.
3. Switch on the power for the furnace roller drive/transmission so as to enable it running. Carefully polish the questioned quartz roller using water sand paper until handle smooth.
4. Remove the wood plate. Clean and purge the floating dust on both upper and lower furnace roller radiation covers by means of blowing with compressed air.
5. Carefully and earnestly wipe up the rollers along the axial direction using a dried wet towel bundled up on a wood wand until there is no dirty marks with the towel. Press **Furnace-body-fall button** finally to close the furnace.

   Cautions: When lower the upper furnace body, each angle column of furnace body shall be observed to avoid breakage caused by an individual angle column not lowering or asynchronizing lowering of the columns. And it's supposed to lower down the furnace body by means of stepping in when the furnace is about to close. Pay attention to observe the running condition of the roller conveyer in order to avoid any roller conveyer blockage or even broken during the furnace body lowering since there may be deformation with the furnace after a long time service.

ⅩⅧ. Special operation

1. When there is a pause during the production (including the time for having lunch and dinner, no person to watch the furnace), the switch on

display screen for heating on/off, running and triggering power supply inside control cabinet must be cut off; And the air switch inside power regulation cabinet must be off after work.

2. While the heating furnace commences operation or after stops production, when temperature reaches higher than 350℃, switch of D. C. power supply on the operating desk must be turned on or when there is electricity cut or emergency, the furnace roller may deform due to its shut down.
3. When temperature is higher than 300℃, unless there is emergency, it is strictly prohibited to being temperature down by means of lifting the furnace body, otherwise, it will cause deformation with the furnace body.
4. During the process of heating up, if there are failures of furnace glass broken, glass blockage and/or problems with control system, and for those failures, you can not determine what causing it, you should take the following emergent measures: Press the **Main emergency** button on the buttons box located in rear furnace door. Press the **D. C. Drive (Transmission)** button on the buttons box after opening the rear furnace door until all the glass discharges completely. Loosen **the D. C. Drive** button. After closing the rear furnace door, you can find the cause of the malfunctions and eliminate them.
5. If glass could not be discharged entirely by taking measures mentioned in phase Ⅹ Ⅷ. 4., then:
   1) Immediately stop the electrically heating. If it is necessary, to lift the furnace body up by about 100mm, use a hook or equivalent to poke glass out (beware not to damage the quartz roller) while protect the non operational place with a metal plate from any furnace body deformation.
   2) The furnace body can also be lifted up by about 20mm, use a floor electrical fan to blower at the internal of the furnace so as to speed up the cooling. Turn off the main drive and dot-crawl the D. C. switch to prevent the glass blockage with the rollers while carefully observe if there is deformation with the furnace.

ⅩⅨ. Adjustment of main parameters for the equipment

1. Setting of loading stepping in

Press the **Loading stepping** button on the loading roller table once, the loading roller table runs for a certain distance and then stops by itself until the glass reaches to the loading detecting position where loading

stepping is nullification while the indicator of loading stepping is on. The User can set “loading stepping” length on the screen as per the length of glass sheet to be processed. When the glass sheets have been laid alternately, value of the “loading stepping” can be set as 20. In this way, if keep pressing the **Loading stepping** button, the roller conveyer initiates running; when loosen the button, the roller stops running.

2. **Setting of temperature zones**

When glass is heated up in the furnace by means of oscillating, there is glass available in the middle of the furnace under ordinary circumstances while there is or no glass sometimes at the either end of the furnace with oscillation of the glass. Therefore, it is necessary to ensure the heating capability in the middle part of the furnace. Temperature settings in the middle heating-zone should be higher than the either end by 10 ~ 30℃.

Cold glass entirely passes furnace-loading end when putting glass into the furnace absorbing a lot of heat at the loading end. In view of the above, it is, therefore, setting temperature at the furnace-loading end should be higher than the furnace area by about 10℃.

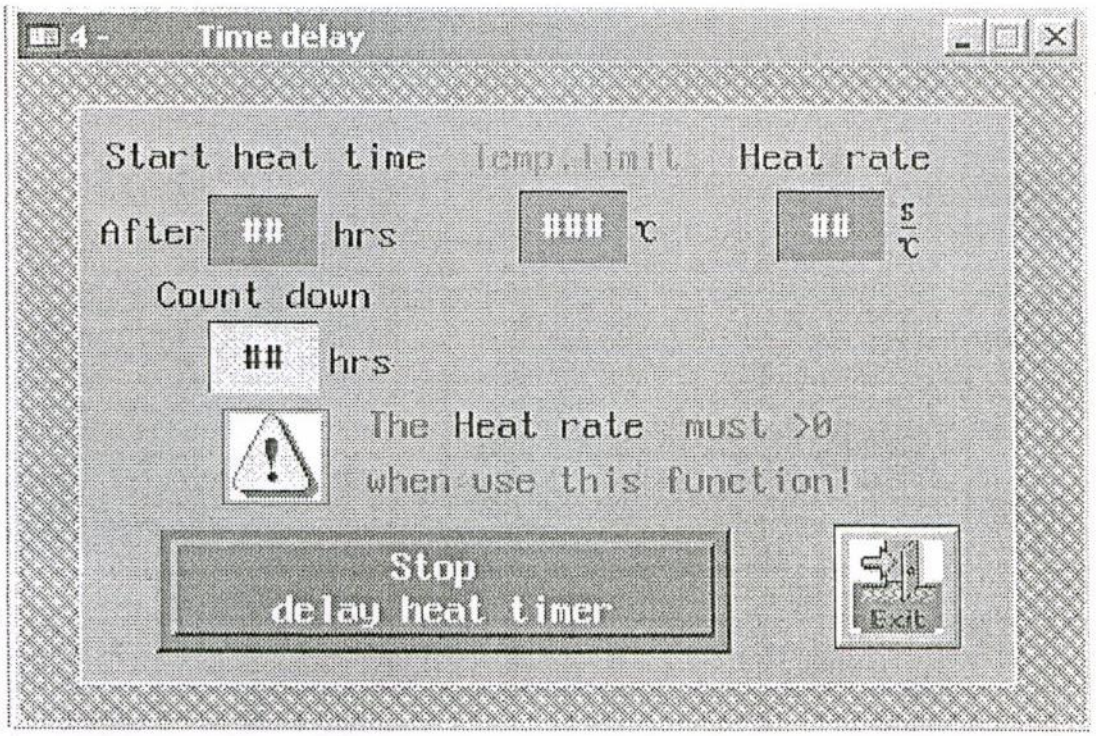
From lateral direction of the furnace, a part of roller conveyer is not covered with glass against the either end of the furnace. Edge heat at the either end of the furnace is thus absorbed tardily. Hence, setting of temperature at both ends of the furnace should be lower then the middle by 5 ~ 20℃.

Temperature setting value varies due to different composition, color of glass supplied by various suppliers. Following listed is the value as per glass thickness:

4 mm	735ºC
5 mm	730ºC
6 mm	725ºC
8 mm	720ºC
10mm	710ºC
12mm	700ºC
15 mm	685ºC
19 mm	675ºC

3. **Adjustment of time for heating-up**

As what mentioned before, setting of time for glass heating in the furnace is generally based on 40 seconds per mm glass thickness. When thickness of glass exceeds 8mm, setting of time for heating has to be 45 seconds per mm glass thickness. (See chart below.)



Because there is a certain tolerance with glass thickness, and the composition for glass in different factory is also different. As a result, time for heating up for different glass should be slightly different.

Heating time is necessary to adjust according to different glass with different colors. Glass with dark color usually absorbs heat fleetly; time for heating up should be shortened duly and correspondingly.

Heating time for glass after a longer time empty-furnace waiting and continuous loading are slightly different. For the former, since time for heating is longer with sufficient heat amassment, therefore, time for heating should be befittingly curtailed.

The capability of heat absorption is different with glass areas in the furnace. If area with glass in the furnace is less, heating time should also

be shortened.

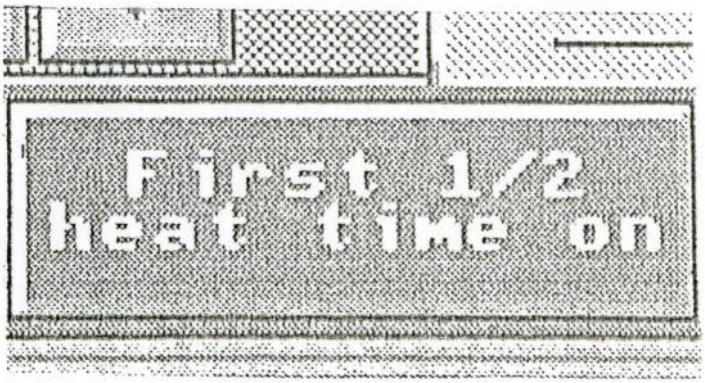
4. **Setting of parameters for thermal equilibrium**

Thermal equilibrium means that compressed air blows into the furnace body to enhance the hot air convection so as to realize uniform heating. 1) Conditions for using hot air circulation

In the heating furnace, thin glass (thickness of 3.2mm or 4mm) with high heating temperature and short time, by using thermal equilibrium properly, the uniformity of granularity of the tempered glass can be improved and rate of finished products also increased.

When glass to be tempered is with large area, despite heating zones distribute thick and fast, there may be case that temperature is not uniformly distributed on a same piece of glass. Under such circumstance, it will enhance temperature uniformity and eliminate breakage when blowing by aptly using thermal equilibrium.

2) Mode setting of thermal equilibrium



There are four (4) modes of thermal equilibrium state setting on the touch screen,

i.e.: "**Thermal equilibrium Off**"(See chart on the right)---circulating air blower runs at low speed; "**On, Half an hour before heating**" ---It is on during the first half an hour of heating and off during the last half an hour; "**On, when heating**"--- It is on when glass is in the furnace and off after glass discharging; **"Thermal equilibrium On"**---circulating air blower runs at the set speed.

3) Adjustment of thermal equilibrium pressure

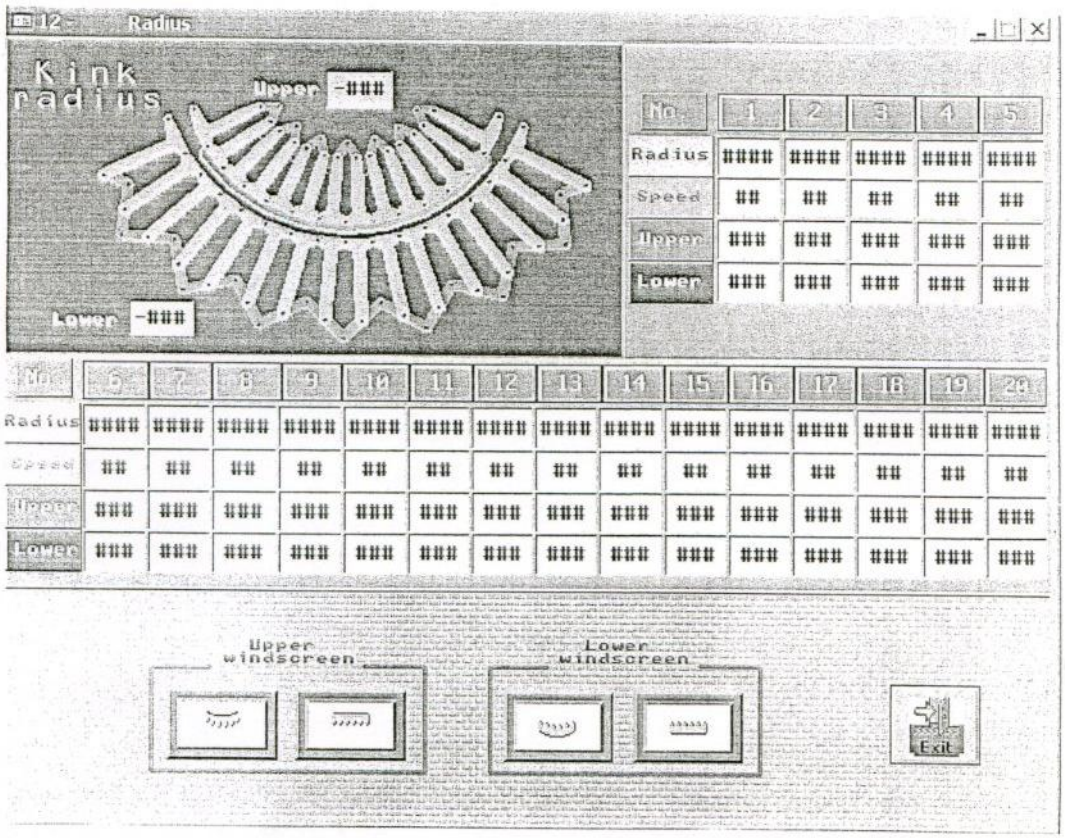
The quantity of thermal equilibrium pipe is different according to different type of the heating furnace. The main regulation valve and the main pressure gauge are installed on the main thermal equilibrium pipe.

Steps of adjustment of the pressure:

a. Set parameter of thermal equilibrium on the computer screen as "thermal equilibrium on"

b. Regulate the main valve at pressure of about 0.4Mpa.

5. **Setting of speed of lifting-bending as well as bending curvature** (See chart below)



1) Principal of setting lifting-bending of bending windscreen: The thinner the glass is, the faster the lifting is, vice versa.

2) Principle of setting bending curvature of bending windscreen:

In view of flexibility deformation of glass, the set value shall be slightly smaller than the required value.

6. **Adjustment of time for air blowing and oscillating**

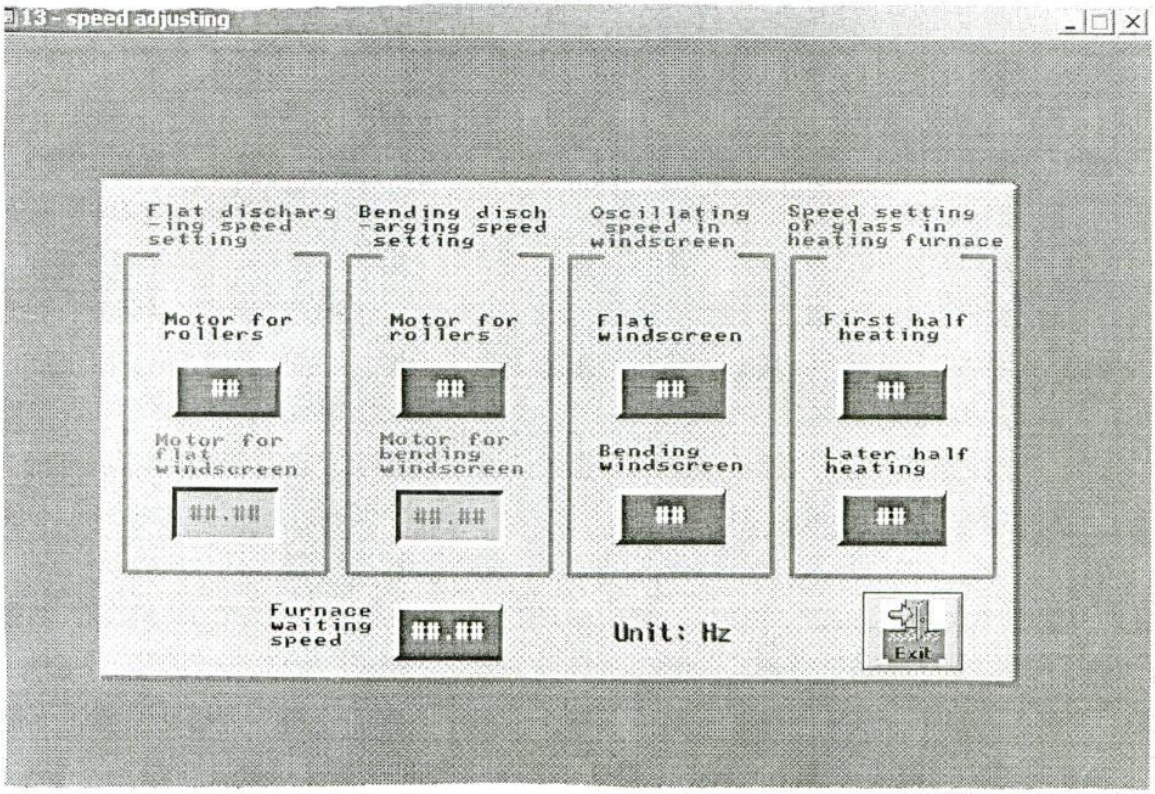
1) Determination of time for air blowing.

Fundamental of determination for air blowing: Curtail air blowing time as short as possible so as to save energy and ensure unloading

temperature at about 45℃. Thin glass is normally with high cooling strength and electricity consuming, it calls for short time blowing; to the contrary, thick glass is normally with low cooling strength and it requires a longer blowing time.

2) Determination of time for windscreen roller reciprocating

Small and thin glass requires shorter course of reciprocating; On the contrary, large and thick glass requires longer course of reciprocating.



7. Adjustment of windscreen opening

1) Fundamental of setting for windscreen opening

Opening of the windscreen should be small when producing thin glass. It should be increased properly with glass thickness. When opening of the windscreen is small, cooling strength is strong, and air availability is high. But when producing thicker glass, because of slow tempering with thicker glass, if opening of the windscreen is too small, some wind speckle would be caused affecting its optical performance. It is therefore recommended to befittingly increase opening of the

windscreen when running thick glass. The windscreen is about 15 ~ 70mm far from the upper surface of glass in general. After increasing opening of the windscreen, the air pressure should be reasonably boosted in order to ensure the granularity.

2) Method of flat windscreen opening adjustment

There is a windscreen opening setting ranging from 0 ~ 99 on the touch-screen. For one thing, the setting is relative opening. For instance: Setting of opening is "0", the actual opening of the windscreen from glass with thickness of 3.2mm is about 5mm. After that, every additional increment by 1 to the value, the windscreen opening will be increased by 1.5mm. The windscreen reaches set position by itself by setting new value on the computer and validating it.

8. Method of setting for air pressure

1) Fundamental for air pressure setting:

Thin glass tempering requires high cooling strength, air pressure setting should be high. With increment of glass thickness, cooling strength required for tempering is reduced, and setting for air pressure should be in turn decreased accordingly. The final requirement is that the granularity of tempered glass meets the national standard. Following is the air pressure setting arrangement as a reference:

2) Setting method for air pressure

One thing should be pointed out that set value for air pressure on the computer screen suggests the openings of the valve (giant blower) and speed of the frequency converter (small blower), not the real value of the air pressure. There is indication/display for it at operating location.

One more thing is that the air pressure detecting is led from inside of windscreen, its value is lower than measured value at places of both air nozzle and static pressure box. When blowing, it is normal that there is some fluctuation with the indication air pressure value and it is in connection with if there is glass to block the nozzle or not. Press the **Windscreen open-close** button on windscreen operating box to lift the windscreen if you want to observe its precise regulating.

9. Method of adjustment for air equilibrium

1) Fundamental of adjustment

The bending of the glass is much more under the influence of adjustment of upper and lower air pressure. Its regulating fundamental is to keep flatness (or planeness) of the tempered glass. Reduce the upper air pressure and boost the lower pressure when glass is crooked upwards; And decrease the lower air pressure while increase the upper air pressure when the tempered glass is crooked downwards.

2) Glass with different thickness shall have different equilibrium values. The equilibrium value suggests position of valve. The medium value means same openings of the upper and lower.

3) If the furnace is the type that it is equipped with the upper and lower windscreen separately control, when regulating air equilibrium, you can just adjust the height of the upper and lower windscreen individually.

10. Setting of parameters for position adjustment

"Position adjustment" means the position to commence reversing when glass entering to the windscreen roller conveyer from the heating furnace. It's necessary to adjust it when following instances occur:

After roller rope has been changed or when there is a case that chain cable for the windscreen transmission system loosened or a case that the transmission gets stuck causing glass position changed in the windscreen. At this moment, it is necessary to modify the "Position adjustment" in a small range.

11. Regarding furnace holding time

1) Meaning of time for furnace waiting

The previous furnace of glass bring a lot of heat out when discharging and temperature inside the furnace requires a process of temperature rising again and balancing so that heating up of the following furnace of glass can be thus insured. It will need a longer waiting time when producing thicker glass since thick glass is with a abundant absorption of heat, what's more, discharging temperature is relatively low; whereas the thinner glass requires a shorter furnace waiting time.

2) Setting of time for furnace waiting

Setting of the furnace waiting time is normally 1/7~1/10 of heating time.

12. Setting of speed of roller conveyer inside the furnace

1) Effect of speed of roller conveyer on tempered glass

Higher speed of roller conveyer may aggravate friction between the glass and roller causing some friction marks. Thinner glass needs higher heating temperature and is easy to deform, so the speed of roller conveyer should be fast. But since light weight with thin glass and short heating time, it commonly will not cause any damnification. Contrariwise, thicker glass needs lower heating temperature and longer heating time as well as heavy weight, what's more, it is easy to deform, so setting of speed of roller conveyer should be slow.

2) Setting method of speed of roller conveyer

Setting of "Slow Rate" means the roller conveyer moves at lower speed while "Fast Rate" means the roller conveyer moves at higher speed. No matter what the setting it is, whether Slow Rate or Fast Rate, in the first or last hours during the process of heating up, speed of roller conveyer changes through a process from slow rate to fast rate. The only different is two different groups of speed. Further more, Low Rate is used before glass softening temperature while using Fast Rate when approaching softening point.

3) Roller speed of some type of glass tempering furnace has been set in Orders, which is without any setting of fast or slow rate. The corresponding speed of roller conveyer can be set factitiously at discretion through computer and stored in the Orders with easy and agile calling as well as with high accuracy.

13.Store and access of the order

0~149 of total 150 Orders can be set with glass tempering plant for calling of production for different glass thickness and varieties. All the parameters for glass tempering furnace will be altered automatically with change of the Orders. In the mean while, temperature, air pressure as well as height of the windscreen will reach to its values. Another kind of product can be produced after temperatures have met new parameters' value. If blowers required are different, however, it is necessary to switch on/off blowers manually. Significance of the Orders: It is not necessary to reset the parameters for the new orders when change over the glass thickness and varieties by calling the data stored

before only.

Usually Order NO. 0 is supposed to be the order of heating up and run-in test according to practice while Orders No. 3, 4, 5, 6, 8, 10, 12, 15 and 19 are respectively for distribution of orders specified as per ordinary glass thickness. Orders for other varieties of glass are respectively supposed to be in zones of 20~39, 40~59, 60~79 and 80~99 and so forth. Trained technical personnel from Tucheng Glass will input Orders with Nos. less than 20for the Users when commissioning. The User himself has to adjust and input the other Nos. of the Order.

14. Usage of SO_2 gas

1) Significant of using SO_2 gas:

SO_2 reacting (chemical reaction) with glass forms a fine white powder that falls down to quartz rollers taking effect of lubricating and antifriction.

2) Usage of SO_2 gas

When there is light scratch or friction appeared with glass, SO_2 gas can be aptly used. SO_2 gas, however, has a certain erosive attack on the materials inside the furnace, it should be therefore, restricted to use. When there is serious scuffing marks or friction, one should consider stopping the production and cleaning the furnace instead of increasing the use of SO_2 gas.

Under normal condition, when temperature goes down to ambient temperature, or reheating up after furnace cleaning, a proper quantity of SO_2 gas can be added to for the first one or two furnaces of glass so as to keep the roller lubricating and then stop using it; If SO_2 gas is used as long as 10 minutes when there is friction and scuffing marks occurring, and the problems can not be eliminated, one should consider stopping production and cleaning the furnace.

There is a float-ball type flow-meter installed on the cylinder of SO_2 gas. The flow rate has to be controlled under at flow when the float ball lifting at about 5mm.

Appendix 1

Max. glass size, capacity and installed power of GT series glass tempering equipment

Model	Max. glass size mm	Prodn. Cpcty. sq•m/hr	Installed power Kw		
			Heating & Driving	Blowers	Total
GT2110	2100×1000	38	160	110	270
GT2212	2200×1200	48	200	132	332
GT2415	2400×1500	65	265	162	427
GT3015	3000×1500	81	330	162	492
GT3017	3000×1700	92	370	162	532
GT3320	3250×2000	117	470	197	667
GT3621	3660×2150	142	560	265	825
GT3624	3660×2440	160	640	295	935
GT5024	5000×2440	210	880	325	1205
GT6024	6000×2440	250	1060	360	1420
GT6030	6000×3000	310	1315	400	1715
GT8024	8000×2440	380	1400	400	1800
GT8033	8000×3300	450	1900	452	2352
GT10033	10000×3300	594	2170	640	2810
GT12033	12000×3300	712	2610	640	3250

Appendix 2

Floor occupation and air flux for heating-balance of GT series glass tempering equipment

Model	Size of equipment m			Size of Blower Room m			Air Flux for Heating-Balance m^3/min
	L	B	H	L_1	B_1	H_1	
GT1307	7.60	3.00	1.75	4.0	3.5	3.0	0.5
GT1610	8.68	3.50	1.90	4.0	3.5	3.0	0.7
GT2110	11.90	3.80	1.90	6.0	4.5	3.0	0.9
GT2212	12.30	3.90	2.00	6.0	4.5	3.0	1.2
GT2415	13.68	4.20	2.00	7.5	5.5	3.0	1.5
GT3015	15.93	4.20	2.00	10.0	6.0	3.0	1.8
GT3017	16.34	5.30	2.00	11.0	6.0	3.6	2.2
GT3320	19.54	5.80	2.00	11.0	6.0	3.6	2.5
GT3621	19.54	5.90	2.00	11.0	6.0	3.6	2.8
GT3624	19.54	5.36	2.11	12.0	6.0	3.6	3.5
GT5024	23.99	5.36	2.11	12.0	6.5	3.6	4.0
GT6024	29.63	5.36	2.11	12.2	8.5	3.6	4.5
GT6030	29.63	5.86	2.30	16.6	8.5	3.6	5.0
GT8024	37.81	5.86	2.11	16.6	8.5	3.6	6.0
GT8033	37.81	7.00	2.30	17.0	9.0	3.6	6.5
GT10033	46.75	7.00	2.50	17.0	9.0	3.6	7.0
GT12033	55.84	7.00	2.50	17.0	9.0	3.6	7.5

Appendix 3

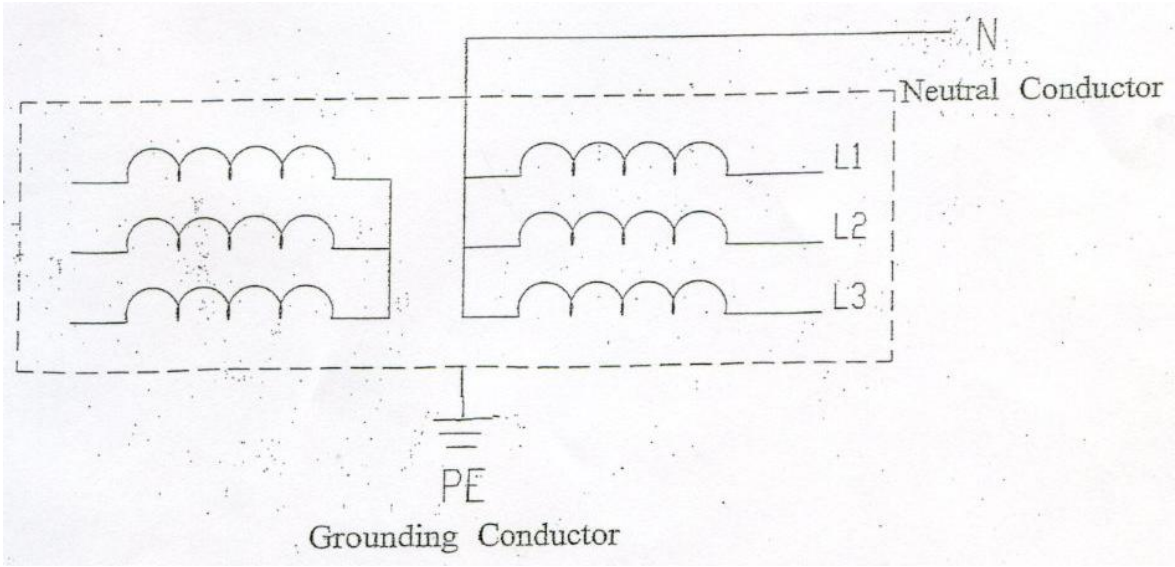
Power supply & earthing requirement

1. Power requirement

   Total installed power of the whole tempering furnace varies with furnace model. Power for heating of this model is 640kw, blower and transmission 295kw, which totals up to 935kw. In view of working loading rate of heating system and blower, transformer of 630kvA shall be applied to meet production requirement, which is stipulated in technical contract.

2. Earthing requirement

   Earthing of furnace adopts means of TN-C, i.e. three-phase-five-line system. Neutral Conductor N and Grounding Conductor PE is separated, and there are repeated earthing all over the equipment (See chart below).



Appendix 4

Operation of replacement for resistance wire and thermocouple

1. Measurement of the resistance wire

Resistant value of each wire is fixed. Measure the two terminals of the furnace resistance wire (one out of two terminals is connected to the ground) by using Ohm shift of an avometer. If its normal value is 7.8 Ω while the measurement is more than two times of the normal value or to infinity, then it suggests that the wire has been broken; If its value is half of the normal or even lower, then it means that the wire has been short-circuited. Under the circumstances, the resistance wire has to be replaced. For one thing, after temperature of the furnace body has to be reduced down to the ambient before replacing the wire, lift the furnace body, loosen the terminal of the faulty wire and the bolt for lifting hook of the radiant plate, remove the wire and the radiant plate together, replace them with new ones. Put the wire on the radiant place and pierce through the lifting hook. Then insert the lead wires of the two terminals with the resistance wire in and out of the ceramic tube. Firmly fix the bolt for lifting hook and it will be okay if the lead wire is connected well.

2. Detection of the thermocouple

Model of the thermocouple is TC-K. Detect the potential using an avometer first. Then consult E(t) scale intervals for nickel chromium-nickel silicon thermocouple in a special handbook to see if the temperature value corresponding to the potential is in conformity with that of displayed on the screen of the computer. If there is not difference, it means that the thermocouple has been broken down. AT this time, temperature of the furnace body has to be lowered down to the normal temperature first, remove the faulty thermocouple from the terminal, take the fixed bolt from the furnace body by loosening it. Then insert a thermocouple from the hole. Attention: the terminal of the new thermocouple must be inserted into the hole on the radiant plate and fasten the bolt. Make sure that the positive and negative poles could not be connected wrong when wiring.

Appendix 5

Systematic drawing for lubricating system of the plant

① Bearing box is lubricated with thin lubricant oil

② Reducer box is lubricated with thin lubricant oil

③ Driving chain is lubricated with grease

④ Ceramic rollers bearings are lubricated with grease

⑤ Worm/stud is lubricated with grease

Appendix 6

Instruction for using of SO_2 gas

During process of production, when there is slight scratch or friction speckle found on the surface of tempered glass, a small quantity of SO_2 gas can be applied as per the requirement. Under the circumstance of high temperature inside the furnace, SO_2 gas chemically reacts with the surface of the roller to generate a white compound membrane or rather film which has the functions of lubricating the surface of the roller and eliminating friction.

It is harmful and irritative to people's eye, throat and breathing organs when SO_2 gas hit a certain concentration. Therefore, it is only allowed to use the gas occasionally when operation of furnace cleaning is performed. In addition, and the prescription is that time for using the gas could not over 10 minutes, so the volume is very less. SO_2 gas to be used is merchandise in forms of cylinder packing connected to the inside of the furnace through piping without any valves. And the heating furnace body itself is by means of structure of entire insulation with good sealing and without any leakage. In view of above, it will be no any blight to both operational personnel and environment by using SO_2 gas for the plant.