Kingdom of Cambodia

Nation Religion King

Ministry of Health

Medical Equipment Maintenance Guidebook

Part B

Medical Equipment Maintenance Manual and Checklist

Prepared by:

- Hospital Services Department
- National Maternal and Child Health Center
- JICA MEDEM Project

JICA

Japan International Cooperation Agency

December 2008

Edition: 5

Unofficial Translation from Khmer Version

CONTENT

PREFACE

"Guidebook of Medical Equipment Maintenance" is a tremendous result of MEDEM Project working group of the Ministry of Health. Key health development partners, especially JICA were actively involved in the development of this useful Guidebook. The main purpose of this book is to provide the Medical Equipment Maintenance technical skill based on the current resource of health facilities in order to ensure proper Medical Equipment Management and to improve the quality of medical service delivery.

I hope that "the Guidebook of Medical Equipment Maintenance" will become a useful reference for leaders and working groups of all target hospitals as well as development partners and used to strengthen and improve the activities of current and future Medical Equipment Management and Maintenance in public hospitals.

On behalf of the Ministry of Health, I would like to express my deeply thanks to all members of MEDEM Project, especially JICA for the contribution of technical and financial support to develop this Guidebook of Medical Equipment Maintenance.

I privileges to disseminate the use of document officially in the purpose of promotion of medical equipment management and maintenance in public hospitals in order to contribute the improvement of medical services quality and reduce poverty for the citizen.

Phnom Penh, December 16, 2008

For Minister
Secretary of State for Health

Prof. Eng Hout

Abbreviations and Acronyms

GND	Ground
LCD	Liquid Crystal Display
IEC	International Electro-Technical Commission
JIS	Japanese Industrial Standards
NIBP	Non-Invasive Blood Pressure
ICU	Intensive Care Unit
CCU	Critical Care Unit
ALC	Automatic Level Control
FHR	Fetal Heart Rate
FM	Fetal Movement
UC	Uterine Contraction
AF	Audio Frequency

1-1. X-RAY DIAGNOSTIC EQUIPMENT

1. Introduction

When a stream of electron is accelerated by an electrical potential to a very high speed from Cathode part and absorbed by hitting a target material in Anode part, X-rays are produced. Thus the main requirements for producing X-rays are:

A. Electricity

B. X-ray machine

- A source of electrons
- A strong tungsten target
- A source of electrical potential

X-rays have no color, no smell and are invisible, high energy and short wavelength. They can penetrate almost all materials except some metal object e.g. **lead**. Because human body composes of different substances (flesh, water, air, bone, etc.), different density of x-rays passed through them. In medical imaging, these differences in density generate contrast on the x-ray film among the different organs of human body, which enable specialist physician to do diagnosis.

2. Principle of Operation

A. Structure of the X-ray Diagnostic Equipment

The components of X-ray diagnostic system are as follows:

- X-ray tube,
- Collimator or Beam limited device
- Tube stand
- High voltage generator,
- Bucky table/ Bucky stand
- Control unit
- Other accessories such as cassettes and film
- Instruments used in Darkroom and other supplies for exposure and for development-fixation of the x-ray film
- Safety devices, etc.

A-1 X-ray tube:

X-rays tube is a typical vacuum tube, which is usually made of fragile glass. This glass-made x-ray tube is sealed in isolated oil in a thick sheet of metal case. Internal surface of this metal case is covered by lead to prevent leakage of radiation to a wrong direction. The metal case protects the glass

tube from mechanical shock and also protects user from radiation and electrical shock.

Internal diagram of x-ray tube: it shows two electrodes, Anode and Cathode

1. **Anode:** connected to positive pole (+) of the high voltage generator: it is the target. It plays a role as an electron absorber and a shield. X-ray tube has two types of Anode, rotating anode and still Anode.
2. **Cathode:** connected to the negative pole of the high voltage generator. It is the source of electrons since it is consisted of filament made of tungsten wire located in the metal which is called the Focal Spot. Some x-ray machine has only one Focal Sport and some machine has two Focal Spots, one small and one big.

Generation of x-rays

To generate x-rays, first connect power to filament of cathode. The filament heated up and becomes red; electrons move to the surface and make themselves ready to break from filament. After a high potential difference between anode and cathode is generated, electrons quickly break away from the filament to hit target of anode. Such a strong hit generate sparks in which 1% generates x-rays and 99% generate heat.

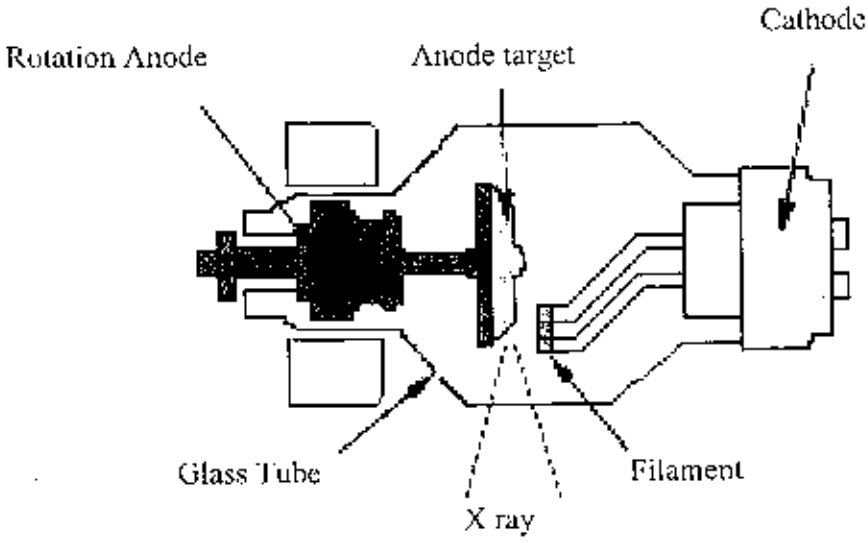


Figure1. Internal diagram of X-ray tube

A-2 Tube Stand

It is a stand and its function is to move, rotate, and regulate horizontal or vertical angles of X-ray tube, which facilitates to exposure.

A-3 Beam limiting device, Collimator

It is put with Halogen lamp to remark the location of X-ray exposure. This device utilizes lead layer for the surface of exposure and reduces useless X-ray quantitative on the patient.

A-4 High voltage generator

The purpose of an X-ray generator is to change the current of electricity and high voltage from low to high that is applied to the X-ray tube for the production of X-rays.

There are several types due to the size and energy of X-ray machine.

- One older type of generator in common use of small X-ray departments is the single-phase generator. In the present, small X-ray machines can be used.
- Three phase generator is more qualified than single phase generator, but it requires proper electricity.
- Recent development of high voltage generator technology points out that, in the future, most X-ray generators will be frequent converter; multi-pulse generators are much smaller, lighter and less expensive than conventional generator. And produce a high quality X-ray beam.

Generally, to protect circuit and another side of this device, it was put with several fuses, which have different intensities due to the charger. These fuses are almost in the control unit except in big X-ray generator that has fuse in the tube of that high voltage generator.

Figure2. External view of X-ray Generator

A-5 Bucky stand

This device plays a role to hold the cassettes and increases image quality because putting Bucky stand helps make the picture clear. It also provided facility for chest examination and other X-ray of bodies in stand situation either low or high.

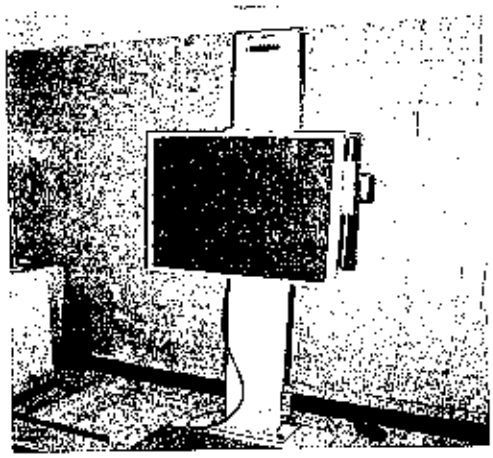


Figure3. External view of Bucky stand

A-6 Bucky table

The Bucky table is used for X-ray examinations when the patient is lying down. It must be able to hold a patient weighing 110kg and permeate to X-rays approximately 100%. It has 2.0m x 0.65m in size to 0.8m, and height 0.7m from the floor. This table was put with Bucky, which make the picture clear.

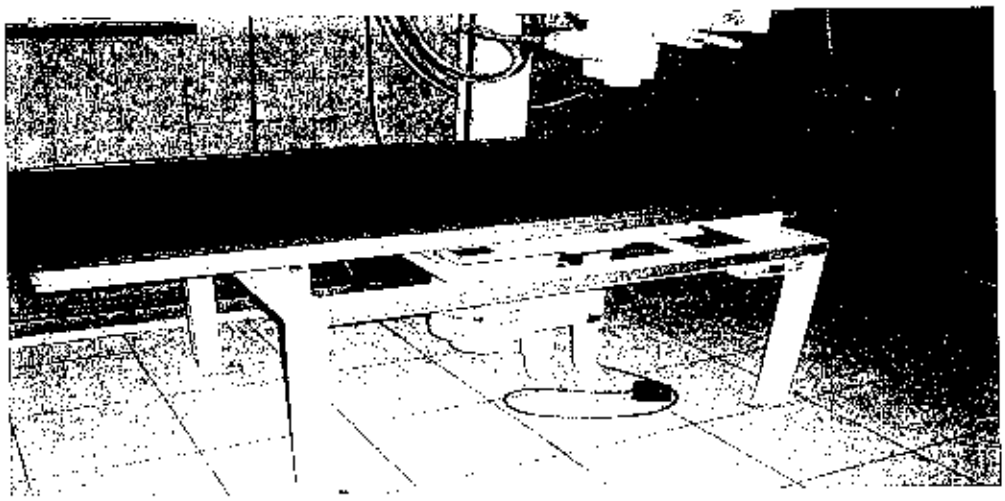


Figure4. External view of Bucky table

A-7 Control Unit including:

- Switch and meter are analog or digital indicators that provide information on the selective values of kV, mA, time or mAs.
- Switch requires electricity voltage supplies.
- And switch orders to X-ray.

Frequently, this control unit must place in X-ray room following the technical standard, which protects from X-ray technician, will have lead glass for visual inspection.

A-8 Cassette and Film

- Cassette is unopened slice box, which sunlight cannot permeate and use for X-ray film. Inside was put with screen that enables to turn X-ray to beam.

A-9 Equipment used in Darkroom

In the darkroom or cleaned film room including:

- Shelf to place the film and cassette, which has 0.6 m width and 1m length.
- Safety lamp should have available erosive light of film types.
- Cleaned film barrel or automatic film equipment (automatic printed picture).
- There are ventilation, irrigation and protective sunlight systems.

A-10 Protective X-ray Equipment

These items including:

- Screen has a covered lead thickness at least 0.5 mm and lead glass that fit to the lead thickness.
- A covered lead room has thickness at least 0.5 mm.
- Lead aprons fit to 0.25 mm of lead thickness.
- Protective gloves mask and lead collar.

3. General Precautions

1) There is no reason for anyone who is not a trained technician and specialist of this skill to repair X-ray equipment. Generally, before opening a cover machine, technician must switch off electric distribution board.
2) All movable parts of X-ray equipment should move smoothly, not stiffly or jerkily. When there is a problem with movement, check to see if there is any dirt or other obvious cause. Should not force the knob to turn. If a knob will not move easily, turn off the generator, wait 5 minutes, turn it again and try once more. If it is unsuccessful, turn off the main switch and call to National Workshop Engineer.
3) The rotating anode target makes a humming noise when it is turned on to start doing x-ray. After an exposure, the target will continue running, gradually slowing down after a few minutes. If it stops suddenly, or if it makes a strange noise, or if the noise increases or sounds "rough", stop using the tube, and send for the service engineer. If the target does not start rotating, you cannot make an exposure at all and then call for the service engineer right away.
4) Should keep water and other liquids well away from X-ray equipment and

especially, the equipment used by electricity.

5) If any fuse blows and it can be easily replaced, use exactly the same type of fuse to reinstate it. First, turn off the main switch. Should not use a stronger fuse than the original one. If the same fuse blows shortly after it has been replaced or repaired, or if other fuses blow almost immediately after the first one, turn off the unit and send for the service engineer.
6) If there is any remarkable heat, smell of burning, smoke or sparking, please turn off the main switch initially. Do not turn it on again until the service engineer is available.
7) Do not keep a spare X-ray tube at the hospital; it will deteriorate even if we do not use it and the warranty will become invalid.
8) It's necessary to stop using the X-ray tube for over a few days in order to warm the X-ray tube. You should determine the figure of X-ray from low to high level at least 3 minutes between the time (for example, for 50KV, you turn on once. After 3 minutes, for 55KV, you turn on again and 60KV...70KV... and determine 1mAs, 2mAs.

4. Maintenance and Inspection

X-ray equipment is complex and expensive. Although, basic maintenance can be done by hospital staff and technician, however, failure diagnosis and repair service requires the trained personnel.

Nevertheless, a regular routine maintenance and cleaning will help to preserve efficiently and provides frequently early warning of developing faults.

4.1 Maintenance Log Book (Maintenance record)

Maintenance Log book is essential for proper maintenance.

If careful records are kept, quality control will be successful. The front page should include telephone numbers (fax number or Email address, etc) of service personnel and suppliers or manufacturers for all the equipment including films, chemicals and accessories.

Every item, large and small, in the X-ray department should have a written record in the log book providing:

1) Manufacture, brand and name of the equipment
2) Specifications for the generator, tubes and all other items including accessories
3) Date of installation (by whom); total cost of the equipment and the installation.
4) A list of the technical service manual provided.
5) Details of any variation or modification from the standard equipment.

Thereafter every service visit, fault, repair, replaced spare parts supplied and their warranty and any other events should be recorded and dated.

Similar records should be keeping with items such as lead aprons are routinely tested, and concerning any other similar departmental maintenance (for example, the regular cleaning of intensifying screens, cassettes, etc.)

4.2 Equipment for X-ray Maintenance

- **Mechanic Equipments**
  - Vise, small or big insulation with double or rectangular edges.
  - Pincers with small edge and insulation
  - Key and wrench
  - Liquid oil cans
- **Equipment inspect quality assurance**
  - Step Wedge and Spinning top
  - Densitometer and sensitometer
- **Spare parts**
  - Fuse for electric equipment
  - Fuse for X-ray equipment
  - There is 15w-20w lamp for the cleaned film room lamp and another necessary lamp.
  - Should not purchase X-ray tube to keep as spare parts because it will deteriorate even if we do not use it.
  - The period of warranty will be expired

4.3 Daily maintenance schedule

1) Clean the floor, sweep and wipe or polish in the installed room.
2) Clean the X-ray table and controls. Do not use water on the X-ray equipment: use a dry cloth and adding alcohol if it is dirty.

Note: It is very important to remove traces of contrast media and plaster from the table top and wipe out blood or other contaminants, but water should not be used where there are electrical connections.

3) Grid Maintenance

Grid is a metal slice produced by the lead rubber sheet to flank with slight aluminum sheet; it plays a role to reduce low X-ray (second X-ray) that makes the dim picture. The most important maintenance beside of cleaning is to protect to avoid being crushed or fallen.

※ For the Mobile X-ray apparatus

1) Wipe out any dirt or dried liquids that may have splashed on to the mobile

X-ray apparatus (e.g., in the operating room or emergency room) but make sure that no liquid runs into the gaps around the control knobs or the edges of the meters.

2) If the unit is a battery power, check the battery meter or other indicators on the control unit to ensure that the batteries are fully charged.
3) If the electrical connecting plug or socket gets hot after an exposure has been made or during battery recharging should pull out the connecting plug and make sure the wires connecting the cable to the plug are not loose.
4) Recharge the apparatus every night by connecting it to the power outlet, also leave connected during the day when we do not use it.

4.4 Six-month maintenance schedule

Every 6 months, adding to all previous routine maintenance the following maintenance should be applied:

1) Whole of X-ray equipment

Check all the movable parts on the equipment, particularly the brakes on the tube column and on the mobile patient support. If the brakes are mechanical, clean where possible. If the brakes are electric and it is not working properly, should propose to service. Do not continue to use the equipment with poor functioning brakes because it can cause danger to the patient and staff. Check all floor rails and wheel on examination table, etc.

2) Collimator alignment

The experiment to recognize that collimator alignment following the process:

- To place cassette in 24 x 30cm size that has film on the smooth surface.
- To open the diaphragm for 18 x 24cm size (if X-ray has no diaphragm), place X-ray tube in the middle of cassette.
- Limit kV, mAs approximately to an exposure for a posterior-anterior view of an adult hand (posterior-anterior: 45kV, 1mAs).

Check the film after cleaning it will show square has clear edge and it has the equal distance to each viewing box. If the alignment is not straight, check to see if the tube casing has rotated or if the collimator is loose. Tighten screw if it is necessary. (See below for tube rotation).

Repeat the procedure with a horizontal X-ray beam in the position used for a chest radiograph of an erect patient.

3) Incorrect collimation

Misalignment will be shown by the exposed area being closer to one edge of the film than the other. There are two common causes:

- **The tube rotated:** the tube almost has circular band due to the location, which we can make to loosen or tighten by screws.
- **Holding loosens equipment:** the X-ray tube was tightening on a base plate with four screws. These screws can become loose. Should frequently retighten

4) Screen maintenance

- Should clean the screen every 6 months per time. Firstly, wipe out the hand. This cleaning should conduct in the darkroom by safety lamp utilization, placing the screen to get sunlight, which causes phosphor would be less qualitative. Also, the cleaning should perform modestly utilizes less detergent, wash with clean water, and wipe out by absorbed cotton until it gets dry.
- Actually, the screen is able to utilize for 5 years.
- The screen is quite fragile and wearable.
- Cleaned film liquids can damage the screen easily. Keep it well away and then wipe out the hand before opening the cassette.
- Make sure that which cassette is dirty or broken should write numbers on the screen.

4.5 Annual maintenance schedule

1) Turn off the generator at the main switch.
2) Visually inspect all the cables and wires for cracks or irregularities, especially where a cable is bent and electric plug connector etc. Make sure that these are not loose or rusty.
3) Check the X-ray tube and the transformer (the other end of the cables from the X-ray tube) for signs of oil leakage.
4) Check the earth cord (connected to the table, the tube stand rails, etc) for looseness, damaged insulation or any wearing.
5) Actually, these inspections should be habitually and made by the service engineer every 6 months.

4.6 Before ask for assistance from National Workshop Engineer

1. **In case of photograph density is unstable in black or white color should:**

   - Check the quality of printed picture cartridge. Does it replace

repeatedly?

- Did printed picture cartridge meter the temperature?
- Does clock utilization limit the cleaned film time?
- Was various film types utilized?
- If there are many cassettes and the screen has different flash speed, should observe that slow, fair or fast.
- Does the screen install is in the correct side?

Utilization of automatic printed picture machine:

- Does automatic printed picture work properly?
- Does the cartridge utilize is appropriate to the technical needs?

2. In case of dim or grey film:

- How many watts of lamp in the cleaned film room have an effect? (Should be smaller than 25W)
- Is erosive beam of safety lamp broken?
- Is new film or expiring?
- Did film get X-ray before utilize?
- What is temperature of cartridge? (Adequate temperature is 20C)
- Is room closed well? (Existence about 10 mns in the room then look around).

3. In case of film have dirty traces at the same place

- Look at outside section of cassette to find the dirty traces (almost is metal debris).
- Open the cassette in the darkroom to look for the dirty traces.
- If cannot find the dirty traces on the cassette, should check the film box, might be cracking causes the light runs into.

CODE	
EQUIPMENT NAME	X ray Diagnostic Equipment
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for X-ray apparatus only		
1	Check & clean X-ray table and control	Good / Fail	
2	Check the battery power (For X-ray mobile apparatus)	Good / Fail	
3	Check the electrical connecting plug or socket, gets hot after an exposure has been made.	Good / Fail	
4	Check all the moving parts (Brakes on the tube column, tube support arm, wheel, etc)	Good / Fail	
5	Check the collimator alignment	Good / Fail	
6	Check high-tension cable for cracks or irregularities.	Good / Fail	
7	Check the X-ray tube and the generator for signs of oil leakage.	Good / Fail	
8	Check the X-ray tube rotating sound for signs of raise up noise	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

1-2. X-RAY FILM PROCESSOR

1. Introduction

The X-Ray film could be developed and X-Ray images could be made by the following 4 procedures:

- Developing
- Fixing
- Rinsing by clean water, and
- Drying by film dryer

Combination of the procedure mentioned above into one unit and those are controlled by electricity and microprocessor made up **X-Ray Film Auto Processor.**

The figure 1 & 2 show the typical automatic x-ray film processor used in X-Ray department. It can develop X-ray film faster, better quality and safer than manual processing.

Figure1: Front View

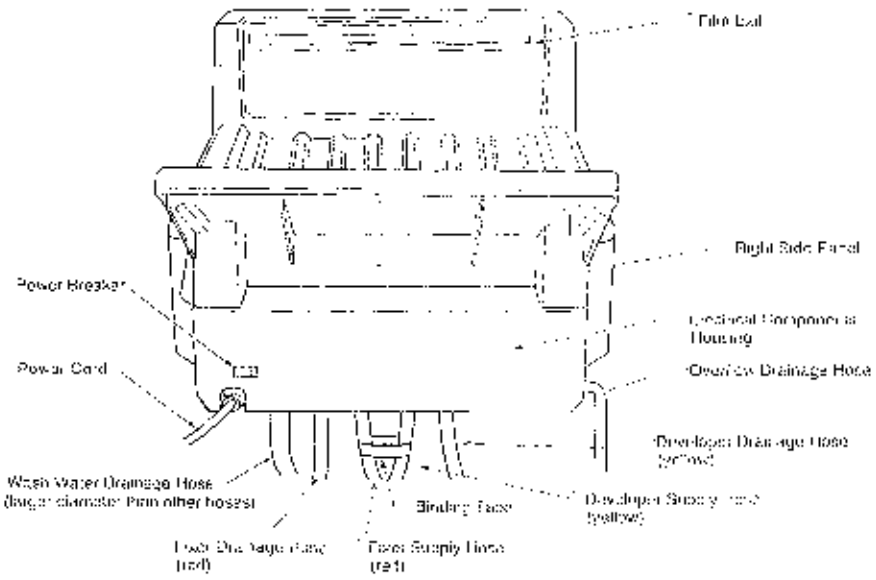
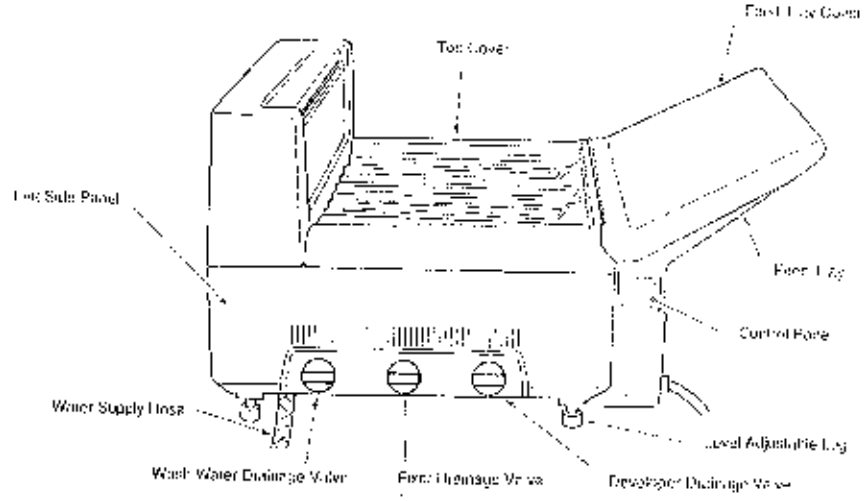


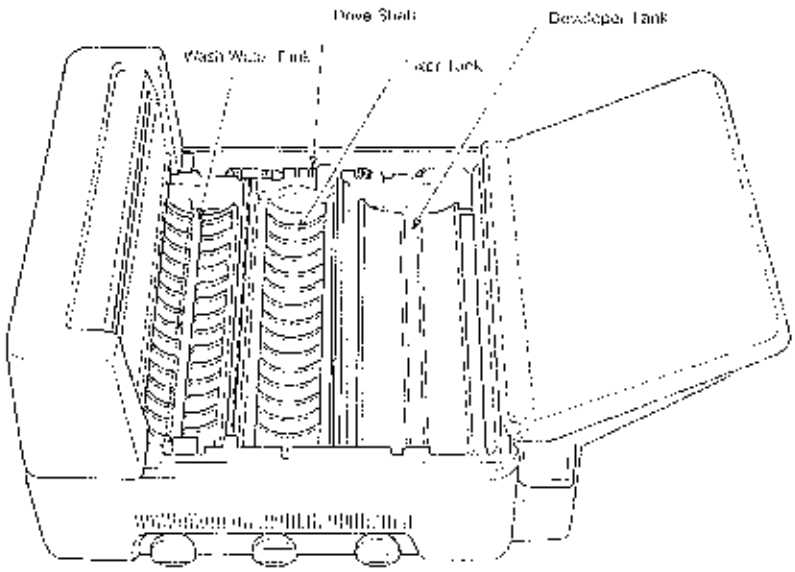
Figure 2: Side View

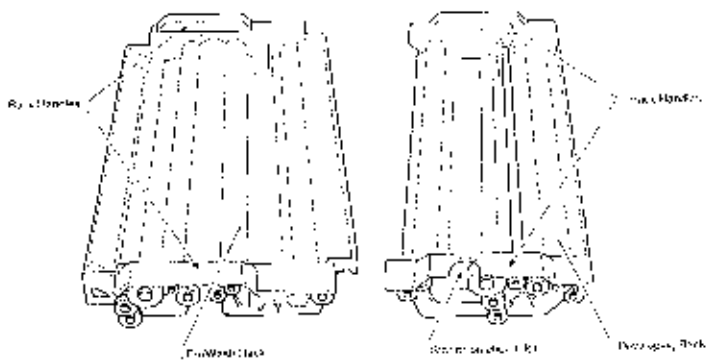


The major parts of X-Ray film processor (Figure 3) are:

1. Film entry system
2. Transport system
3. Chemical and recirculation system that is included: developing and fixer tank
4. Replenishment system
5. Water system is included wash water tank,
6. Drying system

Figure: 3 inside Unit



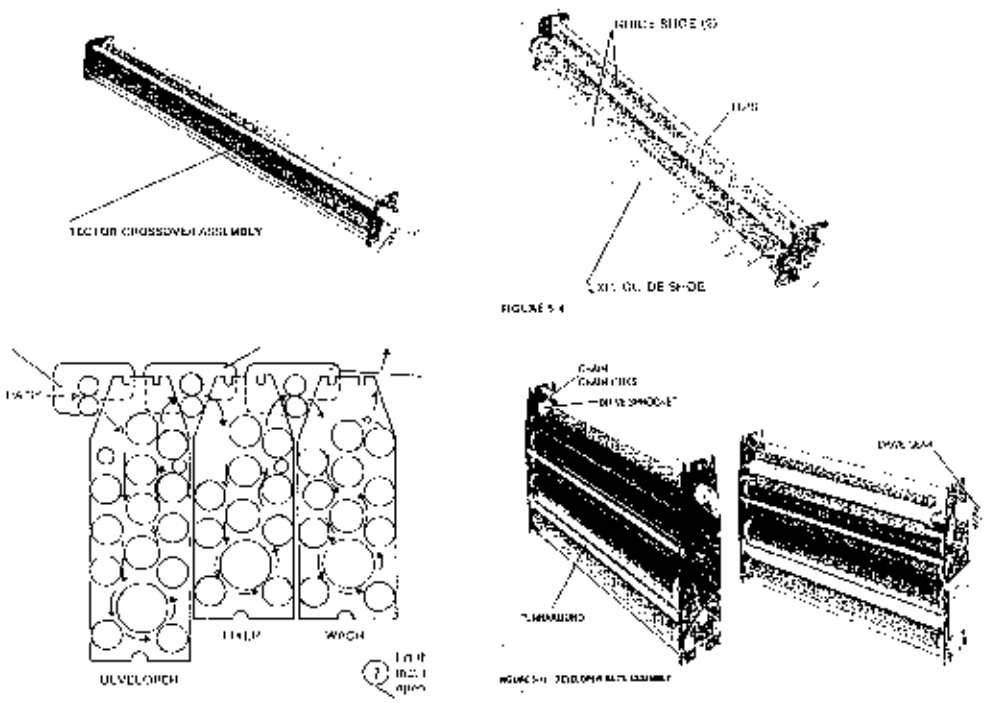


2. Principle of Operation

The X-ray can be taken into processor by film entry system (feed tray & feed rack) and then transport into developing tank. Developing process is taken period of second. The transport system continuously transports film into fixer tank and then transfer into wash water tank. The final processing film will transport into drying system. Please note the feature of processing is below:

1. Developing and fixing solutions (chemical) are continuously circulated to maintain the best activity and more stable temperature by centrifugal pump.
2. Replenish system is automatically operated in case of inserting films to compensate for used chemistry and when the level in one tank drops. The amount of replenished chemistry can be adjusted by controller.
3. Temperature of developer, fixer and dryer is automatically controlled by the heaters and thermisters installed in each sections.
4. Empty tanks are filled very quickly by automatic filling pumps.
5. Both the developing and drying sections are provided with level switches to prevent over heating.

Figure 4: Film processing



3. General Precaution

3.1 Installation

The location of installing of X-ray film processor should be following conditions:

- Must be installed in dark room at X-ray department
- Power supply must be safe to equipment
- Ground the unit to prevent electric accidents.
- The ambient humidity & temperature should be low & room should be had enough ventilation.
- It should not be installed closed to flammable things
- Floor should be solid, level and not vibration
- It should be had enough space for easy operation, checking & maintenance.

3.2 Hazards

Some procedures have been taken to prevent hazard from operation;

- There are dangerous high voltage areas inside the processor. Do not try to remove cover without disconnecting or turn off power supply.
- Keep unnecessary objects from falling into processing tanks

- The processing solution and starter are dangerous to eyes, skin and clothing. In case of eye injury wash your eyes thoroughly with cold running water and then consult with doctor. In case of contact with skin or clothing wash the affected areas immediately with water.
- During running, if you detect any unusual noise or smoke coming from the processor, discontinue use immediately, switch the power off and disconnected the power cord from the socket. Then call for service technician.

4. Maintenance

4.1 Daily maintenance:

- Warm up equipment by turn on the power
- Test equipment with insert cleaning film make sure that it is working properly

4.2 Monthly Maintenance

- Cleaning the inside of the top cover with cleaned water and be sure that the cover is completely dry before re-installing it.
- Cleaning the racks of Developing and Fixer/Wash racks.
- Cleaning the Area around the processing tanks with wet cleaned cloth
- Cleaning the Inside the processing tanks

Please note:

- Before taking maintenance or cleaning action, power supply must be disconnected
- The cleaning procedure should be follow the advice of operation manual, otherwise parts may damage.

CODE	
EQUIPMENT NAME	X ray Film processor
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for X-ray Film processor only		
1	Physical check: Feed tray, Film exit port, Top cover	Good / Fail	
2	Check the Developing supply hose and fixer supply hose	Good / Fail	
3	Check the Developing drainage hosen and fixer drainage hose	Good / Fail	
4	Check the wash water drainage hose and overflow drainage hose	Good / Fail	
5	Check the water supply hose	Good / Fail	
6	Check Developing, Fixer/Wash racks	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

1-3. ULTRASOUND SCANNER

1. Introduction

Diagnostic ultrasound is now applied for obtaining images of almost entire range of internal organs in the abdomen. The internal organs include the kidney, liver, spleen, pancreas, bladder, major blood vessels and of course, the fetus during pregnancy. It has also been usefully employed to present pictures of the thyroid gland, the eyes, the breasts and a variety of other superficial structures. In a number of medically meaningful cases, ultrasonic diagnostic has made possible the detection of cysts, tumors or cancer in these organs. The diagnostic ultrasound has also been extensively developed to allow the dynamics of blood flow in the cardiovascular system. Thus, the method of diagnostic ultrasound in which investigates with non-invasive, real-time and mobile is extremely useful.

2. Principle of Operation

Ultrasonic waves are sound waves associated with frequencies above audible range and generally extend upward from 20 kHz. These waves exhibit the same physical properties as the audible sound waves but they are particularly preferred in situations favored by one or more of the following reasons:

- Ultrasonic waves can be easily focused, i.e., they are directional and beams can be obtained with very little spreading.
- They are inaudible and are suitable for applications where it is not advantageous to employ audible frequencies.
- By using high frequency ultrasonic waves, which are associated with shorter wavelengths, it is possible to investigate the properties of very small structures. It is particularly true in detection of defects where the wavelengths utilized should be of the same order as the dimensions of the defect.
- Information obtained by ultrasound, particularly in dynamic studies, cannot be acquired by any other more convenient technique.

Transmission of ultrasonic wave motion can take place in deferent modes. The wave motion may be longitudinal, transverse or shear. However, for medical ultrasonic diagnostic applications, longitudinal mode of wave propagation is normally used as these waves can be propagated in all types of solids, liquids and gases. In longitudinal waves, the particles of the medium oscillate to and from in the direction of propagation of the wave resulting in alternate regions of compressions and rarefactions.

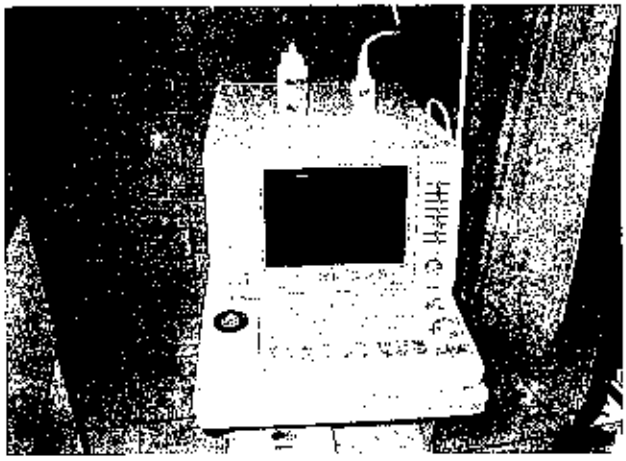


Figure 1. *External view of Ultrasound scanner*

3. General Precautions

3.1 Installation

1) Install the equipment where it is not exposed to water.
2) Install the equipment in an environment where it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, sulfur component, etc.
3) Keep the equipment stable and avoid tilting vibration, and shock as much as possible, even during transport.
4) Do not install the equipment in a storage environment containing gas or other chemicals.
5) Make sure the main line voltage, frequency and power are correct for the operation of the equipment.
6) Make sure the power system for the equipment is properly grounded.

3.2 Use of Equipment

1) Ensure proper earth grounding. Connect the power cord to a receptacle (3P) with earth terminal. When using a receptacle (2P) without earth terminal, contact the earth terminal on the near of the device to the earth point. If the device is earthed to a tap-water pipe, do not connect it to a non-metallic pipe.
2) This equipment is not explosion proof. Do not use in the presence of flammable anesthetics.
3) This equipment is not drip proof. Do not use in an environment that is exposed to water or in a gaseous atmosphere.
4) If the equipment has been stored in a cold environment and moved to a warm environment for operation, dew condensation may occur inside of the equipment. If the equipment is used under these conditions, it may become defective. If this situation occurs allow sufficient time for the

instrument to adapt to the warmer temperature before turning.

5) If the instrument is operated near other equipment such as X-ray, other ultrasound equipment, magnetic resonance equipment, etc. it may not perform to its proper specifications. If this happens, relocate the instrument as far as possible from the sources of interference.
6) Caution should be used if this equipment is used in conjunction with other equipment. Disconnect the ECG patient cable from the patient if this instrument is used with electrical surgery knifes or during defibrillation.
7) Always run turn OFF the power switch before replacing probes or connection cables.

3.3 Use of Probes

1) Probes are not shock resistant, especially the contact surface and probe connector. Be very careful not to drop or sterile any probe.

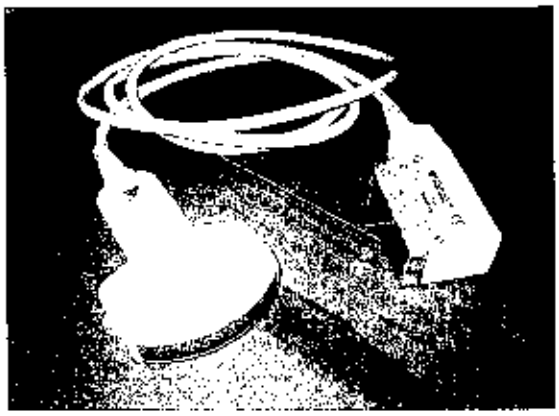


Figure 2 A Convex type ultrasonic probe, 3.5 MHz

2) Do not submerge the probe into liquid. The contact surface may be submerged for a short period of time. Be particularly careful not to moisten the connector portion of the probe when cleaning.
3) Do not kink or pull with excessive force on any probe cable. If the internal probe cable is exposed due to exfoliation of the probe cord sheath, do not use.
4) Always wipe off any echo gel and other debris completely after each use. For cleaning of the probes, use a neutral detergent or alcohol. Do not use thinner or other organic solvents. Keep the probes clean at all times when not in use.

4. Maintenance and Check

4.1 Cleaning

To ensure proper operation of the Ultrasound scanner and its accessories, a periodical cleaning should be performed.

1) If the operation panel and keyboard are dirty, wipe them with a soft cloth dampened with a neutral detergent. Operation errors may occur if the trackball becomes dirty.
2) If the monitor surface is stained with fingerprints or dust, it can be cleaned with a soft cloth dampened with a neutral detergent. Take care to not scratch the monitor surface.
3) Keep the probes clean at all times to ensure proper operation and longer useful life. Clean the contact face with a neutral detergent or alcohol. Take care not to scratch the contact surface.
4) Keep the ECG electrodes clean at all times to prevent corrosion and ensure adequate patient contact. Wipe off all electrode paste and clean the electrodes with alcohol.

***NOTE**: Do not any thinner or other organic solvents when cleaning the equipment or any of its probes or cables.*

4.2 Routine Check

To ensure proper operation of the equipment, check the equipment on a routinely.

1) Check the probe connection on both the main unit and the probe it self to make sure none of the pins are bent, etc.
2) Check the probe cable. Make sure the outside insulation is intact and the joints of the probe cable and connectors/probe head are normal.
3) Check the ground wire and power cord periodically. If there is any exfoliation of the outside insulation, carefully disconnect the power cord and replace it with a new one.
4) Check the control knobs on the main unit for looseness, excessive play and other defects.

***NOTE**: Do not remove the main unit cover; if any trouble is found contact your service representative.*

CODE	
EQUIPMENT NAME	Ultrasound scanner
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Ultrasound scanner only		
1	Check & clean operation panel	Good / Fail	
2	Check & clean trackball	Good / Fail	
3	Check & clean Display surface	Good / Fail	
4	Check & clean Transducer (Probe)	Good / Fail	
5	Check & clean Transducer connector	Good / Fail	
6	Check function of image on the display	Good / Fail	

REMARKS

Date inspected	/	/ 2006	Inspector	
Room Temp.		℃	Approved by	

2-1. ECG EQUIPMENT

1. Introduction

The Electrocardiograph is widely used medical equipment that measure bio-potential differences arising from electrical activity of the heart muscle. It usually uses surface electrodes, and it requires high-input-impedance differential amplifies and compensation for common-mode voltage inputs. The electrocardiograph is designated with the initials ECG, as is the electrocardiogram, a record of the data. It terms of the electrical signal, the ECG has a magnitude of about 1 mV at the electrode surface. In terms of signal processing, the significant features of the ECG data are the feature durations, polarities, and magnitudes.

2. Principle of Operation

The ECG is designed to measure and to record electrocardiogram. The complete waveform with labels *P, Q, R S,* and *T* indicating its distinctive features is shown in Figure2. The P-wave arises from depolarization of the atrium. The *QRS* complex arises from depolarization of the ventricles. The magnitude of the R-wave within this complex is approximately 1 mV. The T-wave arises from re-polarization of the ventricle muscle. During the T-wave, partial re-polarization of the cardiac muscle causes ionic currents, and corresponding ECG potential, as previously describes for the R-wave. The U-wave that sometimes follows the T-wave is a second-order effect of uncertain origin and is of little diagnostic significance.

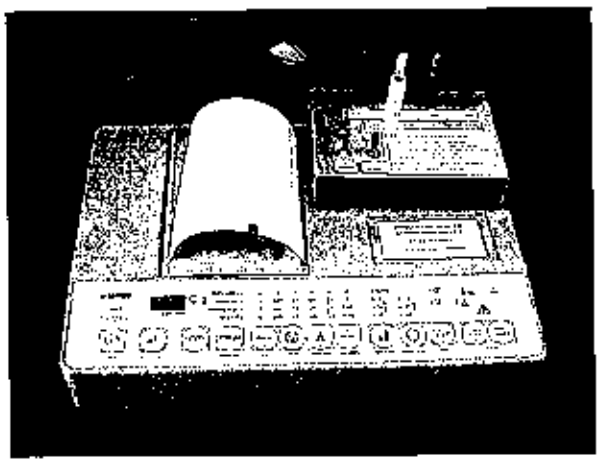


***Figure** 1 A 3-channel ECG equipment (under testing with ECG checker)*

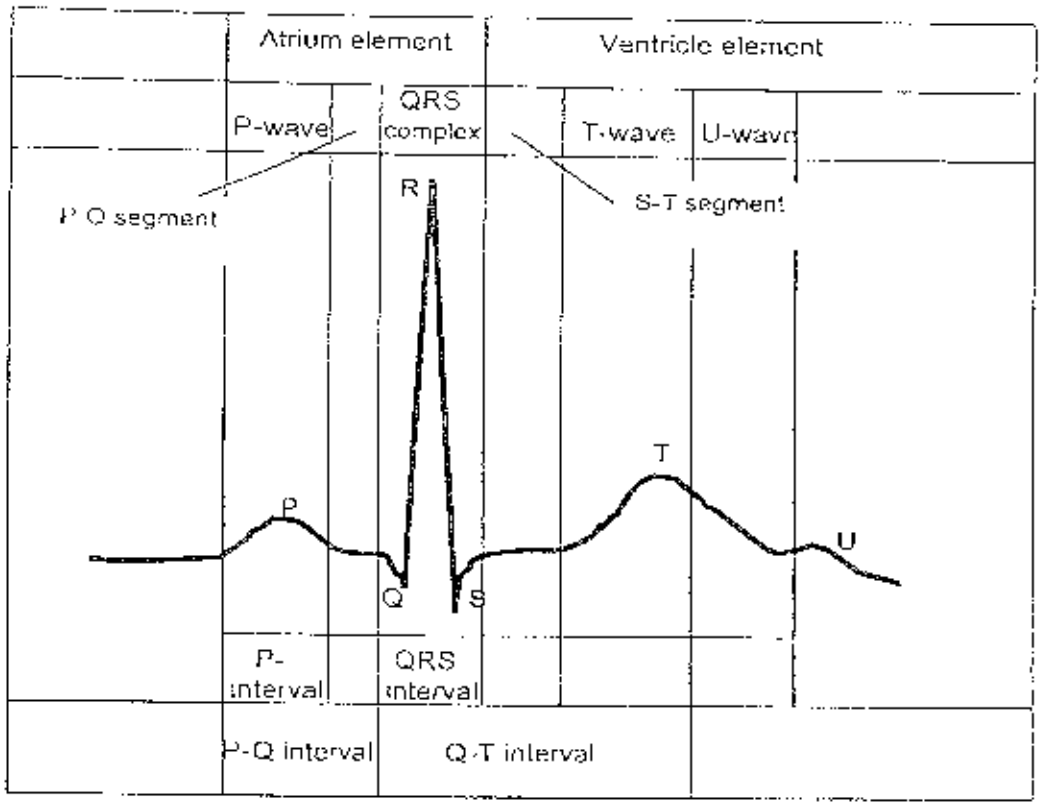


***Figure 2** ECG waveform*

※ Structure

Figure 3 shows a simplified block diagram of an ECG. An ECG device amplifies an ECG signal and displays it on an output unit. Representative specifications on the unit are as follows:

Input impedance	5 MΩ
Frequency response	±0.5 db (0.14 Hz to 25 Hz)
	3 db (to 100 Hz)

The ECG device processes the bio-potential signal into a form suitable for the output unit. Often the data is presented graphically on a strip chart recorder:

Normal rate	25 mm
High rate	100 mm

In its path through the instrument, the bio-potential from the surface electrodes passes through a defibrillator protection circuit. Various combinations of the ECG leads can be selected for configurations. A 1 mV calibration pulse is used to calibrate the amplifier by enabling the technician to observe the output and adjust the scale so that a known deflection corresponds to a 1-mV input signal.

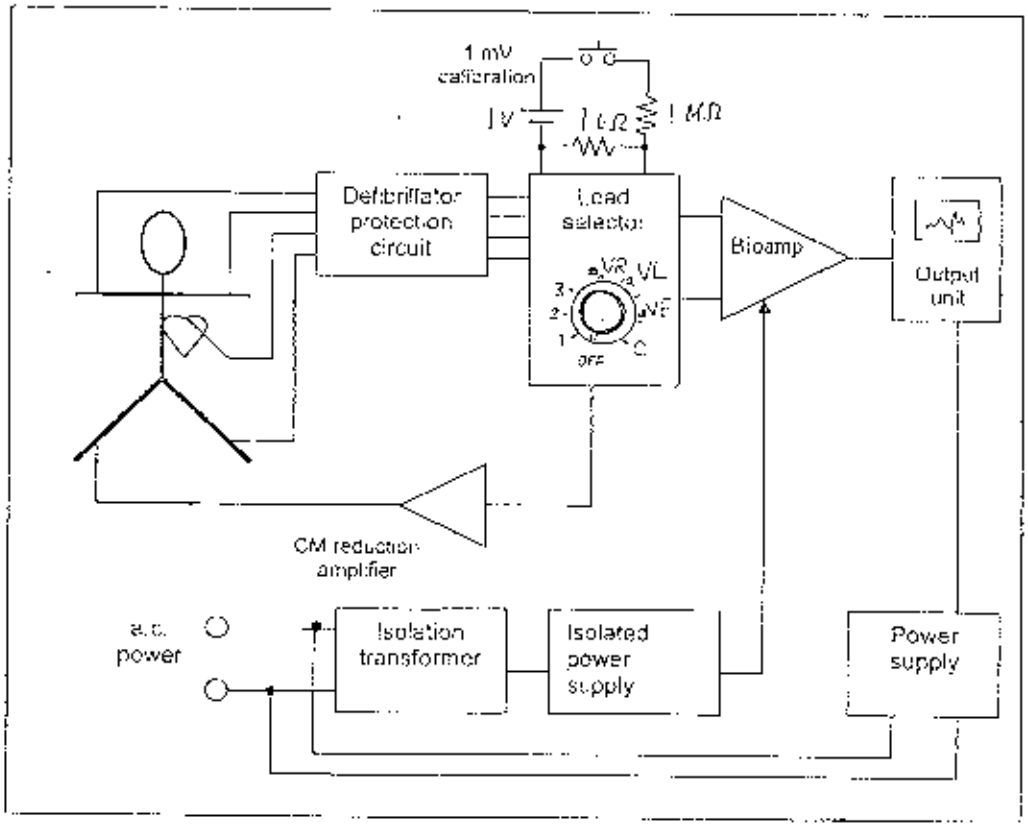


Figure 3. *Simplified block diagram of an ECG*

Since the patient leads of an ECG are connected through relatively low impedance electrodes, and are positioned on the skin across the heart, it is necessary to avoid that the *macro shock* resulting from currents exceeding 10 mA. If the patient is wearing an external pacemaker or the patient's heart is catheterized, *micro shock hazard* will be exists and patient-level currents must be maintained below 10 μA. This is done by providing bias power to the amplifier through an isolation transformer, which drives an isolated power supply. Because the electronic power requirements are low, a rechargeable battery may also be used. The output unit, consisting of a paper chart recorder or a cathode-ray-tube screen or LCD (Liquid Crystal Display), requires high power and often requires an electronic power supply. This power supply does not require the same degree of isolation as the amplifier because it normally does not contact the patient.

The ECG equipment is classified as B type, BF type and CF type depending on the degree of protection for the patient. His flux type ECG must be CF type since the equipment is directly contacted to patient's heart. The most popular type of ECG equipment is BF or CF type, which the input part is isolated with the floating circuit.

3. General precaution

1) Make sure the power connection for the equipment is properly connected to the ground (GND) to avoid AC noise.
2) Take care the place were the equipment installed in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, etc.
3) Do not keep the electrode and patient cable without cleaning because some dirt will be fixed tightly, as result, it could not be extracted.
4) Installed place should be selected properly to avoid high frequency noise from the electro surgery unit. Because the waveform of ECG could not be acquired appropriately.
5) Keep the equipment stable and avoid tilting vibration and shock as much as possible, even during transport.

4. Maintenance and check

4.1 Visual Inspection

This inspection should be carried out at least once in every six months. Recommended items in this inspection are shown in Table 1.

Table 1. Visual inspection list for ECG equipment

Check Item	Description
1. External Packing	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body
2. Electrode	- Rust electrode - Contaminated electrode - Spring muscle - Absorption, effect on electrode
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Cord/Lead wire, etc.	- Injured/broken conductor/wire and cable insulation - Stain, twist and hardness of insulation of cable or conductor
5. Connector (Input connector, power connector, etc.)	- Cracked/broken connectors - Bent/cracked connector's pins - Smooth movement between male and female contact - Gripping force of connectors
6. Screw, Nut, Washer, etc.	- Loose/missing screws/nuts/washers/bolts
7. Caster	- Caster wheels/machine level - Free movement of casters - Functioning of caster's stoppers
8. Accessories	- Number of accessories - Consumable - Operating manual

4.2 Electrical Functional Inspection

This inspection should be carried out at least once per annum. Ideally, the inspection items, which are stipulated by IEC or National Standard (e.g., JIS), should be performed.

1) Check that the ECG waveform on the recorder is normal by using an ECG simulator (if it is not available, can be used with human body).
2) Check that the damping of square waveform is normal while putting CAL signal (See Figure 4).
3) Check the timing rate. Measure the time period, which the movement becomes 37 % while putting CAL signal continuously.
4) Check that the recording paper feeding speed. Measure the value of the feeding speed with selecting switch 25 mm/s within 10 seconds.

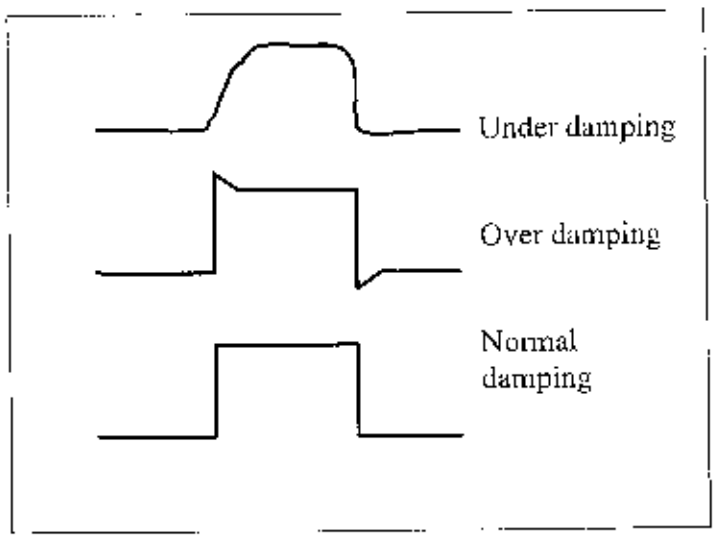


Figure 4. *Calibration for damping of waveform by using CAL*

CODE	
EQUIPMENT NAME	Electrocardiograph
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Electrocardiograph only		
1	Check & clean patient electrode and cable	Good / Fail	
2	Check function of operating panel, knob and switch	Good / Fail	
3	Check gripping force between mains plug and mains socket	Good / Fail	
4	Check contact between patient cable and electrode	Good / Fail	
5	Check function of thermal pen	Good / Fail	
6	Check the 1mV calibration for waveform	Good / Fail	
7	Check function of recorder	Good / Fail	
8	Check & replace Rechargeable battery (If equipped with)	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

2-2. PATIENT MONITOR

1. Introduction

Patient monitors have functions of monitoring ECG, respiration, NIBP and SpO_2. Some types of patient monitors provide arrhythmia analysis function too. The measuring results are all displayed on the screen; otherwise, ECG is recorded with the recorder. Patient monitors are usually designed to comply with the international safety requirements for medical equipment, IEC 601-1.

This section provides advises for operator and staff of the ME section to maintain in order to ultimate future problems and keep the instrument in a condition providing completely safe and satisfactory operation.

2. Principle of operation

Figure 1 shows the system configuration of a typical patient monitor.

1) Connection of the lead cable and ECG relay cable with the monitor allows monitoring of ECG and respiration.
2) An optical SpO_2 sensor allows monitoring of SpO_2.
3) A cuff allows monitoring of NIBP.

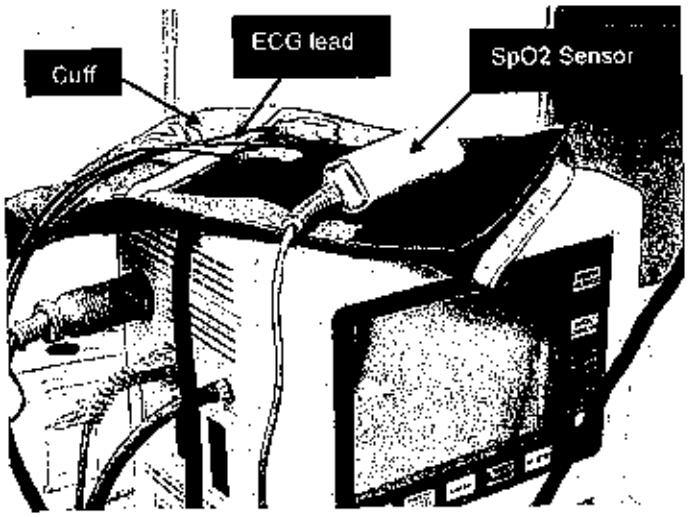


Figure 1. *A patient monitor with measuring devices (measuring Blood Pressure, Respiration, ECG and O_2 Saturation)*

4) The optional battery allows monitoring even during patient transportation.

3. General precautions

1) Strong radiant electrical noise from some environments can cause interference. For example, leakage current, electrostatic induction and electromagnetic induction enter the measuring circuit. Install the monitor and bed in a place where a high-voltage line or an electrical cable with large load is not located nearby.
2) Pay attention to x-ray apparatus, ultra-short wave instrument, radio receiver and fluorescent lamps. These may cause interference.
3) The room temperature should be kept in a range of 20 to 30°C.
4) Select a low humidity environment.
5) Avoid using near equipment generating high temperature or from using in direct sunlight. Especially, if the monitor is powered with the battery, operation in such an environment may have an adverse effect on the charge/discharge time of the batteries.
6) In general, patient monitors do not future an explosion-proof design. Do not use it near anesthetic equipment generating inflammable gases.

Equipotentialization Grounding

7) If two or more medical electric instruments are used in conjunction, there may arise a potential difference between them. Such the potential difference may let the current flow to the patient to whom the instruments are connected, thereby causing an electrical shock. You should take care to avoid such electrical shock especially when using the instrument in the operating room, ICU, CCU, cardiac catheterization lab, cardiovascular X-ray room. To eliminate a potential difference between instruments, connect the equipotentialization terminal of each instrument to an identical grounding terminal. This method is called equipotentialization groundings.

Defibrillation Protection

8) The unit can remain connected to a patient during defibrillation. The patient cable and input circuits are designed so the unit is not damaged even if defibrillator electrodes come into contact with the ECG electrodes during defibrillation.

***NOTE**: This defibrillation protection is effective only if the correct patient cable supplied with the instrument is used.*

High-frequency surgery

9) The patient monitor may be used during surgical operation, provided that cautionary instructions in the operator's manual for the electro-surgical knife are strictly observed, with special attention paid to the placement of the counter-electrode plate.

If not observed, the high-frequency energy of electro-surgical knife may cause a skin burn at the site of an ECG electrode or may damage the instrument.

4. Maintenance

4.1 Cleaning and Disinfections

Electrodes and electrode cables

For disinfection, the electrodes and electrode cables should be rubbed with a swab or cloth moistened with a 2% glutaraldehyde germicide.

Under no circumstances may the electrode cables be immersed in any cleaning fluid.

Nor may they be subjected to hot sterilization with water, steam or air or to ether sterilization.

Monitor

The instrument cabinet may be cleaned and disinfected in the following manner:

- Cleaning: Rub the unit with a cleaning cloth moistened with water to which a household cleaning detergent can be added if necessary. Never use ether or benzene.
- Disinfection: Thoroughly spray the cabinet with a 2% glutaraldehyde germicide.

4.2 Visual Inspection

Table 7.1 shows the visual inspection check sheet for patient monitors.

Table I. *Visual inspections check sheet for patient monitors*

No.	Inspection Item	Description
1	Accessories and Consumables	1) Are mains cable, each cord and induction cord normal? 2) Are electrodes, relay cable, cuff, hose, gel, etc. completed? 3) Is an operating manual available?
2	External Packing	1) Broken enclosure of main body 2) Cracked/broken panel 3) Missing characters 4) Rusts/dents on the main body 5) Cracked/broken knobs/switches 6) Gripping force between mains plug and mains socket 7) Loose screws
3	Electrodes, Sensor, Cuff and their Connections	1) Rusty or contaminated electrodes 2) Spring muscle of SaO2 sensor 3) Absorption effect on electrode 4) Hose connections of cuff
4	Terminals, etc.	1) Broken earth terminal 2) Loose terminal
5	Display	1) Brightness on the screen 2) Picture damage on the screen
6	Caster	1) Smooth movement 2) Stopper 3) Level surface

4.3 Functional Inspection

Table 2. Shows the functional inspection check sheet for patient monitors

Table 2. Functional inspections check sheet for patient monitors

No.	Inspection Item	Description
1	Preparations (before operation)	1) Confirming first positions of function switches, accessories, etc. 2) Connections of accessories, i.e., ECG leads, SpO2, cuff 3) Connection of mains cable 4) Inspection of mains cable and earth connections
2	During Operation	1) Switch the equipment ON. 2) Confirm about anything seems to be wrong around the equipment, e.g., flame, smoke, unusual smell, sound, heating. 3) Confirm the indication lamp lights, display, etc. 4) Confirm for proper setting knobs/programmes. 5) Is there any noise or interference? 6) Are all functions of switches normal? 7) Is A.C. power-battery power selection normal? 8) Is battery charge normal condition?
3	After Operation	1) Returning function switches to first set position? 2) Power switch OFF (next procedure should be done after 20 - 30 seconds). 3) Take off electrode, cable, and arrange them. 4) Take off accessories, etc. and arrange them. 5) Make the equipment ready for next operation/use.

CODE	
EQUIPMENT NAME	Patient monitor
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable ,etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Defibrillator only		
1	Check & clean patient electrode and cable	Good / Fail	
2	Check function of operating panel	Good / Fail	
3	Check gripping force between mains plug and mains socket	Good / Fail	
4	Check & clean SpO2 sensor	Good / Fail	
5	Check & clean the Display (Brightness and picture damage, etc.)	Good / Fail	
6	Check the base line indicate in center position on the screen	Good / Fail	
7	Check the 1mV calibration test signal	Good / Fail	
8	Check & replace Rechargeable battery (If equipped with)	Good / Fail	

REMARKS

Date inspected	/	/ 2006	Inspector
Room Temp.		℃	Approved by

2-3. DEFIBRILLATOR

1. Introduction

Various kinds of cardiac muscles make up of the ventricle of the heart. These are continuing the stroke with the stimulating signals generated by sinus tubercle, repeating relaxation and contraction. When every cardiac muscle looses its normal work by certain reasons, they cannot eject the blood. Such situation is called the ventricular fibrillation.

When a high current is given to the ventricular that the fibrillation is occurred, the contractions occur in all the cardiac muscles.

2. Principle of operation

2.1 Types of Defibrillators

1) For use on removing ventricular fibrillation

To remove the ventricular fibrillation, 150 - 400 Joule of energy passed via chest wall is required. For restarting the heart after cardiac operation, 20 - 30 Joule of energy is applied to it so that the heart can directly be irritated. In this case, the energy discharged from capacitor is applied. This type of equipment is called the DC-defibrillator. A typical appearance of this equipment is shown in Figure 1.

2) For use on removing atrium fibrillation

50 - 100 Joule of energy is applied for curing atrium fibrillation with R-wave synchronizing system.

3) Plant type defibrillator

This type of defibrillator is planted into the body which ventricular fibrillation and ventricular tachycardia often occur. The equipment irritates the heart directly with the energy of 10 -30 Joule detecting fibrillation automatically.

2.2 Basic Structure

The basic structure of defibrillator, DC-defibrillator for example, is mainly composed of five devices as shown in Figure 2, i.e., high voltage DC generator, capacitor, output switch, inductor and irritating electrodes.

1) High voltage DC generator
   This device generates approximately 7,000V DC, and charges the capacitor, C.
2) Capacitor: C
   This device has a capacitance of 10 - 40μF, and stores the static energy of 300 - 400 Joule.
3) Inductor: L
   This device has an inductance of a few mH, and has a role of damping the discharging wave of the capacitor.

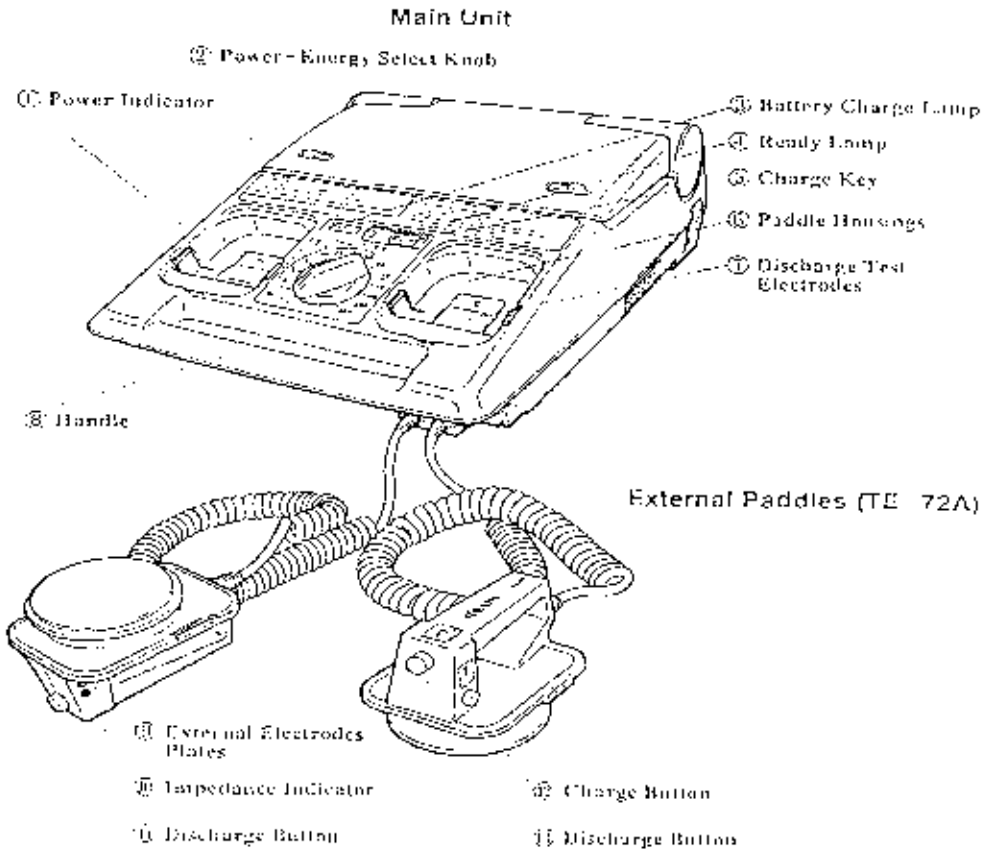
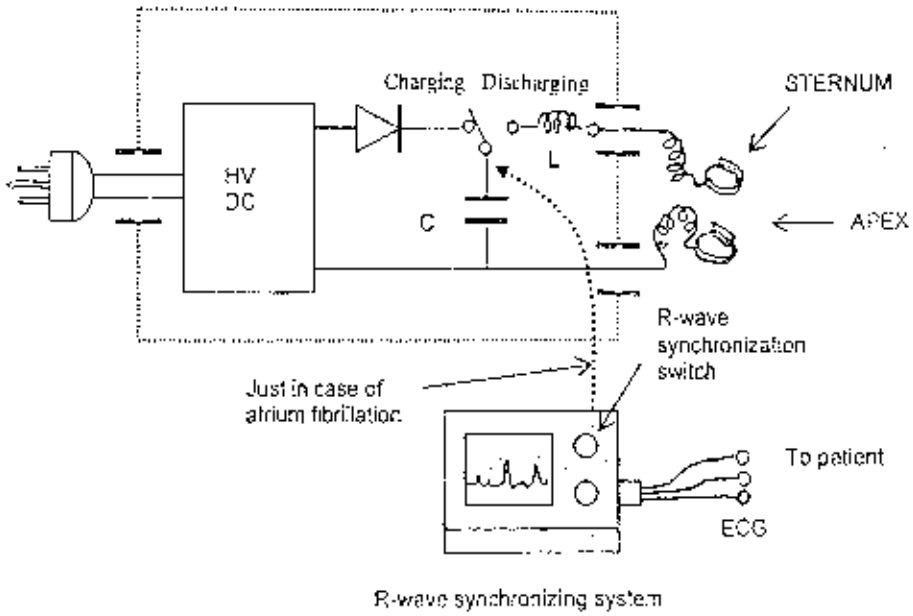


Figure1. A typical DC-defibrillator



Figer 2. Basic structure of defibrillator

4) R-wave synchronizing system
This is system that discharges the energy synchronizing R-wave of electrocardiogram when removing atrium fibrillation.

5) Irritating electrode
Irritating current is flowed into this electrode. There are two types of electrodes, i.e., external electrode and direct electrode.

2.3 Output Waveform and Energy

LCR type discharging for example generates the output waveform as shown in Figure 3. The output waveform is little bit vibratory or critical dumping based on a load resistor of 50Ω. The shape of the waveform changes depending on the value of the load resistor.

The output energy is scaled as supply energy to the load resistor of 50 Ω. The unit is represented as:

J [Joule: 1J = 1W · s]

The output covers the range from 10 - 360J in standard. Where charging voltage is V, the charging energy, En, is represented as:

$En = CV^2/2$

3. General precautions

1) Ensure to check properly before defibrillate, check volume of paste enough and power of press the paddle to patient. If they do not prepare properly, may be invalid to defibrillate and occur burn to the skin.
2) Make sure put the paste onto the body surface separately between APEX and STERNUM, if paste touch between them output current could not enter to body deeply.
3) Make sure the power connection for the equipment is properly connected to the ground (GND).
4) Never touch by your hand directly the paddle and patient body during discharging of defibrillate. You will get serious electric-shock.

4. Maintenance and check

4.1 Visual Inspection

Recommendation of the visual inspection items is shown in Table 1 and it shall be carried out at least once every three months.

Table 1. Recommendation of visual inspection for defibrillator

Item	Description
1. Accessories, consumable, etc.	1) Outer electrode 2) Interior electrode 3) Jelly 4) Protective rubber grove 5) ECG induction cable 6) ECG electrode 7) Mains cable 8) Instruction manual
2. External packing	1) Control panel 2) Scale 3) Switches 4) Energy setting knob 5) Indicators 6) Connector 7) Cable

4.2 Functional Inspection

Functional inspection shall be carried out at least once a week.

1) Insert the mains plug to power supply
2) Turn on the switch of equipment, and ensure that the power indicating lamp lights.
3) Apply the electrodes.
4) Set the energy setting knob to maximum position.
5) Push the button and ensure that energy charging is working normal.
6) Set puddles to mains body then push the switch button and ensure that energy discharging is working normal.
7) Return all the function switches to the original position.
8) Thereafter, clean up accessories, cords, leads, etc., and arrange them neatly for next use.

CODE	
EQUIPMENT NAME	Defibrillator
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power calbe,etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Defibrillator only		
1	Check & clean the Paddle (Spiral cable, surface of paddle and charge button)	Good / Fail	
2	Check & clean Paddle housing	Good / Fail	
3	Check & clean ECG patient cable	Good / Fail	
4	Check & clean the operation panel	Good / Fail	
5	Check to indicate the battery charge lamp	Good / Fail	
6	Check damage of rechargeable battery	Good / Fail	
7	Check charging time	Good / Fail	
8	Check function of discharging test	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

2-4. PULSE OXIMETER

1. Introduction

Pulse Oximeter mostly can be used in emergency room, operation room, pediatric ward etc. in hospitals for patients who need to constantly monitor SPO2 level, asthma patients, etc. It can measure patient's (your) pulse and patient's (your) oxygen saturation level of arterial blood.

The Pulse Oximeter consisted of:

1. Main unit with display that can be showed numeric or numeric and graphic of SpO2 and heart rate.
2. Sensor probe (Sensor device) that has two important parts; Light Source & Photo Detector

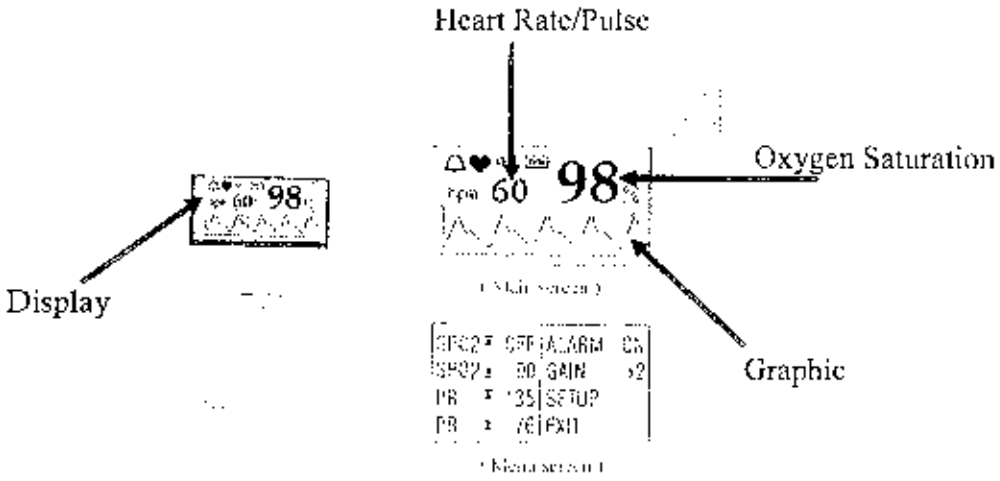


Figure1. Pulse Oximeter (Pocket Type)

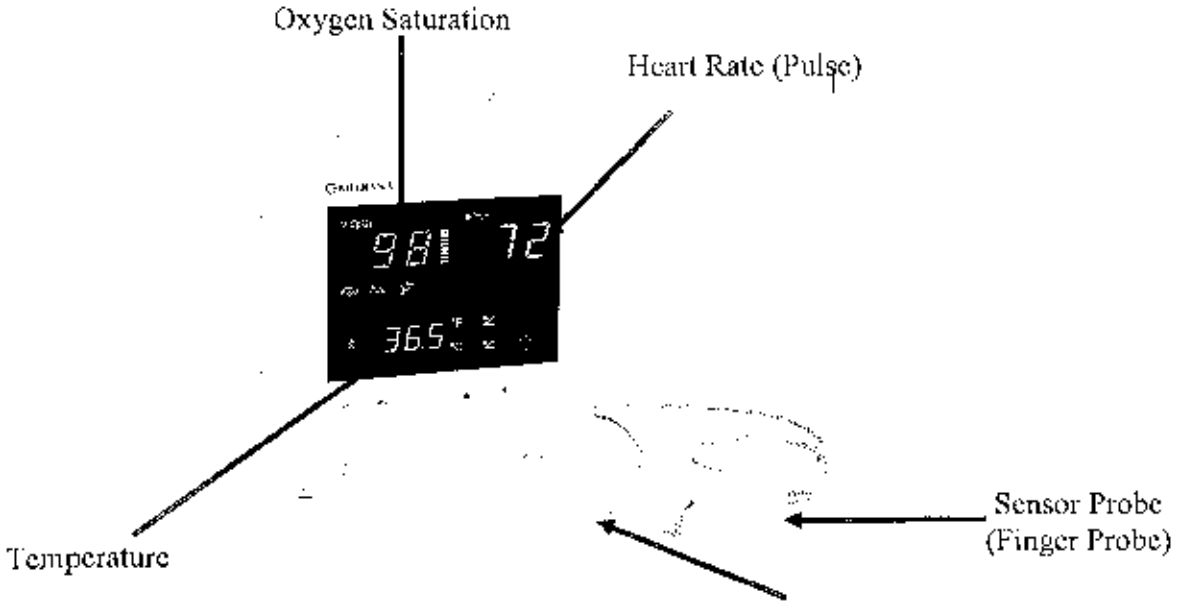


Figure 2. Pulse Oximeter (Portable Type)

2. Principle of Operation

The pulse oximeter is a noninvasive monitoring technology used to estimate the measurement of arterial oxygen saturation SpO2 of hemoglobin. The Figure 3 showing that a sensor device that contains a light source and a photo detector is placed around a pulsating arteriolar bed such as the finger, great toe, nose, or eartobe. Red and infrared wavelengths of light are used to determine arterial oxygen saturation. The measurement information & result will appear on small screen or indicate as number on display.

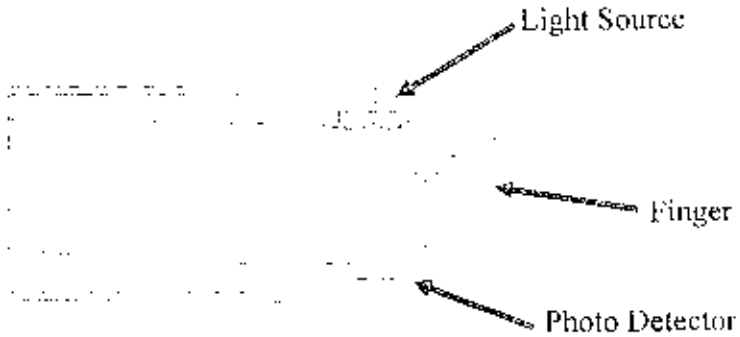


Figure 3 Structure of the Sensor device

The picture below can show you how to placed sensor probe on some parts of body.

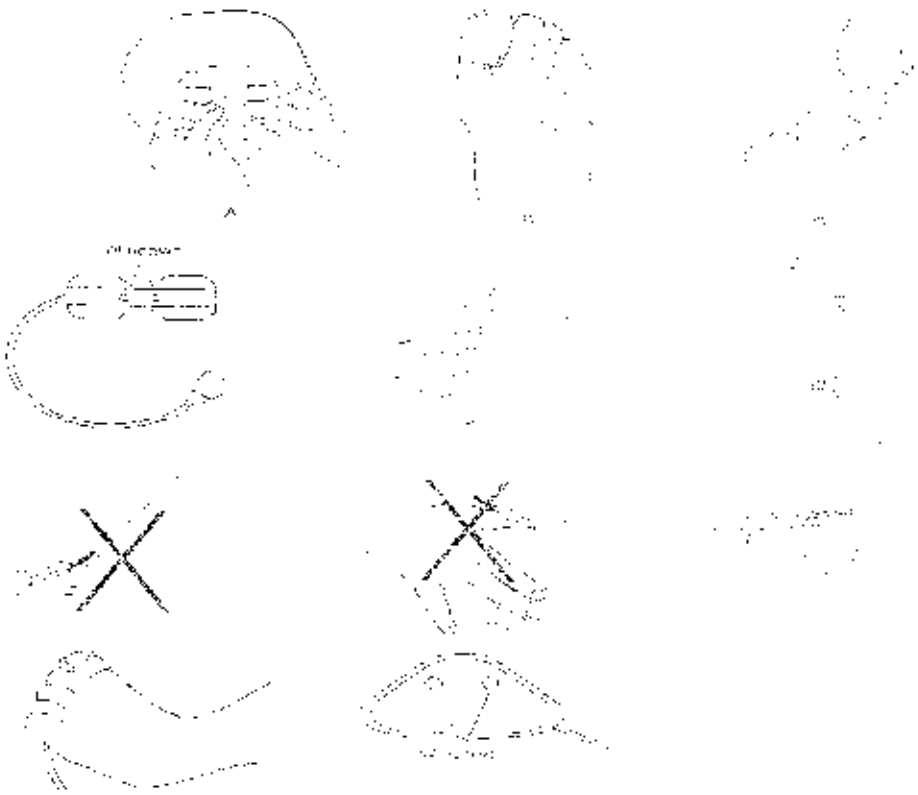


Figure 4. Several type of the Sensor probe

3. General Precaution

The pulse oximeter is simple medical equipment, but it is very sensitive to defective of some parts such as sensor probe, extension connector and plug connector to main body. Some action must be taken during using and checking pulse oximeter:

1) Make sure the power connection for the equipment is properly connected to the ground (GND) to avoid AC noise.
2) Be careful the place where the equipment installed in an environment; it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, etc.

3) Do not pour or drop water inside of the main unit, also do not operate with wet hand, it will be caused of electric shock, also, equipment broken easily.
4) Do not keep protein precipitates on the equipment for long term, it will be cause of damage of function and contamination. Therefore, you should always clean the machine, especially should take them away.
5) Make sure the power system for the equipment is properly grounded.
6) Install properly on mobile cart or mount pole with lock screws
7) Do not drop the unit, especially pocket type.
8) Do not drop or hard pressure to sensor probe

4. Maintenance

Daily maintenance must be taken:

1.Make sure that sensor probe have to be cleaned after using.

2.Make sure that cable of sensor probe has not bend and break during using with patients.

3.After using keep them in cabinet or proper place with appropriated temperature.

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. *Visual inspection list for Pulse oximeter*

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dust/dirt on the surface of body and operation panel
2. Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Finger sensor probe	- Crack, injured, broken, dirt, clotting blood protein or deteriorates on the face of light source and photo detector.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for Pulse oximeter

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check function of the finger sensor probe	- After turn ON, check well on the display to indicate the heart rate and SPO2 rate properly.
4. Check the battery function	- Battery charging properly. - Main unit operate with the battery properly.

CODE	
EQUIPMENT NAME	Pulse oximeter
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Pulse oximeter only		
1	Check the cable of sensor probe properly. It is can be broken inside during using.	Good / Fail	
2	Check the connection the extension of cable sensor probe properly. It is properly look.	Good / Fail	
3	Check the connection of cable sensor probe to main unit properly	Good / Fail	
4	Check the sensor probe, it is led up or not and it may break or crack.	Good / Fail	
5	Check display. It is working properly.	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

2-5. RESPIRATOR

1. Introduction

A medical ventilator is a device that helps a patient to breathe. Patient usually placed on ventilator because of a medical problem that makes hard for them to breathe well on their own. While on the ventilator, the body is able to rest so that it can heal. The ventilator can help with breathing or totally breathe for the patient.

Ventilators are mainly used in intensive care medicine, home care, and emergency medicine and in anesthesia, as a component of an anesthesia machine.

In its simplest form, a ventilator consists of a compressible air reservoir, air and oxygen supplies, a set of valves and tubes, and a disposable or reusable "patient set".

Ventilators may also be equipped with monitoring and alarm systems for patient-related parameters (e.g. pressure and flow) and ventilator function (e.g. air leakage, power failure), backup batteries, air and oxygen tanks, and remote control and alarms. The pneumatic system is nowadays often replaced by a computer-controlled turbo pump.

Here is the sample of ventilators, Figure 1 is mobile type and Figure 2 is portable type that can be used even in ambulance.

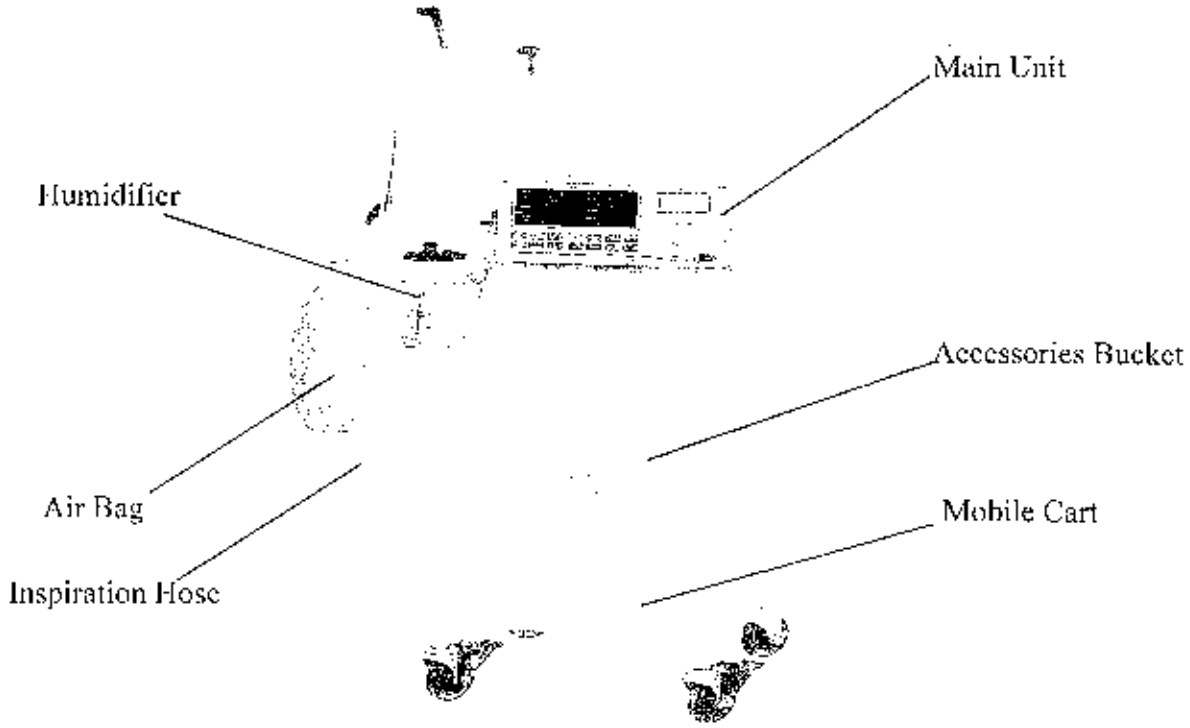


Figure1 Mobile Type

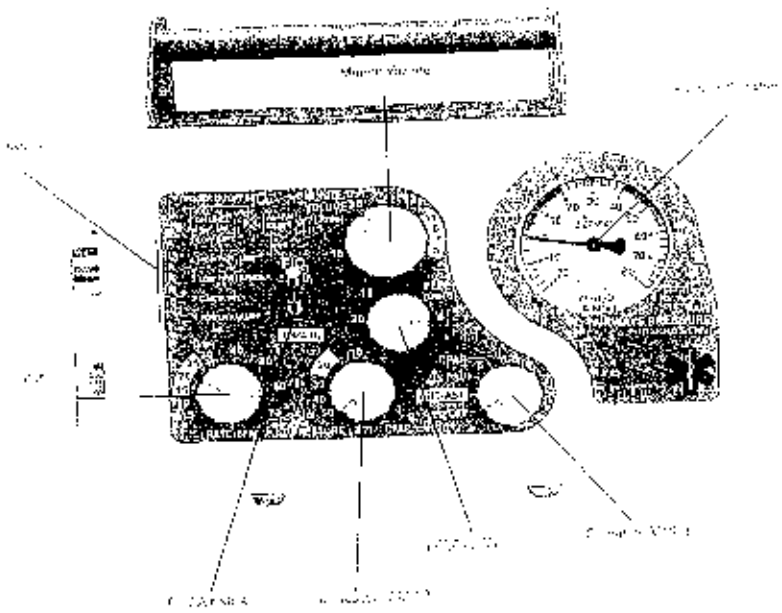


Figure2 Portable Type

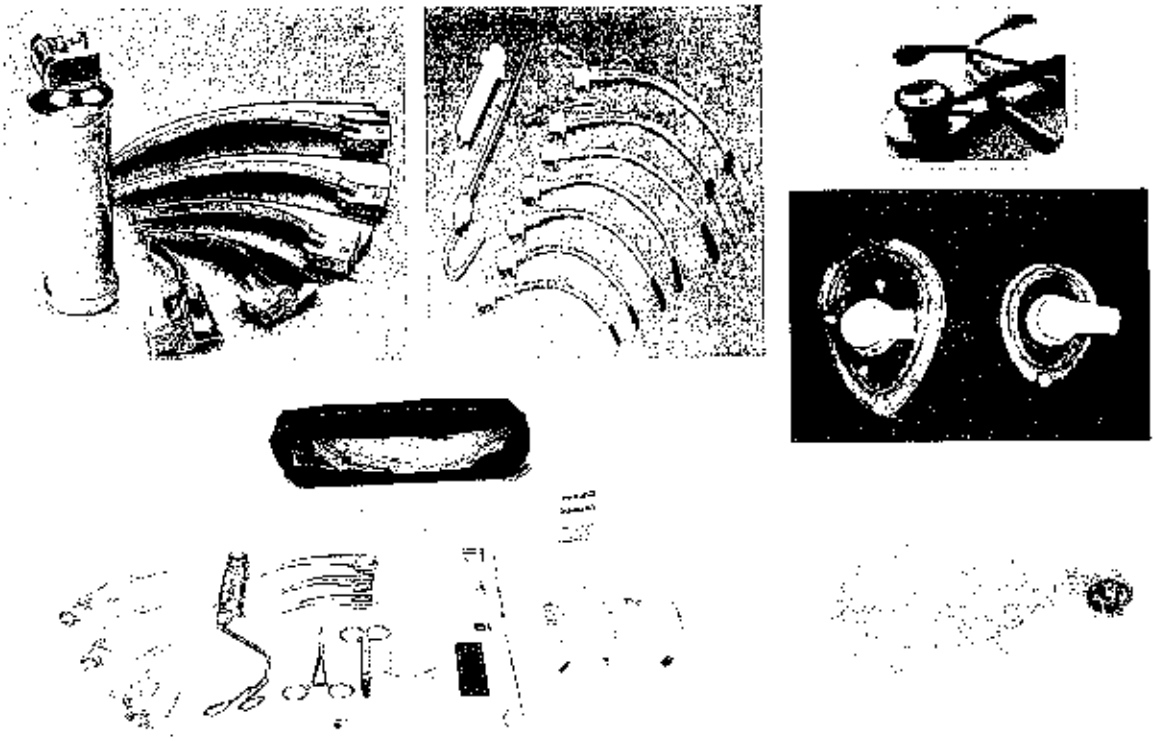


Figure 3 Accessories used with Ventilator

2. Principle of Operation

Ventilator is the process thought which oxygen and carbon dioxide are exchange between the lungs and the air. For those who cannot breathe without assistant, ventilating machine supports or manage this process.

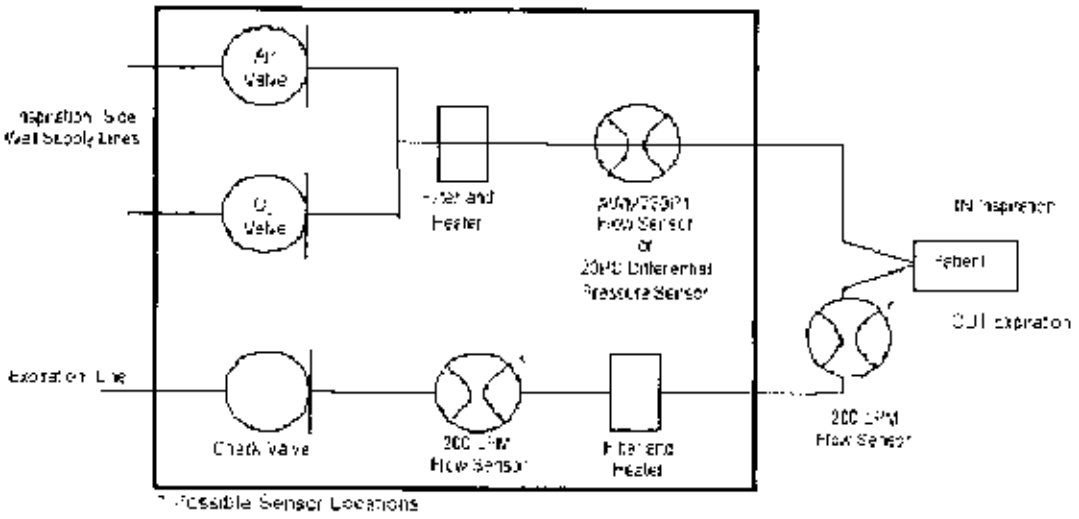


Figure 4 Block Diagram of Ventilator

Figure 4 illustrates a typical ventilator application. High pressure gases enter the ventilator and pass through an adjusting valve. The adjusting valve ensures that oxygen and the fresh air supply are combined in appropriate proportions. This mixture passes through a main flow bacterial filter. Next, the oxygen and the fresh air mixture travel through a flow sensor that measures the inspiratory gas flow.

Finally, the ventilator flow sensor sends an output signal to a signal conditioner or an analog digital converter interface that relays the signal to a microprocessor. The microprocessor compares the gas flow measurement to the preset inspiratory volume.

If the actual gas flow does not match the preset inspiratory volumes, a stepper motor opens or closes the gas check valves to adjust flow delivery.

The patient exhales oxygen and carbon dioxide that returns to the respirator or passes through an open exhalation line. At this point, there are several possible exhalation sensor, filter and heater configurations. In Figure 1, the patient's exhaled gases pass through a gas flow sensor mounted between the patient and the filter heater assembly. This sensor is optional depending on the application requirements.

Next, the patient's gas expiration travels through a heater and filter that removes

large particles and condensation. The expiration then travels through a flow sensor that measures gas flow. As in the inspiration cycle, the ventilator flow sensor sends an output signal to a signal conditioner or an analog digital converter interface that relays the signal to a microprocessor. In this instance, the microprocessor compares the gas flow measurement to the preset expiratory volumes. If actual gas flow exceeds or does not meet preset expiratory volumes, a stepper motor opens or closes the check valve.

3. General Precaution

3.1 Installation

When selecting the location to install an infant warmer, the conditions must be considering as the following:

- Power supply should be constantly 220VAC/50Hz (Standard power supply in Cambodia). If power supply voltage is not constant, automatic voltage stabilizer must bet used and included power supply back up UPS unit to prevent city electricity cut off at any times.
- The ventilator must be connected to ground to avoid electric shock.
- Do not install the unit close to flammable materials or gas.
- The room temperature and should be appropriated

3.2 Hazard

To prevent the accident and damage to equipment, patient and operator, some actions have to be taken care as following:

- Check all necessaries things to running ventilator before using
- Do not place foreign object on the ventilator or in accessory bucket
- Disconnected power supply cord to ventilator before cleaning
- Do not leave the patient unattended when using the ventilator. Check the patient's breathing regularly to ensure the comfort and the safety of the patient.
- Do not use ventilator if the system failure alarm is activated. Remove the unit from service and call for servicing.

** **The Important:** The hazards may be more than above description, so please try to learn more hazards from operation manual that it should be came with the unit.

4. Maintenance

4.1. Daily Maintenance

- Every day (morning), clean the ventilator by using soft cloth.
- The air bag, Humidifier, inspiration hose, patient mask, etc must be cleaned after using and keep them in safe and close cabinet

4.2. Monthly Maintenance

Please note that ventilator is instrument supporting life, so monthly maintenance and some function calibration must be applied by qualified engineer or technician.

The monthly maintenance and calibration procedures were advised by manufacturer and dealer is according to their equipment feature.

CODE	
EQUIPMENT NAME	Respirator
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Respirator only		
1	Check & clean display and control panel	Good / Fail	
2	Check Humidifier, Air bag & Inspiration hose	Good / Fail	
3	Check the leaking of the patient circuit	Good / Fail	
4	Check Air valve, O2 valve and expiration valve	Good / Fail	
5	Check Alarm function	Good / Fail	
6	Check & lubricate the wheel caster	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

2-6. OXYGEN CONCENTRATOR

1. Introduction

Oxygen concentrator was introduced in the mid - 1970s and have become the most convenient, reliable source of supplemental oxygen available today. Without an oxygen concentrator, the average patient would require a delivery of 12 bottles/ cylinders of oxygen each month. Your oxygen concentrator produces all the oxygen you need, with no deliveries required

The air we breathe contains approximately 21% oxygen, 78% nitrogen, and 1% other gases. In the room the unit is installed, room air passes through a regenerative adsorbent material called molecular sieve. This material separates the oxygen from the nitrogen and other gases. The result is a constant supply of concentrated high purity supplemental oxygen that is delivered to the patient.

2. Principle of Operation

Oxygen concentrator is consist 2 type differential functions.

One is adsorbent separator type and another is membrane separator type by principle of operation.

1) Adsorbent separator type

This type consists of compressor, adsorbent cylinder A (Adsorbent which the main component is consisted the almino silicate for adsorbing nitrogen from the air is filled.), Buffer tank, flow manometer and humidifier.

① Iligh concentrated oxygen could obtain continuously by repeating with following two process :

② In Figure 1, under adsorbent process, compressed room air pass to the adsorbent cylinder A, nitrogen will adsorb and oxygen concentrate. When the adsorbent saturate with nitrogen, the process will be changed to the reproducing process.

③ Obtained oxygen density decrease depends on flow rate. However, in currently model, it can obtain the concentrated oxygen more than 90% of 2~4L/min.

④ Concentrated oxygen pass through the apparatus, moisture also adsorb, thus it should connect with humidifier to inhale to patient finally.

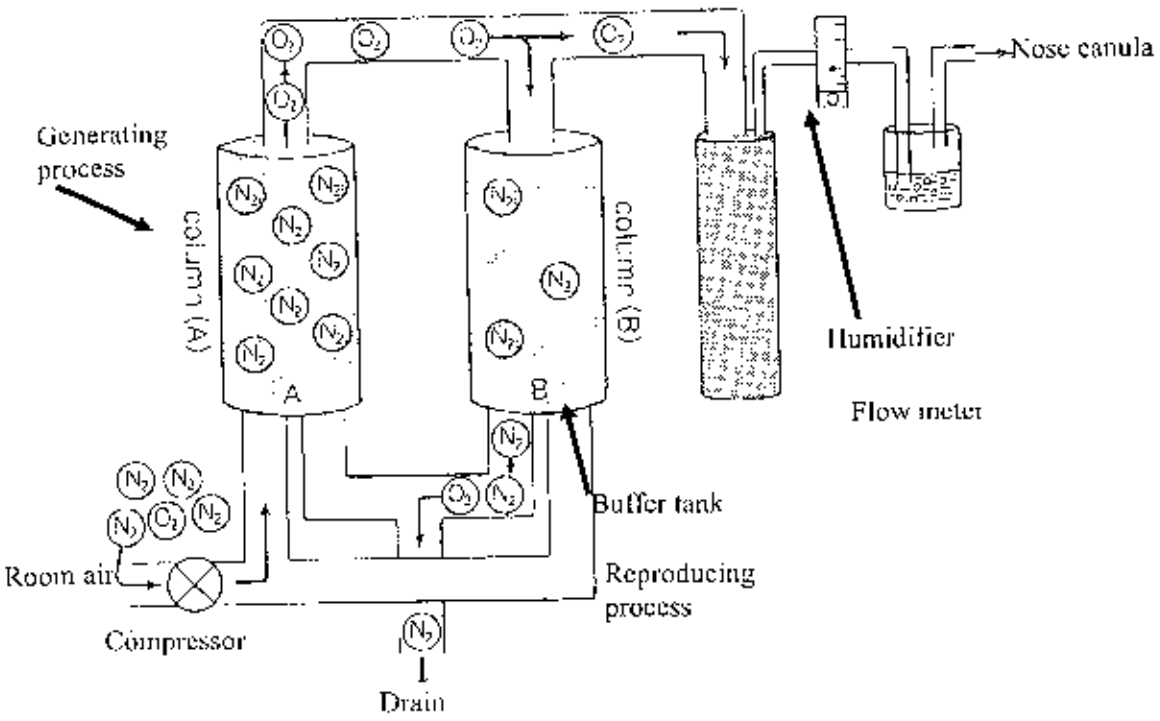


Figure 1. Principle of operation for Adsorbent separator type

2) Membrane separator type

This type consists of High polymer membrane, vacuum pump, flow meter.

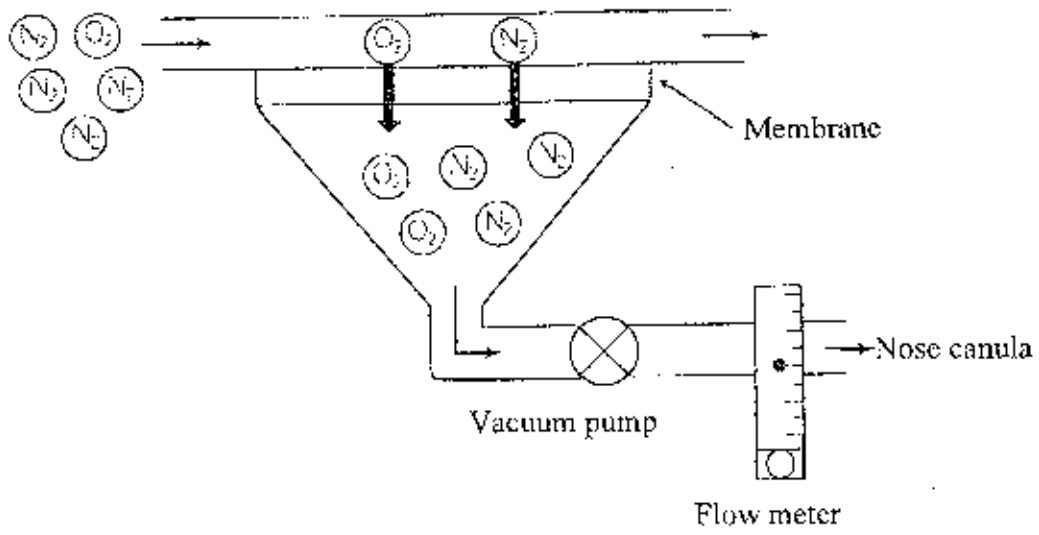
① It generates differential pressure through the high polymer membrane by vacuum pump.

② For obtaining more high concentrated oxygen, ratio of coefficient of transmission between oxygen and nitrogen must be large. Currently, the high polymer membrane which can be used for the oxygen concentrator have limit of separation coefficient, that's why we can obtain only until 40% concentrated oxygen.

③ It is no necessary through the humidifier because the membrane type

④ Transmit moisture.

Figure 2 Principle of operation for Membrane separator type



3) Comparison between adsorbent type and membrane type

Compare with adsorbent type and membrane type, we can see some different points that power consumption, oxygen concentration value and needs of humidifier.

3. General Precautions

1) Disconnect the power cord from the electrical outlet before you clean the cabinet.
2) Do not use liquid directly on the unit (Example: petroleum-based solvents or cleaning agents.
3) Do not operate the unit without the air intake gross particle filter in place.
4) Make sure the power connection for the equipment is properly connected to the ground (GND) to avoid AC noise.
5) Take care the place were the equipment installed in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, etc.

4. Maintenance

4.1 Visual Inspection

Inspect by using naked hand and eyes: loosen screws/fixed components, dirt and dust outside of the unit.

Check items:

- Dust filter
- Humidifier
- Flow meter
- Power cord and switch

4.2 Functional Inspection

1. Check and cleaning the air intake Gross Particle Filter (weekly basis).

   Following these steps to properly clean the air intake gross particle filter.

   1) Remove the filter thoroughly and remove excess water with a soft absorbent towel.
   2) Rinse the filter thoroughly and remove excess water with a soft absorbent towel.
   3) Replace the filter

2. Replace battery: When installing battery, always test for battery alarm. If alarm does not sound, battery may not be installed properly or may be defective.

3. Replace the bacteria filter every 10,000 hours use.

4. After turn ON the Switch of the unit. You must be maintained and checked following points.

   1) Function of compressor and fan (sound, smell, etc.)
   2) Backwater from humidifier to flow meter.
   3) Leakage from plumbing circuit.

CODE	
EQUIPMENT NAME	Oxygen Concentrator
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Oxygen concentrator only		
1	Check & record to read the hour meter	Good / Fail	
2	Check & function of Power failure alarm	Good / Fail	
3	Replace battery	Good / Fail	
4	Check & wash Gross Particle Filter	Good / Fail	
5	Check & replace the Bacteria filter	Good / Fail	
6	Check & replace the battery (If it equipped with)	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

2-7. NEBULIZER

1. Introduction

Ultrasound Nebulizer is used for the inhalation treatment of asthma, fit, bronchitis and artificial respirations.

The vibrating plate moves 1.4MHz, and it makes mist of medicine or water. This mist is sent to trachea approximate 5ml per minutes by hose.

2. Principle of Operation

Structure and principle of Ultrasonic Nebulizer is shown in Figure 1.

※ **Structure**

1) Ultrasonic oscillation unit
   This unit generates electrical output power for producing the ultrasonic oscillation.

2) Crystal oscillator
   It converts from electrical output power where was generated in the Ultrasonic oscillation unit to ultrasonic oscillation.

3) Water chamber
   It conduct the ultrasonic oscillation where was generated at the oscillator to the diaphragm through water.

4) Diaphragm
   The ultrasonic oscillation which was conducted in the diaphragm vibrates sterilized water for 1.5 ~ 2.0 million times / second. And the water will be produced to aerosol.

5) Aerosol chamber
   For put the sterilized water of making aerosol.

6) Ventilation fan
   Aerosol should send to patient's trachea or respirator tube circuit.

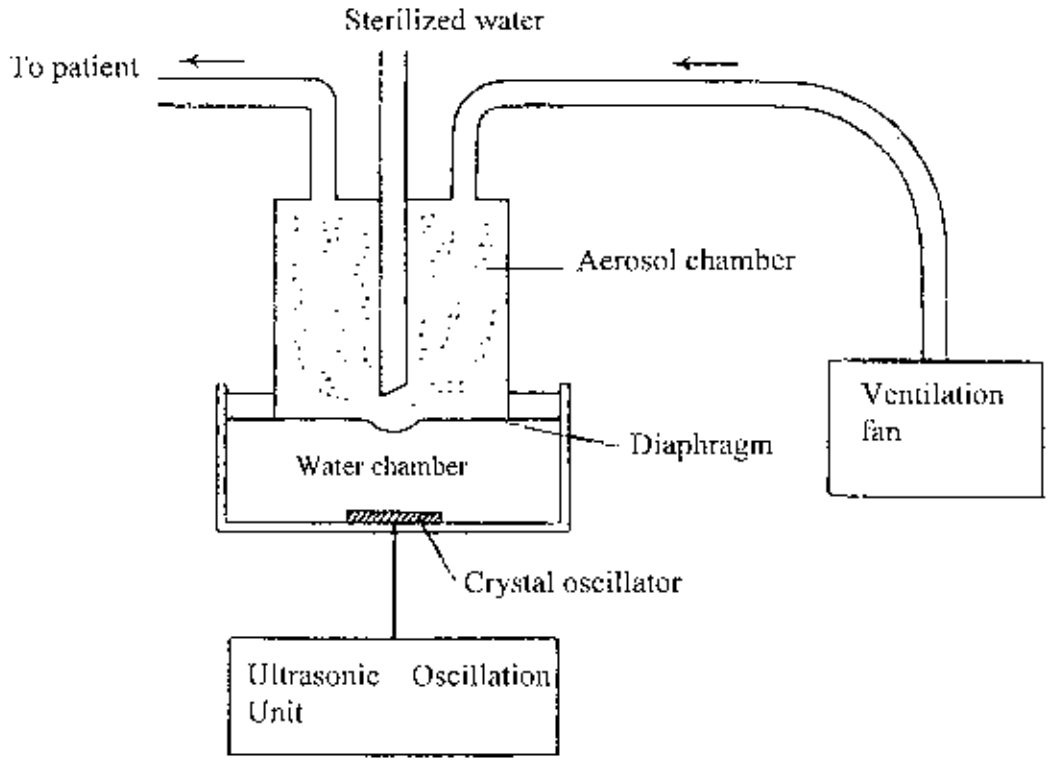


Figure 1. Basic Structure diagram of Ultrasonic Nebulizer

Table 1. Main performance of Ultrasonic nebulizer

Ultrasonic frequency	1.5~1.7 MHz
Ultrasonic output	20~30 W
Nebulizing capacity	0~6 ml/min
Particles size	1~5 μm
Ventilation rate	0~30 l/min
Alarm function	Water level alarm

3. General precaution

1) Make sure the power connection for the equipment is properly connected to the ground (GND) to avoid AC noise.
2) Take care the place were the equipment installed in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, etc.
3) Take care when the diaphragm fix with some oil or soap, it will be caused of malfunction of nebulizing process.

4) Do not pour or drop water inside of the main unit, also do not operate with wet hand, it will be caused of electric shock.
5) To use the unit, make sure the position of place, lower than the patient place always, because it is possible to flow the backwater.
6) Do not keep water or liquid medicine away for long term because it is cause of breeding of bacteria.
7) Clog of the fan filter will decrease ventilation flow, thus during regular maintenance always check and clean.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. Visual inspection list for Ultrasonic Nebulizer

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body
2.Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Patient tube circuit	- Injured/broken conductor/wire and cable insulation - Stain, twist and hardness of insulation of cable or conductor
5. Acrosol chamber and diaphragm	- Cracked/broken connectors - Bent/cracked connector's pins - Smooth movement between male and female contact - Gripping force of connectors
6. Ventilation filter	- Cracked/broken - Fixed with dirt/dust. - Clean it with clean water and dry well.
7. Status of water condition into the water chamber	- If remaining contaminated water into the chamber, throw it and clean and dry the chamber well.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell? - Adjust flow volume properly?
3. Check with fill up the distilled water into the water chamber	- Does exist any leakage of water in any place? - Does activate water level alarm? - Does operate the crystal oscillator?
4. Check with fill up the sterilized water into the aerosol chamber	- Does exist any leakage of some liquid or solution?
5. Check nebulizing function	- Does activate nebulizing function? - Adjust to control the nebulizing volume?

CODE	
EQUIPMENT NAME	Nebulizer
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Nebulizer only		
1	Check water leakage from some joint of water drainage	Good / Fail	
2	Check & clean the water & aerosol chamber	Good / Fail	
3	Check & clean diaphragm	Good / Fail	
4	Check & replace silicon gasket.	Good / Fail	
5	Check & clean Crystal oscillator	Good / Fail	
6	Check & clean the ventilation filter	Good / Fail	
7	Check function of the ventilation fan	Good / Fail	
8	Check nebulizing function	Good / Fail	

REMARKS

Date inspected	/	/ 2006	Inspector	
Room Temp.		℃	Approved by	

2-8. INFUSION PUMP

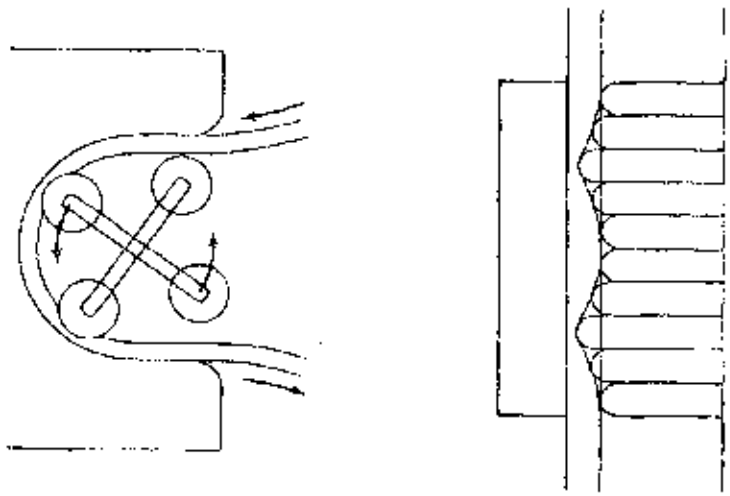
1. Introduction

Infusion pump is the installation to infuse particle medicine constantly. By using the mechanical pump, it is able to infuse more correct amount of medicine than using just by free fall.

2. Principle of Operation

Infusion pumps can be classified three types by its mechanism; 1) finger types, 2) roller types, 3) piston types. Figure1 shows the simple structure of roller pump types and finger pump types.

Figure 1. Structure of pumping type for Infusion pump



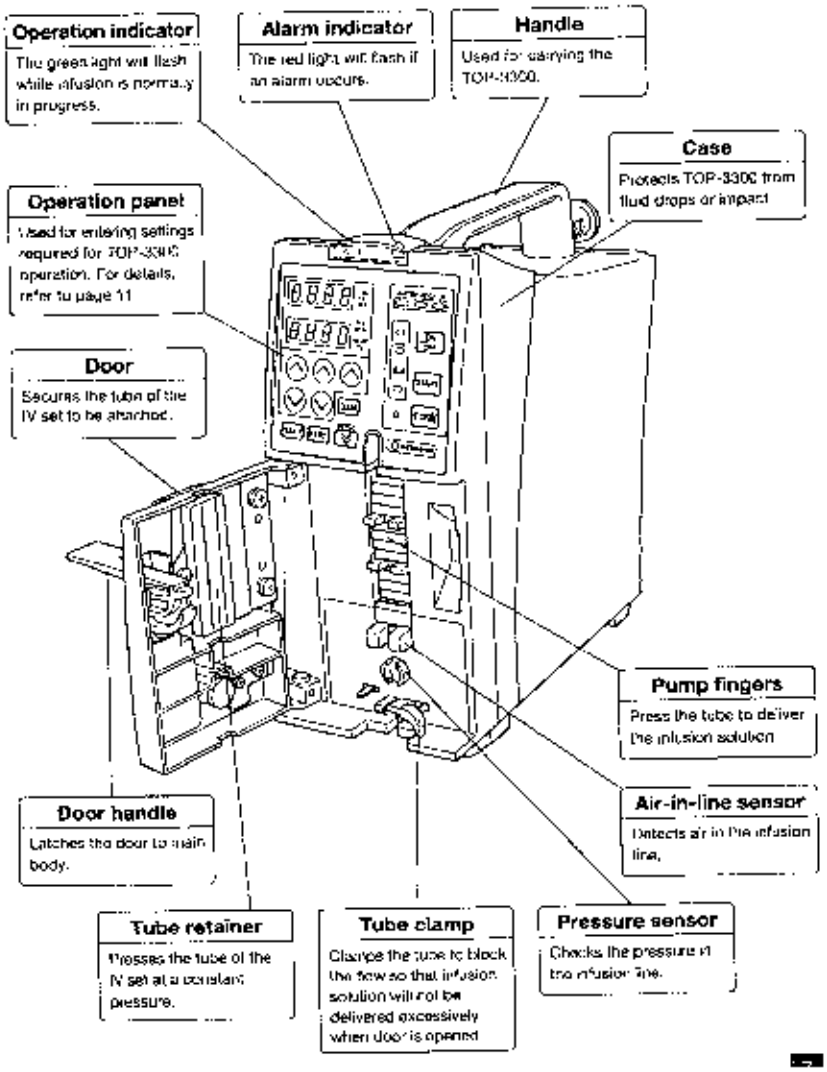
Roller pump type　　Finger pump type

In generally, finger types infusion pumps are more frequently used. The mechanism of finger types infusion pump is as follows;

1) It is consisted by several round rods, and they are lined up like fingers
2) These rods push the tube one by one, and send medicine constantly

The descriptions of whole parts of finger types of infusion pumps are as follows (Figure 2).

Figure 2. Example of Structure drawing for Infusion pump (Finger type pump)



3. General precaution

1) Make sure the power connection for the equipment is properly connected to the ground (GND) to avoid AC noise.
2) Take care the place were the equipment installed in an environment; it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, etc.
3) Do not pour or drop water inside of the main unit, also do not operate with wet hand, it will be caused of electric shock, also, equipment broken easily.
4) Do not keep protein precipitates on the equipment for long term, it will be cause of damage of function and contamination. Therefore, you should always clean the machine, especially should take them away.

5) For using of infusion set, take care to select it properly, otherwise infusion volume and time will be malfunction.

6) Disconnect the power cord from the electrical outlet before you clean the equipment.

4. Maintenance and check

4.1 Visual Inspection

This inspection should be carried out at least once in every six months. Recommended items in this inspection are shown in Table 1.

Table 1. Visual inspection list for Infusion pump

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body
2.Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Pump fingers place	- Check well if it fixed some liquid blood protein precipitates and dirt. - Clean always this place.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for Infusion pump

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check the door handle	- Latch the door smoothly? - Secure the infusion tube correctly.
4. Check the battery function	- Battery charging. - Main unit operate with the battery properly. - Count the working hour of the battery.
5. Check each alarm functions	- Door open alarm - Occlusion alarm - Air-in line alarm
6. Check total performance	- Infusion flow rate - Infusion volume - Infusion time

※ Special note for maintenance of battery performance

To ensure proper performance of the battery, perform battery operation to depletion once every month until infusion is automatically stopped and refresh the battery. When the refresh operation is completed, recharge the battery for over 24 hours for next use.

CODE	
EQUIPMENT NAME	Infusion pump
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Infusion pump only		
1	Check & clean the finger pump	Good / Fail	
2	Check function of the door handle	Good / Fail	
3	Check the battery function	Good / Fail	
4	Check activation of the alarm function	Good / Fail	
5	Check total performance	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

3-1. ANESTHESIA APPARATUS

1. Introduction

Anesthesia apparatuses basically have functions that give inhalation of anesthetic gas and oxygen in accurate concentrations to the patient, and remove carbonic acid gas from exhalation gas. Because this apparatus is used for life support, even apparently minor technical defects seriously affect the safety of the patient. The maintenance carried out on regular basis is, therefore, extremely essential.

In Cambodia, there is very few agents having the technical service for such critical care equipment and also it is difficult to find emergency or contract out services offered by manufacturers. Whatever the situation, in-house work should be carried out to at least the standard set by the manufacturer.

Most manufacturers recommended servicing at three months intervals. This interval is a fair compromise between maintaining the apparatus in a safe condition and keeping the servicing costs or the commitment of the in-house team within reason.

Figurers 1, 2, 3 and 4 show the name of each part of this apparatus. Anesthesia apparatus is made up of two parts, i.e., breathing circuit and piping circuit inside of the apparatus. In addition, safety devices are also equipped in the apparatus.

2. Principle of Operation

N_2O gas from N_2O cylinder is supplied to N_2O stop valve 3 while the pressure is indicated on N_2O pressure gauge 32 and reduced to 2.5 kg/cm^{2}G by reducing valve 31.

N_2O gas supplied from the central piping will advance in the same manner as mentioned above.

In this status, N_2O gas reaches N_2O stop valve 3, but not N_2O flow rate control valve 4B. N_2O gas is not supplied to N_2O flow rate control valve 4B until O_2 gas of 1.3 kg/m^{2}G or more is supplied to N_2O stop valve 3 as described below.

O_2 gas, on the other hand, when supplied from O_2 cylinder, advances toward pressure switch for oxygen supply pressure alarm 45 while its pressure is indicated on oxygen pressure gauge 33 and reduced to 2.5 kg/cm^{2}G by reducing valve 30. O_2 gas supplied from the central piping will also advance toward pressure switch for oxygen supply pressure alarm 45 in the same manner as mentioned above.

※ ***Pressure switch for oxygen supply pressure alarm***

This switch gives an audible alarm, when the secondary pressure from O_2 cylinder or supply pressure from the central piping falls to 2 kg/cm^{2}G or less.

O_2 gas passed through the pressure switch for oxygen supply pressure alarm 45 is supplied to flow detector 10.

3. General precaution

1) This equipment is not explosion proof. Do not use in the presence of any flammable to spark, it will occur serious accident.
2) This equipment is not drip proof. Do not use in an environment that is exposed to water or some liquid surrounding equipment place.
3) Keep the equipment stable and avoid tilting vibration and shock as mch as possible, even during transport.
4) Take care the place where the equipment installed in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust and etc.
5) Make sure the power system for the equipment is properly connected to the ground.

4. Maintenance and check

4.1 Visual Inspection

1) Check for obvious signs of damage to the machine frame such as distortion or dents. Make sure the castors are firmly secured and rotate properly. All four should be in contact with the floor when the machine is placed on a level surface. Check for proper function of brakes.

2) Look for signs of damage to each part of the machine in turn including back bar assembly, flow meter and pressure gauges, pressure regulators, vaporizer, oxygen supply pressure alarm and any other accessory such as a carbon dioxide absorber.

3) Examine the integrity of the fixed pipe work including that under the instrument tray.

4) Check for deterioration of rubber and plastic items such as reservoir bags, anesthetic hoses and fittings.

Gas supply

1) Make sure the cylinder yokes are in good condition and that the appropriate pin index system is fitted to each gas supply. Examine the pins for freedom from distortion and for the condition of the good seal. Make sure the cylinder clamp operates smoothly.

2) Check the pipeline hoses assemblies for correct color coding and that the appropriate probe is fitted. Make sure the probe is undamaged and that the hose is securely attached.

4.2 Function Tests

1) Turn on each cylinder in turn and check for smooth action of the pointer on pressure gauges.

2) Make sure the pointer on pressure gauges returns to zero when the gas supply is turned off and the machine vented. If a pipeline supply is being used make sure the indicated pressure is within specifications. Values for each gas are given in Hospital Technical Memorandum. Ensure that connecting the oxygen probe correctly fits the pipeline hoses and check that only the oxygen rotameter bobbin raises. Repeat this test for the nitrous oxide supply.

3) Turn on each gas supply in turn ensuring that there is flow through the appropriate rotameter and that no other rotameter indicates flow.

4) Check that the machine can deliver its maximum specified flow as indicated by the rotameter bobbin. If it does not, then check for blocked filters. Make sure the float in the rotameter remains stable at its set position spins and rises and falls freely throughout its range.

Oxygen supply pressure alarm

1) Check the correct function of this by turning off the supply of oxygen and observing the pressure at which the alarm starts to sound. Continue decreasing the pressure and observe the pressure reading at which the alarm is interrupted. Consult the manufacturer's specification for the correct values.
2) Check that if an inspiratory air whistle is fitted it operates properly. This can be done by inflating the reservoir bag and gently squeezing it with the

patient outlet connection on the machine occluded. Refer to manufacturer's instructions for the specified test procedure.

3) Excessive pressure indicates malfunction of the oxygen failure alarm or blockage of the pipe work.

Oxygen emergency flush

1) Check that an adequate supply as specified by the manufacturer is being delivered. On some machines timing the inflating of the reservoir bag can do this. Use either a Douglas bag or other flow-measuring device.

2) Make sure the button operates smoothly and that the oxygen supply is cut off when the button is released. If a locking mechanism is fitted make sure it works properly.

Pressure relief valve

Make sure the valve operates at its correct preset pressure normally with the aid of a mercury sphygmomanometer or other suitable gauge. Carry out detailed leakage tests on this only if the machine fails the overall leakage test specified next.

Leak test

Refer to the requirements in the appropriate service manual for the relevant test procedure. Normally a suitable manometer is plugged into the patient outlet connection on the machine and the oxygen rotameter adjusted to produce a specified pressure. The leakage rate can then be read directly from the rotameter. A maximum allowable rate is usually specified. The test is usually carried out with the vaporizer turned off.

Carbon dioxide absorber

Make sure the absorber is correctly assembled. Check for the correct color and condition of the soda lime and if necessary has it replaced. Occlude the patient outlet in the anesthetic machine, partially inflate the reservoir bag and check for correct operation of the spill valve by gently squeezing the reservoir bag.

Breathing circuit

Make sure the expiratory valve functions and that all taper connectors are undamaged. Check for deterioration of rubber and plastic components.

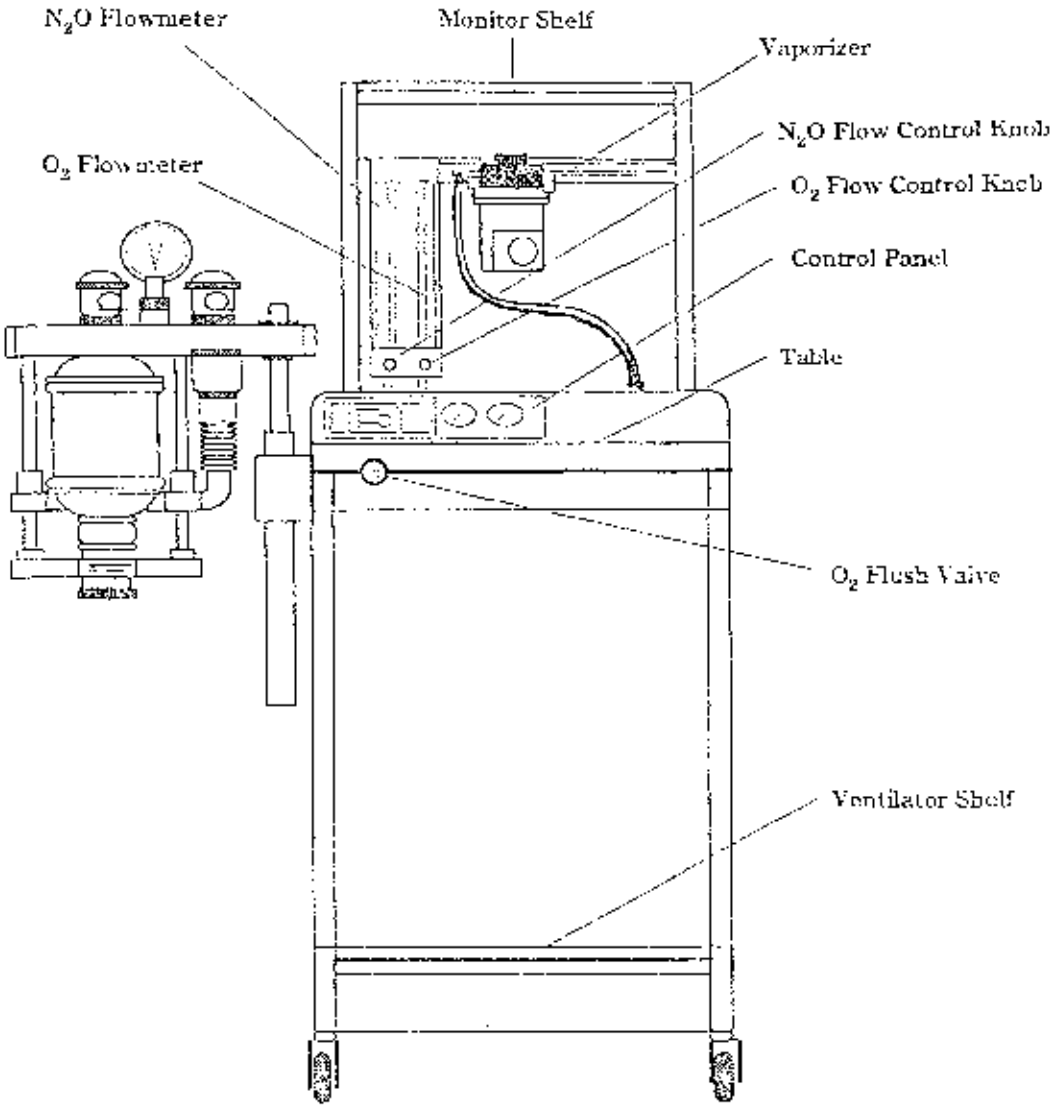


Figure 1. Name of each part in front view

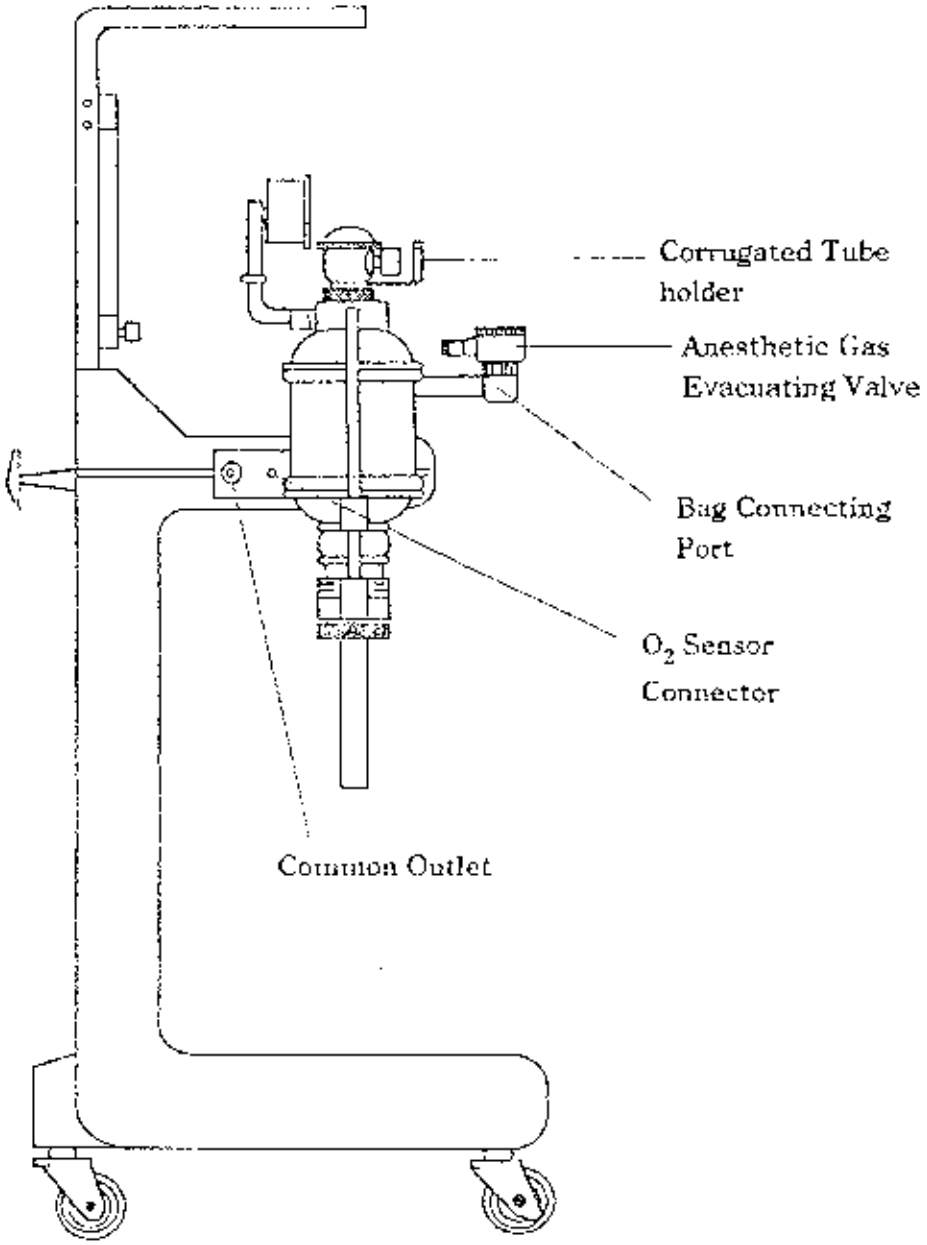


Figure 2. Name of each part in side view

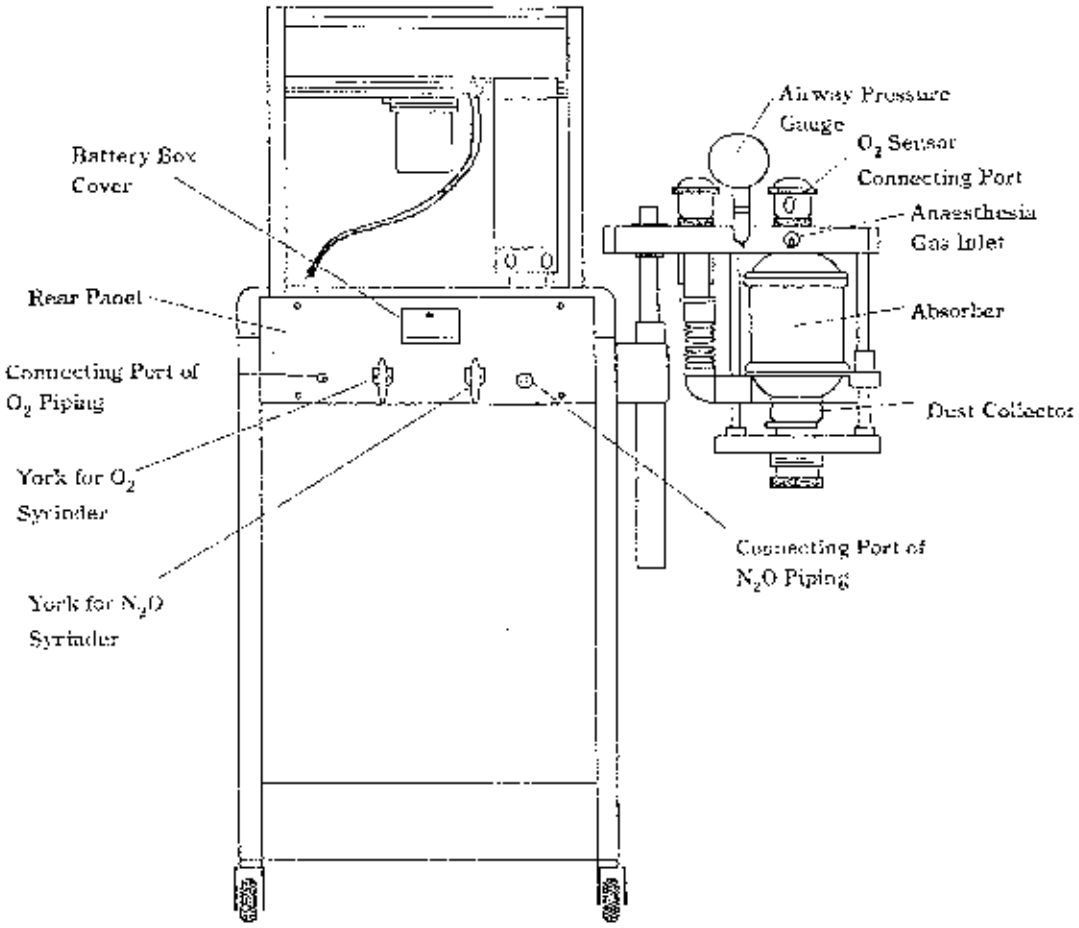


Figure 3. Name of each part in rear view

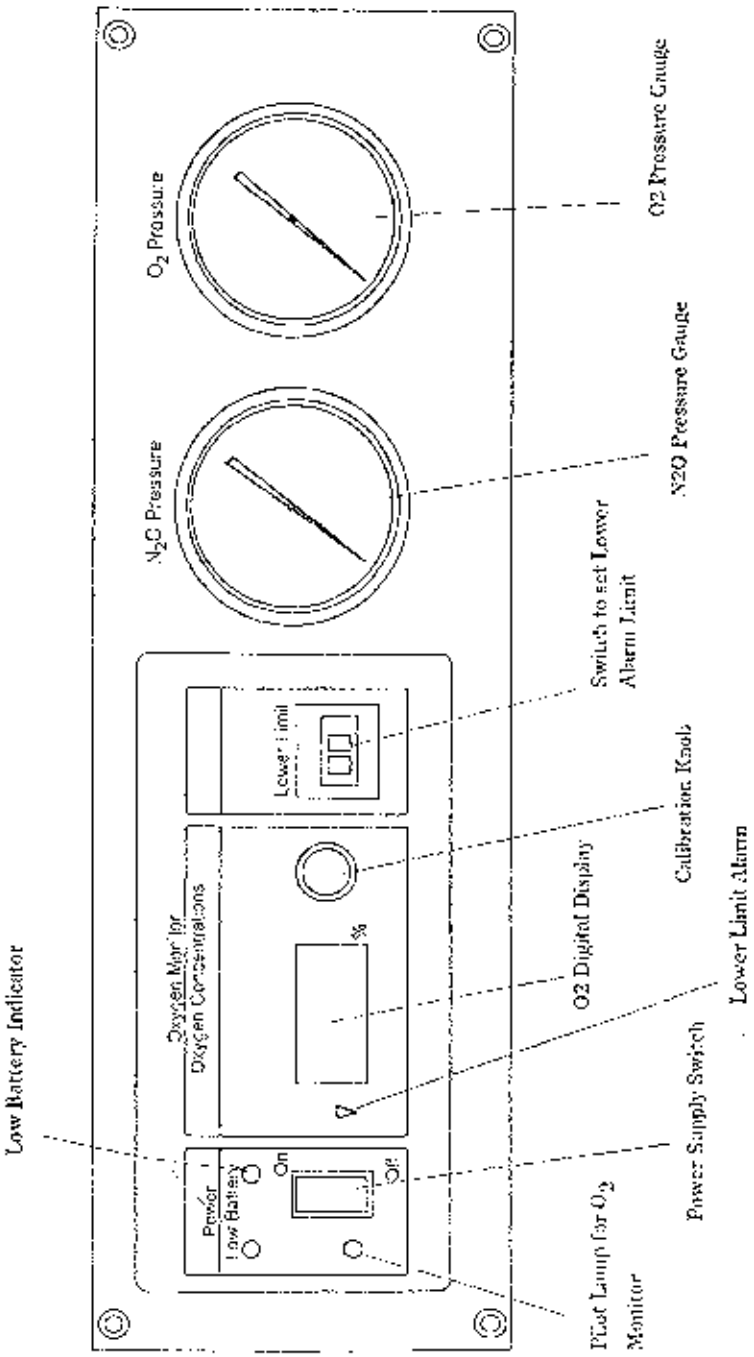


Figure 4. Name of each part of Control panel

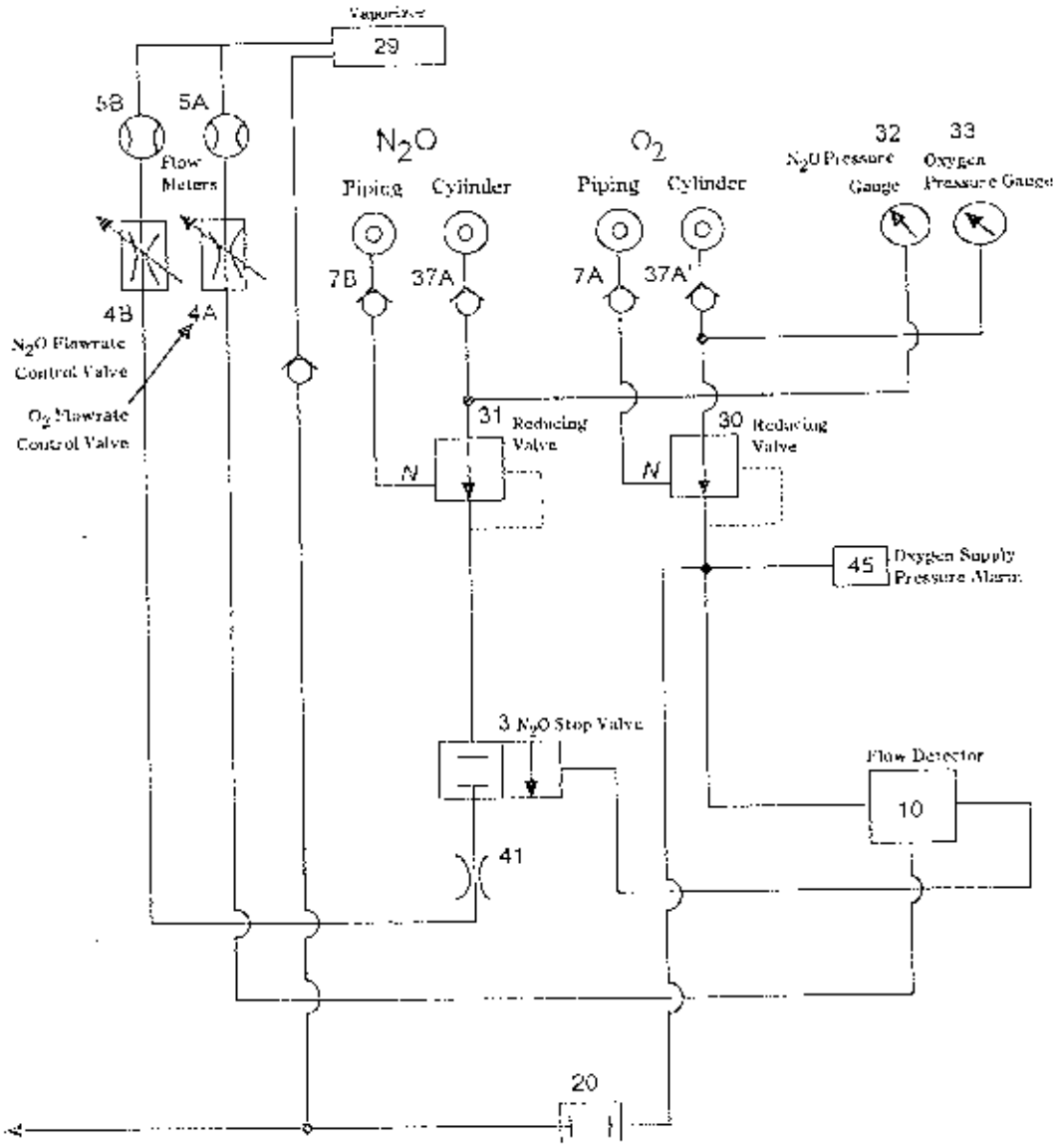


Figure 5. Example of Anesthesia apparatus Gas circuit

CODE	
EQUIPMENT NAME	Anesthesia apparatus
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Anesthesia apparatus only		
1	Check rubber & plastic items (reservoir bags, anesthesia hose, etc.)	Good / Fail	
2	Check piping hose leakage	Good / Fail	
3	Check Oxygen supply pressure alarm	Good / Fail	
4	Check Oxygen emergency flush	Good / Fail	
5	Check & pressure relief valve	Good / Fail	
6	Check Leak test	Good / Fail	
7	Check & replace Carbon dioxide absorber	Good / Fail	
8	Check Breathing circuit	Good / Fail	
9	Check & lubricate the wheel caster	Good / Fail	

REMARKS				
Date inspected	/	/ 2006	Inspector	
Room Temp.		℃	Approved by	

3-2. ELECTRO-SURGICAL UNIT

1. Introduction

Electro-surgical units are indispensable to modern surgical procedures. The contributions they have made in various kinds of operations are quite enormous. However, since the unit gives high energy on the human body, sufficient understanding and correct handling are most important.

In general, electro-surgical units apply the floating circuit with employing other special safety circuits in order to guarantee quite high level of safety for the patient, operator and surroundings. The output circuit of the units is insulated from the ground and a filter capacitor to eliminate low frequency current is incorporated both in the blade and patient circuit. A filter grounding output circuit is designed to ground the high frequency current with high impedance. In addition, the unit is designed to comply with the international safety requirements for medical equipment, IEC 601-1.

※ Basic Structure

Electro-surgical units are mainly composed of three devices as follows:

➢ **Main Body** (See Figure 1)

The main body is a high frequency generator in the range of 300 kHz - 1 MHz, and designed in the following specifications:

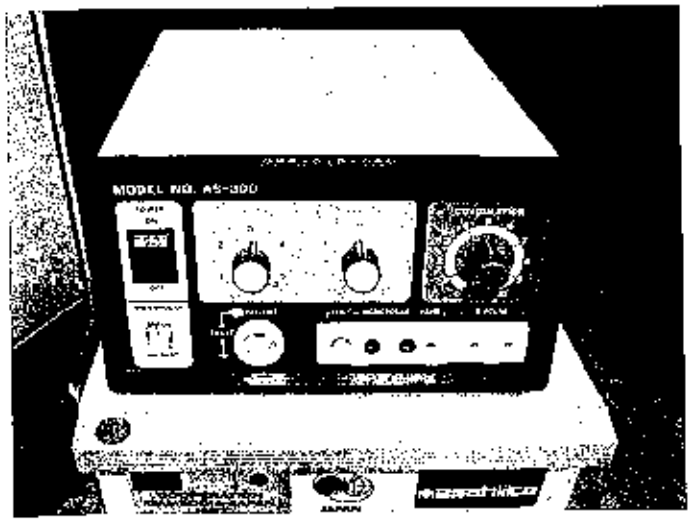


Figure 1 *The main body of an electro-surgical unit*

- Maximum power output: Cutting 200 - 400 W
  Coagulation 100 - 200W
- Load resistance: 200 - 1000 Ω (500 Ω norm)
- Output form: Mono-polar and Bipolar
- Safety monitoring system: e.g., patient plate cord in open circuit

As the electrical threshold value of human body against high frequency is low, high frequency current does not give any affects of electrical shock. For this reason, the high frequency can be used as energy without electrical shock hazard.

➢ **Electrode Tip**

This is electrode that gives actions of incision and coagulation, called the active electrode, as high frequency current run into living body. There are various types of tips are available according to the purpose for use as shown in Figure 2. In general, mono-polar type as one action type is used. Tweezers type of electrode that runs the current only on pinched minute point, called bipolar type (two electrodes type) is used for microsurgery.

The electrode tip is used with a holder having switches, called the hand-controlled type, as shown in Figure 3. In case of older that switches are not equipped, foot switch is used instead.

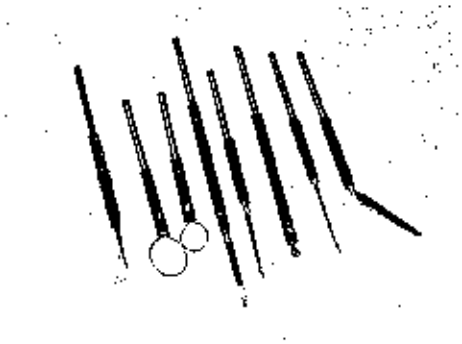


***Figure** 2 Various electrodes as mono-polar types*

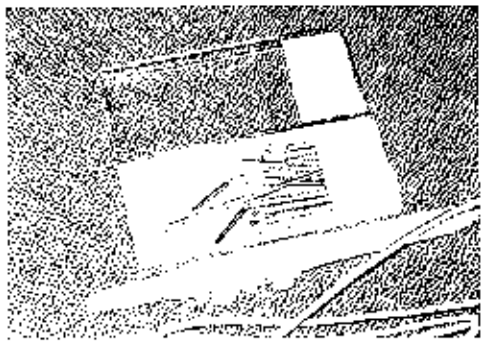


***Figure** 3 An blade holder with switches*

➢ **Patient Plate** (See Figure 4)

The patient plate (or diffusion plate) having wide square measure collect safely the high frequency current that finished the electro-surgery with low current density. Recently, disposable type patient plate that is flexible and adhesive is being used instead of reusable type patient palate made of lead or stainless steel.

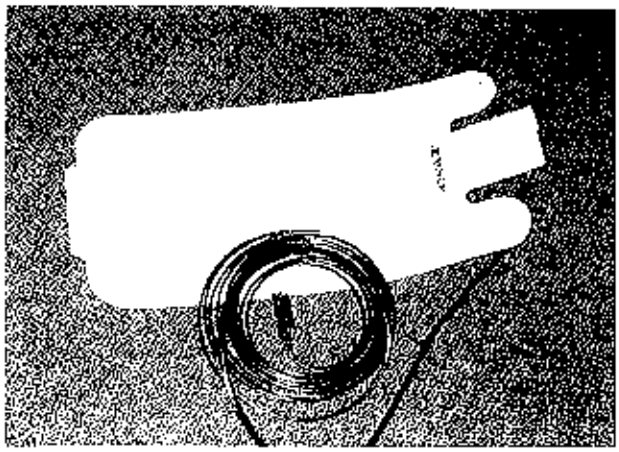


***Figure 4** A disposable type patient plate*

2. Principle of operation

2.1 Cutting Mode

High frequency current (energy) concentrates and flows from the scalpel tip into the living body, and the current flows in the living body spreading itself, and then it is collected by the patient plate as shown in Figure 5. The scalpel tip contacts with the living body striking sparks of less than 1 mm diameter. Resistance at the contact point is about 200 - 1000 Ω.

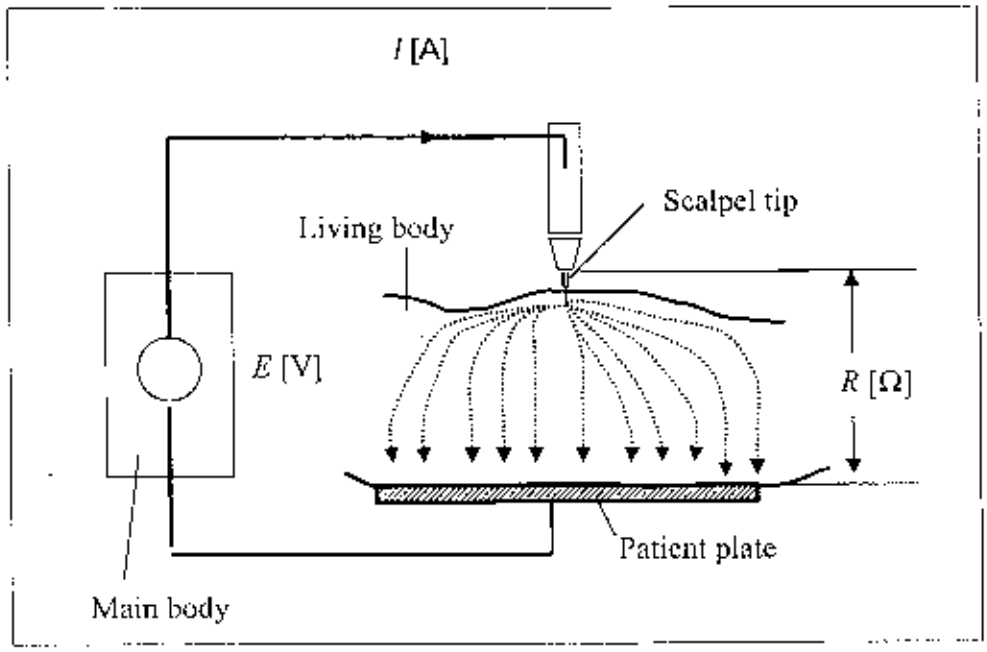


***Figure 5** Basic principle of electro-scalpel*

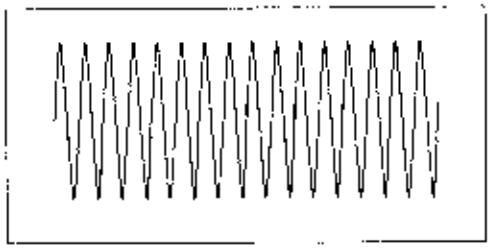


Figure 6 *Continuous sine wave for incision function*

Where the resistance of the contact point is 500 Ω and 1 A of high frequency current flows into it, the quantity of heart is generated in t seconds as follows:

$$H = I^2Rt = 500t \text{ (J)}$$

Such energy is able to explode living cells into steam, called the steam explosion. This is the Cutting Mode of electro-scalpel. In general, continuous sine wave is applied to make the incision function as shown in Figure 6.

2.2 Coagulation Mode

If the current is intermittently turned of and on in short time, the heat is not continuously generated. This, therefore, does not make up of steam explosion, generating just a high temperature of less than 100 °C. As a result of this temperature, protein and blood coagulate. This is called the Coagulation Mode. Burst wave is applied to make the coagulation of electro-scalpel as shown in Figure 7.

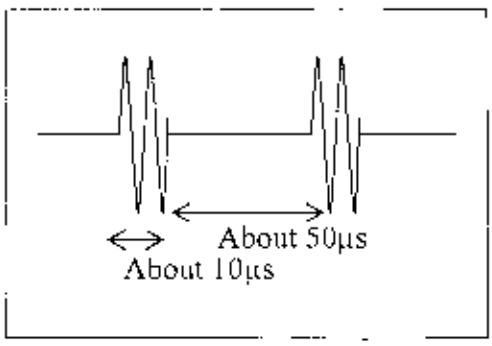


Figure 7 *Burst wave for use on coagulation function*

2.3 Blend Mode

This is combination waveform that has two modes coagulating and cutting the living body, called the blend mode.

3. General precaution

Since the electro-surgical unit gives high energy on the living body, correct handling is strongly required. Hazards caused by electro-surgical unit are shown in Table 1.

Table 1 Hazards caused by electro-surgical units

NAME OF HAZARD	CONTENT
Electrical shock	Micro-shock, Gross-shock, Second hazards caused by electrical shock
Burns	Concentration of current at electrode, High frequency wave shunt current
Explosion	Inflammable anesthetic gases, Operation under high concentration oxygen environment
Interference	interference to monitor, Interference to pace-maker implanted, interference to digital equipment

3.1 Electrical Shock Hazard

Leakage current of low frequency could cause of an electrical shock to the patient. Although a floating circuit type of electro-surgical unit assures quite high level of safety of the patient (Class I Equipment), most careful attention must be paid for this problem. To avoid the problem, confirm that the earth cord is correctly grounded.

On the other hand, spark is generated on the contact point of scalpel tip. This means that high frequency current (AC) is rectified to pulsed DC with low frequency factor. Due to this, electrical shock possibly takes place. Although hundreds and several thousand pF of a capacitor connecting to the output circuit of electro-surgical units intercepts such electrical shock, most careful attention must be paid for this problem.

3.2 Burns

Burns could take place in various reasons as follows:

a) Burns at patient plate: The skin to which a patient plate is attached sometimes suffers burns. It could occur in the case of partial contact of a patient plate to the patient. This will cause flow of high density.

b) Burns through electrodes of other medical electrical equipment connected to the patient; Electric shunting current could flow through electrodes of

other medical electrical equipment connected to the patient.

c) Burns to be caused a portion of the patient body touches or approaches a metallic portion of equipment: The electric shunting could occur when a portion of the patient body touches the chassis of electro-surgical unit, metallic portion of an operating table or other equipment.

d) Burns to be caused by mutual contact of some portions of the patient: When the patient's limbs touch each other or to the body at a small area, electric shunting current possibly could flow.

e) Burns through surgical instruments or treatment instruments: When performing an operation with forcipes or other metallic instruments, there is a possibly that electric shunting current flows through a pinhole of the operator's surgical gloves to the instruments. Also electric shunting current could flow through an endoscope, temperature probes, a cardiac pacemaker electrodes, etc.

f) Burns by blade holder and patient plate: Burns could occur when a hand controlled blade holder cord or patient plate cord is too long.

g) Burns caused by incorrect handling: For a floating type electro-surgical unit, the most careful attention must be paid when a mono-polar mode is used since the output power is quite large.

3.3 Explosion

Under no circumstances should an electro-surgical unit be used where explosive gases exist. Note that there is a possibly that alcohol applied on the patient skin may become ignited by sparks emitted by an electro-surgical unit.

3.4 Noise Interference

The use of an electro-surgical unit could cause of noise to monitoring equipment. Some noise eliminating parts should be installed to the equipment if necessary.

3.5 Accident Caused by Simultaneous Use with Other Equipment

Technical study must be made among the staff members when simultaneous use of an electro-surgical unit with other medical electrical equipment is required.

4. Maintenance

4.1 Sterilization

Requirements for sterilization of parts of electro-surgical units are shown in Table 2.

Table 2 Requirements for sterilization of parts of electro-surgical units

NAME OF PART	STERILIZATION REQUIREMENTS
1) Blade	Autoclave (1.0 - 2 kg/cm) 121 -132℃
2) Electrode plate with cord	Usually not required. For the patient with infectious diseases----E.O.Gas (preferable), boiling, hormalin
3) Hand controlled blade holder	E.O.Gas (preferable), boiling, hormalin
4) Earth cord	Not required
5) Power cord	Not required
6) Foot switch	Not required
7) Bipolar pincette	Autoclave
8) Bipolar cord	E.O.Gas (preferable), boiling, hormalin
9) Bipolar foot switch	Not required
10) Suction electrode	Boiling, Autoclave
11) Extension adaptor	Boiling, Autoclave

4.2 Visual Inspection

The following items are recommended to be inspected at least once every three months:

1) Mains cable, Mains plug
2) mains fuse
3) Foot switch cord
4) Probe electrode with connector
5) patient plate
6) patient plate jelly
7) Patient plate cord with connector
8) electrode holder
9) Hand control switch
10) Knob, Switch
11) Meter indicator
12) Indicating lamp
13) Sound (tone, intensity)

4.3 Electrical Safety Checks

The following checks are recommended to be inspected at least once every six months:

1) Earth conductor resistance
2) Resistance of patient plate cord
3) Patient safety monitoring circuit

4.4 Electrical Functional Inspection

The following items are recommended to be inspected at least once every six months:

1) CUT output
2) COAG output
3) BIPOLAR output
4) Current waveform

CODE	
EQUIPMENT NAME	Electro-Surgical unit
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Electro Surgical unit only		
1	Check & clean the foot switch cord	Good / Fail	
2	Check & clean Patient plate cord with connector	Good / Fail	
3	Check & clean Surgical electrode holder	Good / Fail	
4	Check function of cut & coagulate knob	Good / Fail	
5	Check electrical cut performance with wet soap	Good / Fail	
6	Check electrical coagulate performance with wet soap	Good / Fail	
7	Check Alarm function test (disconnecting patient plate)	Good / Fail	
8	Check function of indicator or meter	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

3-3. SUCTION UNIT

1. Introduction

Suction Units are used on sucking secretions such as pus, exudates and washings as well as blood bled in surgical operation. In addition, it is also used for sucking blood/secretion/vomit inside of oral cavity, and also blood/secretion inside of trachea. Moreover, the suction unit is indispensable equipment in case of resuscitating the respiratory tract in emergency as well as anesthetize and treatment after techeotomy.

Suction units are composed of negative pressure generating source, pressure controller and suctioned stuff storage part. According to the deference of negative pressure generating source, the suction units could be classified into three categories, i.e., electric type suction unit, wall type suction unit and foot stamping suction unit.

2. Principle of Operation

An electric motor with suction pump is applied as negative pressure generating source (See Figure 1). The suction pump is classified into three types, i.e., rotary pump, diaphragm pump and cylinder pump.

Figure 2 shows the suction flow diagram of the unit. When switched on, the motor pump starts generating negative pressure. The negative pressure is controlled by the reducing valve and its value monitored by the pressure gauge. Suctioned stuff coming from the patient is collected by the external suction bottle without overflow.

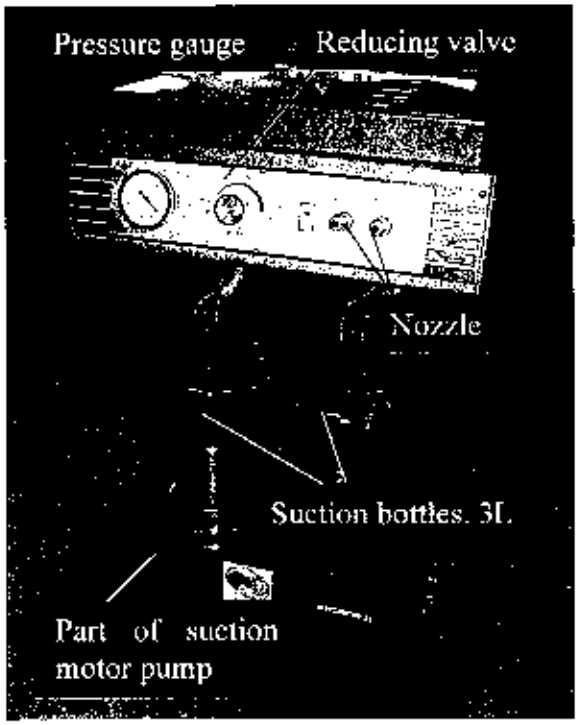


Figure 1. Electric type suction unit

The outlet filter connected with the outlet of the suction motor pump avoids contaminated air spreading to outside.

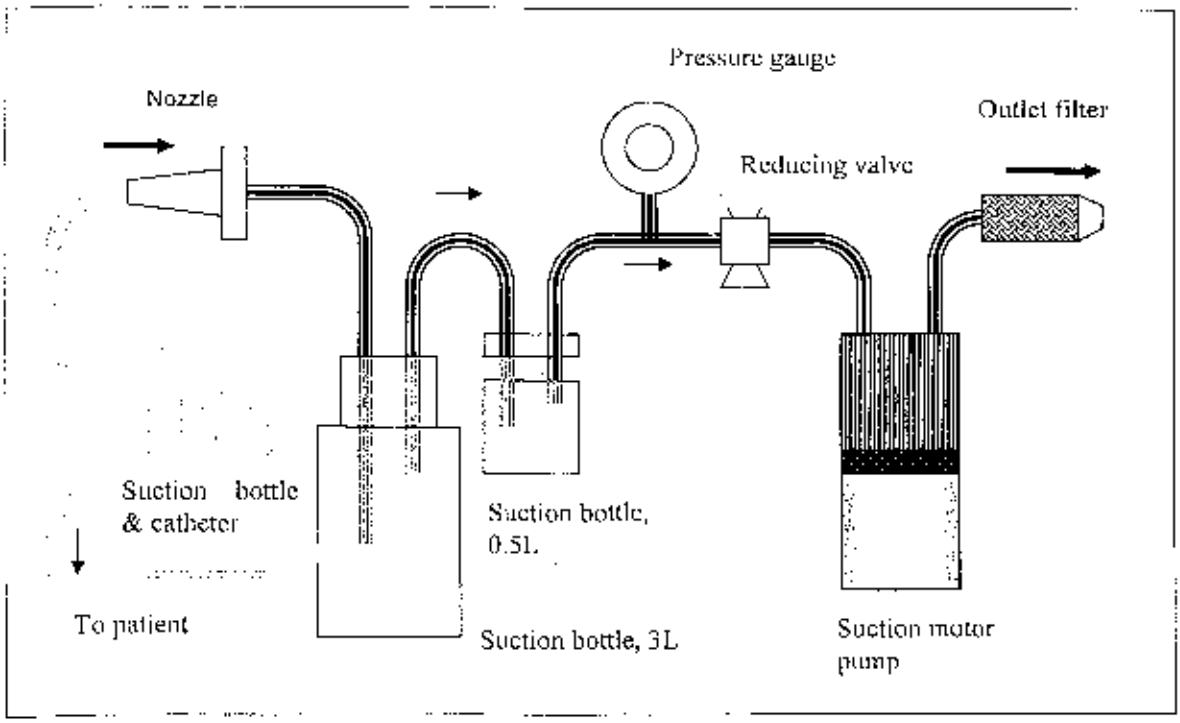


Figure 2. *Suction flow diagram*

3. General precautions

1) Suctioned stuff should not be sucked into the unit (overflow). Suctioned stuff that becomes overflow causes of equipment failure. When the suctioned stuff comes into the unit, the operation should be stopped and should be checked and clean inside of the vacuum pump. Even do not keep suctioned stuff for long time into the suction tube, suction bottle, etc., because it will be cause of sticking.
2) Do not neglect to clean the parts cleanable (such a suction tube, bottle, cap, etc.) periodically.
3) Make sure the power system of the equipment is properly grounded.
4) Avoid some unfavorably affect to the place where the equipment installed in environment (such a atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, etc.)

4. Maintenance

4.1 Visual Inspection

Inspect by using naked hand and eyes: loosen screws/fixed components, dirt and dust outside of the unit, degradation of tubes and rubber caps.

4.2 Functional Inspection

1) Breaker/power switch for normal operation
2) Foot switch for normal operation

3) Reducing valve for normal operation
4) Pressure gauge for normal operation
5) Is maximum negative pressure near to 760mmHg
6) No air leaking form tubes, rubber caps and metal fitting

4.3 Replacement of Rubber Made Components

The unit applies many rubber made components between the mechanical parts and the suction bottles, e.g., tubes and rubber caps. The rubber made components would become easily degradation with the passage of time. These, therefore, should be regularly replaced by new ones.

4.4 Maintenance of Oil

The rotary type pump would lose its oil level with the passage of time. Otherwise, water often enters into the oil. For these reasons, the oil should be regularly replaced by new one.

4.5 Maintenance of Mechanical Part

If the unit is not use for along time, the motor should be run once in a week so that the rust of inside of the motor pump can be avoided.

4.6 Replacement of Outlet Filter

The outlet filter connected with the outlet of the suction motor pump has role of avoiding contaminated air spreading to outside (See Figure 3). This filter would become dirt or clogged with the passage of time. To avoid this, the filter should be regularly checked and replaced. Absorbent cotton can be used as replaced by old filter.

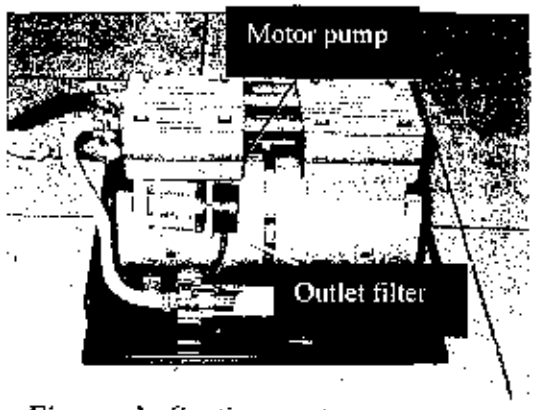


Figure 3. Suction motor pump with outlet filter

CODE	
EQUIPMENT NAME	Suction unit
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable ,etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Suction unit only		
1	Check & adjust loosed screws	Good / Fail	
2	Check & replace degradation of tubes and rubber caps	Good / Fail	
3	Check & replace suction bottle have crack or broken	Good / Fail	
4	Check function of foot switch operation	Good / Fail	
5	Check function of Reducing valve operation	Good / Fail	
6	Check function of pressure gauge	Good / Fail	
7	Check function of suction to come max vacuum pressure (760mmHg)	Good / Fail	
8	Check air leaking from tubes, rubber caps and metal fitting	Good / Fail	
9	Check & clean air filter	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

3-4. OPERATING TABLE

1. Introduction

This section will describe about manual controlled operating tables with oil pressure mechanism. The section will also provide advises for inspectors so that the table will be kept in good condition with long life.

2. Principle of operation

1) Use the Pedals ① and ② to elevator lower the tabletop.
2) Turning the Handle ④ located under the head section performs pitching.
3) The back section ⑫ can be set and located at a desired angle by lifting the section. When lowering it, slightly lift the section to release the lock lever.
4) The Leg Section ⑦ is normally stored under the Waist and Back Sections (⑫ and ⑬). Loosening two Stopper Screws ⑭ at both sides can draw it out. Fully draw the Leg Section out, and raise it a bit towards you. Push it back until it hits the Waist Section ⑬, and fix the position by tightening the Stopper Screws. When storing the Leg Section back under Waist/Back Sections, follow the steps in reverse order.
   Structure and the name of parts for gynecological operating table are shown in Figure 1.

3. General Precaution

1) This equipment is not drip proof. Do not use in an environment that is exposed to water or some liquid surrounding equipment place.
2) Keep the equipment stable and avoid tilting vibration and shock as much as possible, even during transport.
3) Take care the place where the equipment installed in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust and etc.

4. Maintenance and check

4.1 Visual Inspections

Inspection of:

- Loosed screws, level adjusters, mattress and its cover, covers for knee clutch, armrest, headrest, etc.

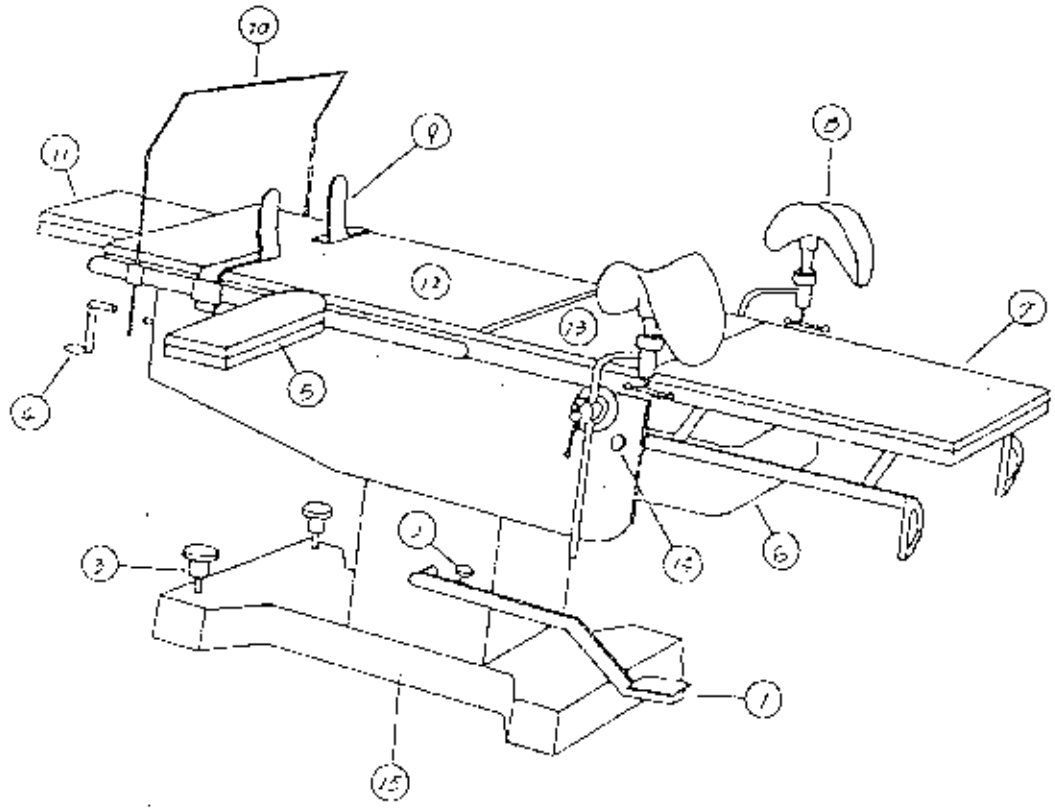


Figure 1. Gynecological operating table

①	Pedal (for table top elevation)	⑨	Shoulder-rest
②	Pedal (for table top lowering)	⑩	Curtain Frame for Anesthesia
③	Level Adjuster	⑪	Headrest
④	Handle for Pitching	⑫	Back Section
⑤	Arm Rest	⑬	Waist Section
⑥	Waste Receptacle Funnel with Neting	⑭	Leg Section Stopper Screws
⑦	Leg Section	⑮	Base
⑧	Knee Clutch		

4.2 Function Tests

1) Is level adjuster fixed on the floor completely?
2) Could the pedal ☐ function to elevate the tabletop?
3) Could the pedal ☐ function to elevate the tabletop?
4) Could the handle ☐ pitch the table?
5) Could positioning of knee clutch ☐ be moved smoothly and fixed completely?
6) Could the shoulder rest ☐ moved smoothly and fixed completely?

5. Requirement for Spare Parts

This complete mechanical equipment contains several consumable components. For long life operation, the following spares and material should be considered:

5.1 Pressure Oil

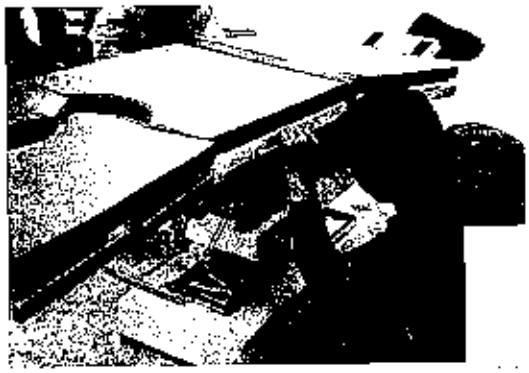
Pressure oil could lose its level with the passage of time due to degradation of O-ring and gasket for example. When oil level is low, refill it in appropriate level, and required oil "No. 32" bay be available in the local market.

5.2 O-ring and Gasket (See Figure 6.2)

These are actually consumable parts. The life span may be 3 to 5 years depending on the frequency of mechanical movements. Several quantities of O-rings are applied to the oil pump and elevation cylinder. These O-rings must be genuine parts to keep original performance.

5.3 Bed Covers

With long operation of the equipment, the bed covers and mattress become dirty and broken. In this situation, the equipment is no longer keeping its cleanliness. Replacement of covers and mattress, therefore, should be considered.



***Left**: Dismantle an operating table*

***Below**: Reassemble the equipment*

***Above**: Broken O-ring with piston*

Figure 2. *Replacement of O-rings and gasket of Operation table*

CODE	
EQUIPMENT NAME	Operation table
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Operation table only		
1	Check & adjust loosed screws	Good / Fail	
2	Check & adjust level adjusters	Good / Fail	
3	Check & clean mechanical movement parts (Pedal, Arm rest, knee clutch, etc.)	Good / Fail	
4	Check function of elevator (Up & down) by pedal	Good / Fail	
5	Check & replace pressure oil	Good / Fail	
6	Check & replace O-ring gasket	Good / Fail	
7	Check & replace Bed cover and mattress	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

3-5. OPERATING LIGHT

1. Introduction

The operating light is used in operation room or small surgical room. The operating light, it is the important part of surgical operation; it will provide the best suitable light and high intensity for surgical operators. The deep cavity illumination can be focused on job area of operation. The operating light is constructed into housing by: ultem reflector, halogen bulb, heat reflecting filter and diffuser acrylic cover, so it will provide brightness, more cool and may color corrected illumination. They fount that operating light has two types: Figure 1 is mobile type and Figure 2 is ceiling type.

Figure 1. Operating light
Mobile type (External view)

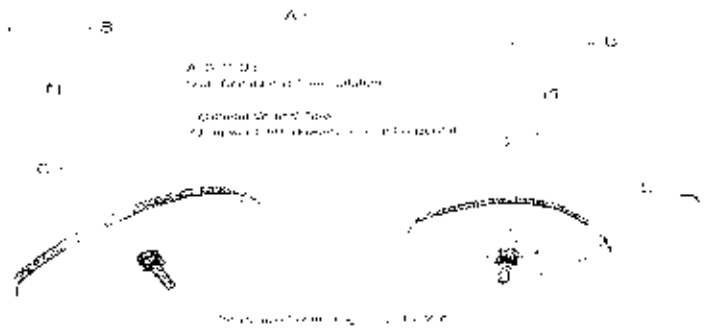


Figure 2. Operating light
Ceiling type (external view)

2. Principle of Operation

The Figure 3 showed how the each operating light is working. Most of operating light is supplied by 220VAC/50Hz, standard power supply in Cambodia, but the this voltage must be stepped down to 12VAC/50Hz or 24VAC/50Hz by step down transformer and supply to Halogen Bulb. The optical system as Figure 3 is to make

ensure a cool working environment. The ultem reflector is expelling infrared energy heat, heat reflector filter is repels infrared energy heat and combination of reflector & filter produce high quality light and excludes infrared rays.

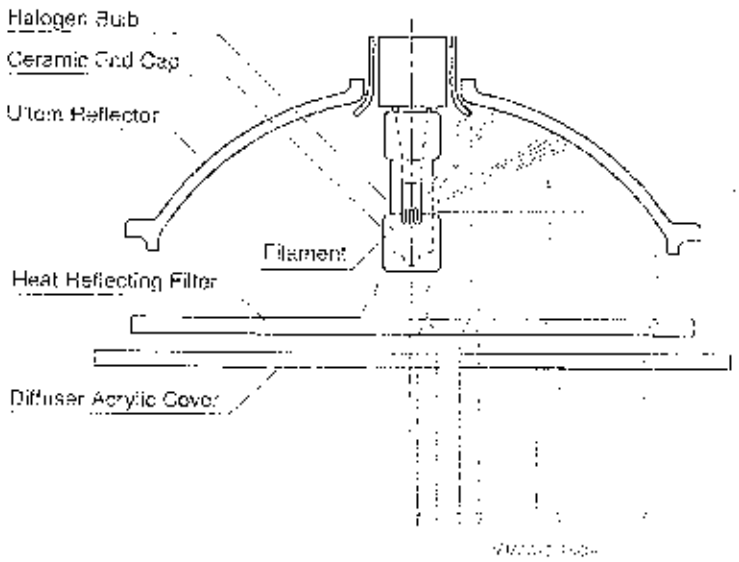


Figure 3. Operation principle for the operating light

3. Precaution

3.1 Installation

The Figure 4 showed how to properly install operating light. This job mostly has done by qualified technicians, must be made very sure that all parts of operating light have been strongly & properly connected. The installation must be step by step of all parts connection and correctly.

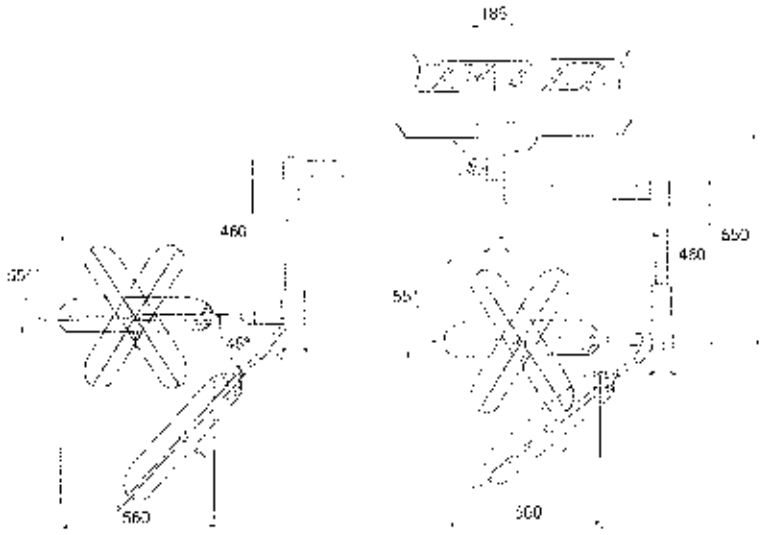


Figure 4.

3.2 Power requirement:

The source voltage must be within acceptable range 220VAC +/- 5% even at maximum load. The 220VAC can be stepped down to 12VAC or 24VAC by step down transformer. And the voltage can be controlled by control unit for On-Off / Dimmer setting.

3.3 Hazard

- To be preventive the hazard that can be caused by electric shock, the base of operating light must be properly connected to ground terminal.
- Do not remove heat reflecting filter or diffuser acrylic cover.
- Turn the power off if you suppose to do maintenance or replace halogen bulbs
- When replace halogen bulbs, must be care your hand may be wet so you have to use tissue or glove.

4. Maintenance

4.1 Daily maintenance

- Clean surface of light heads by using clothes with clean water and
- Turn it on every morning to make sure that all halogen bulbs are lighting up

4.2 Monthly maintenance

- Check all light head vertical travel, they are working properly
- Check all continuous rotation at all axes, they are working properly
- Check positioning handle (fixed focus), they are working properly

CODE	
EQUIPMENT NAME	Operating light
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Operating light only		
1	Check and clean the surface lamp head	Good / Fail	
2	Check performance of the position focus handle	Good / Fail	
3	Check the continuous free rotation	Good / Fail	
4	Check the light head vertical travel: upward, downward from horizontal	Good / Fail	
5	Check & replace the halogen lamp	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

3-6. OPERATION MICROSCOPE

1. Introduction

This equipment is used for the imperceptible operations such as ENT, ophthalmology, cranial surgery, and plastic surgery. This equipment generally be used in Operation Theater

2. Principles of operation

The structures of this equipment such as lends head, optical support and arms are different of each medical treatment, however basic structure is the almost same. The part of lens head is consisted by the eyepiece and object lens. This equipment are introduced technology which the sight of operation is kept be clear and bright by using device of light source.

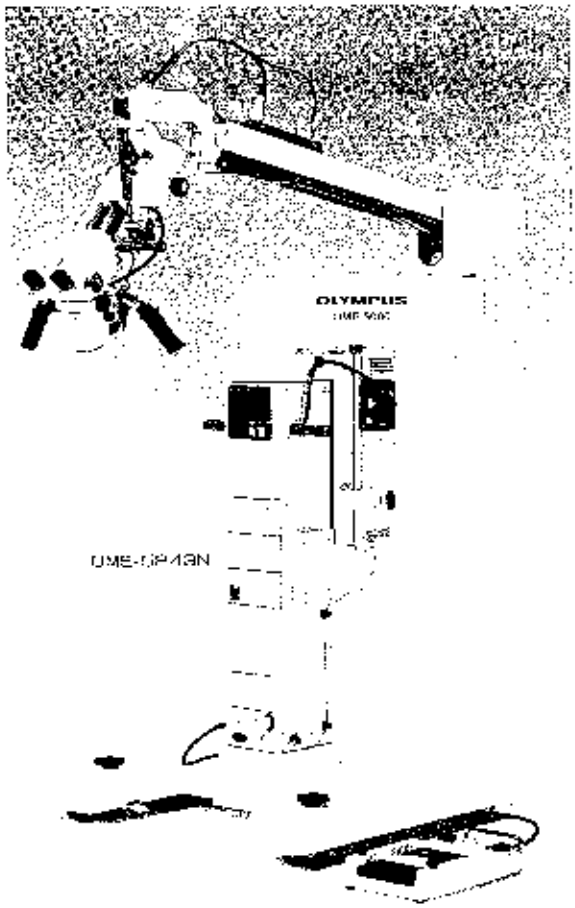


Figure 1. Total exterior of the Operation microscope

3. General Precautions

- Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
- The equipment must be installed in a clean environment, away from chemicals.
- Workspaces should be well ventilated or permanently air-conditioned, otherwise, humidity and higher temperatures often result in the growth of a fungus that can corrode optical surfaces.
- Make sure the main line voltage, frequency and power are correct for the operation of the equipment.
- Make sure the power system for the equipment is properly grounded.
- Never splash water or any liquid directly onto the equipment as this may cause electric shock or short circuit to break the equipment.
- Always turn off and plug out from the equipment during preventive and corrective maintenance.
- Optical instruments should not be kept for long periods in closed compartments since these conditions encourage fungal growth.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. Visual inspection list for Operation microscope

Check Item	Description
1.External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dust/dirt on the surface of body and operation panel
2.Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Lens surface, optical filter.	- Crack, injured, broken, dirt, or fungus on the surface
5.Room condition	- Dirt, dust, any gavages. - Temperature, humidity

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for Operation microscope

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check Halogen lamp of light source	- Turn ON the lamp properly? - Adjustment for brightness control. - Clear observation on the frame of lens.
4. Check and Clean each lens (Objective lens, eye piece lens, optical filters, etc.)	- Check and clean any dirt, dust and fungus on the surface of lens.
5. Cleaning the main body.	- Clean the body with soft cloth. If heavy dirt, put with a little of neutral detergent or soft water.
6. Lubricating mechanical parts	(Movement between Lens head, Arm and optical support, etc.)

CODE	
EQUIPMENT NAME	Operation microscope
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Operation microscope only		
1	Check & clean each lens (eye piece, objective, optical filter)	Good / Fail	
2	Check room condition (Dirt, dust, temperature and humidity)	Good / Fail	
3	Check & clean whole of the unit	Good / Fail	
4	Check function of ventilation fan	Good / Fail	
5	Check & replace of the halogen lamp of light source	Good / Fail	
6	Check & lubricate mechanical parts (moving parts)	Good / Fail	
7	Check total performance	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

4-1. STEAM STERILIZER (AUTOCLAVE)

1. Introduction

Autoclaves generate steam from water at a temperature above 100 l in a closed chamber (Figure 1). At these temperatures, the steam is above atmospheric pressure, and the conditions are optimal for the sterilization of laboratory equipment, such an environment, but viruses are not necessarily killed. The temperature can be kept 30 – 40°C lower than in dry-air ovens, so that temperature –sensitive materials can also be sterilized. However, autoclaves need careful handling and must be inspected regularly; they can be dangerous and cause serious injury if steam accidentally escapes from the equipment.

2. Principle of operation

Two types of autoclave are available. The non-jacketed autoclave, which exists in vertical and horizontal versions, is simpler and has some practical disadvantages, but it is cheaper than a steam-jacketed autoclave with automatic air and condenser discharge.

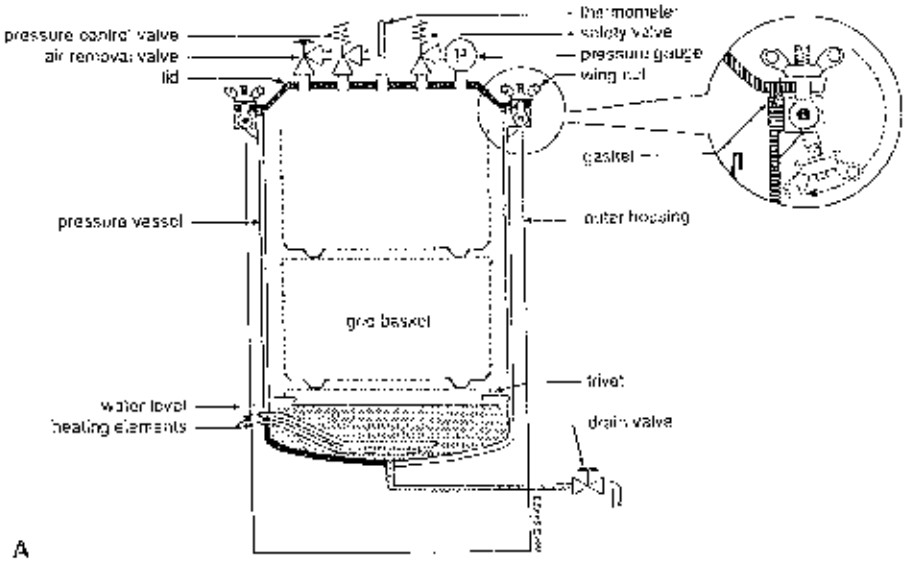


Figure 1. Schematic structure of Non-jacketed autoclave

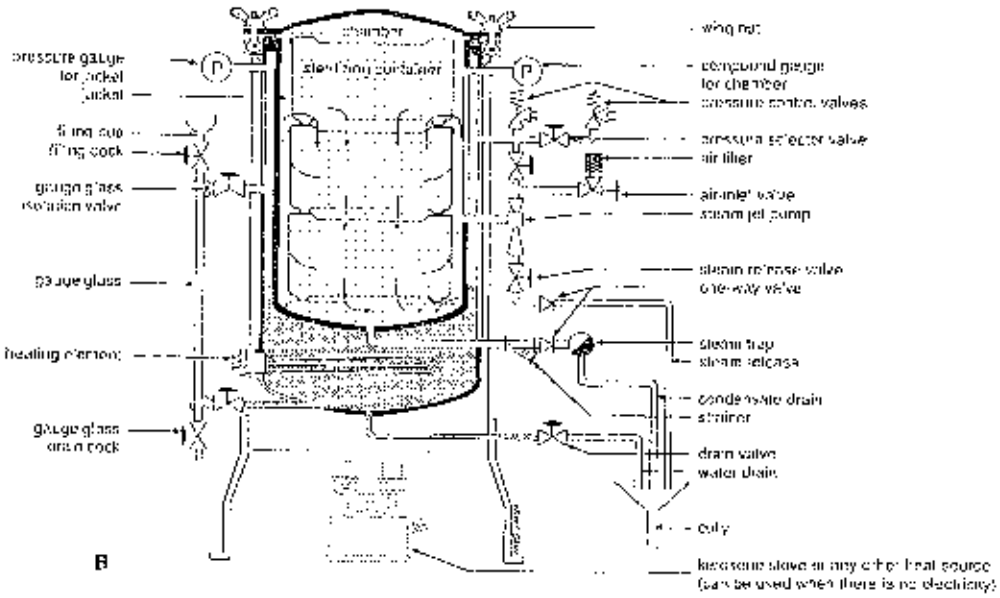


Figure 2. Schematic structure of Steam-jacketed autoclave

Sterilization of porous materials, like laundry and bandages, is more difficult, since the air in these materials must be replaced by steam. This replacement is improved by evacuating the closed chamber of the autoclave containing the materials to be sterilized. With modern autoclaves, the chamber can be repeatedly evacuated so that the pressure in the chamber falls to 5.5kPa. The chamber is then heated to evaporate water for sterilization.

The main factors influencing steam sterilization are:

- Saturated steam
- Temperature
- Time

The materials can be exposed to steam in a single heat cycle. However, this method of sterilization is less effective than intermittent exposure in three cycles over three days, which may kill all vegetative forms of sporulating microbes. The cycle conditions may be shortened by increasing the pressure and hence the temperature of the steam (Figure 3.). As with hot-air sterilization, effective steam sterilization starts when the autoclave has reached the appropriate temperature (Figure 4.)

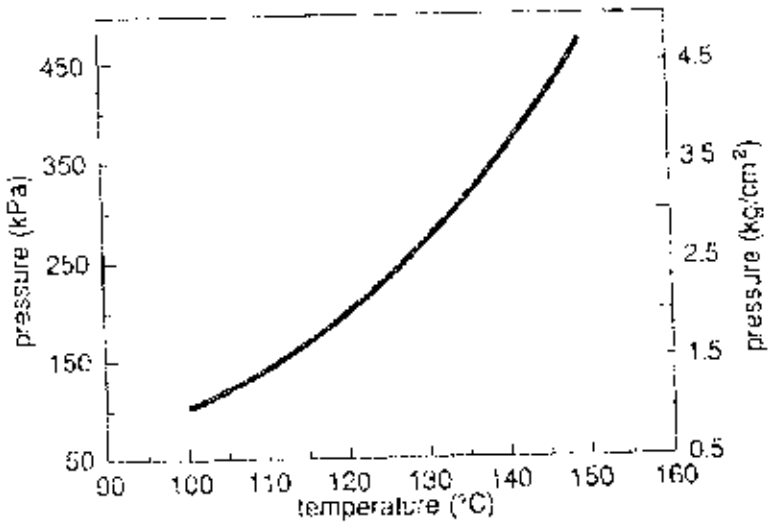


Figure 3. Relation between steam pressure and temperature at constant

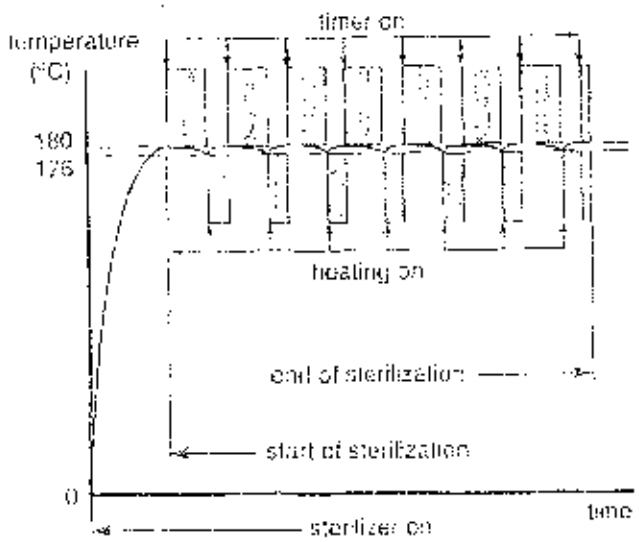


Figure 4. Temperature variation during autoclave sterilization

Table 1. Operating condition for autoclaves

Sterilizing TEMP (℃)	Appropriate pressure (kPa)	MIN. holding time (min)	Overall time (min)
115	75	30	50
122	115	15	40
128	150	10	30
136	225	3	20

3. General Precautions

1) Take care the place where the equipment in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, etc.
2) Keep the equipment stable and avoid tilting vibration, and shock as much as possible, even during transport.
3) Make sure the main line voltage, frequency and power are correct for the operation of the equipment.
4) Make sure the power system for the equipment is properly grounded.
5) Use of equipment should only be performed by skilled operators.
6) Do not neglect to check and maintain part of steam and water circuit (such as several valves, strainer, vacuum pump, etc.)

4. Maintenance and Check

To ensure proper operation of the Autoclave, a periodical cleaning should be performed.

1) Door gaskets should be kept clean and regularly checked for cracks and pitting due to deterioration.
2) Door clamps and door locks should be checked for proper operation and lubricated with high-temperature grease. The proper operation of the pressure locking device should be determined.
3) Valve discs and seats must be inspected for signs of wear or cutting.
4) Check and clean periodically the valves, strainer, and air filter every 3 months.
5) Check the function of vacuum pump every 3 months.
6) Adequate functioning of autoclaves should be checked weekly by the use of a biological (spore suspension) or chemical indicator.
7) The function of manometer (Pressure gauge) must be checked every

3months.

8) Check regularly the power cable and breaker connection for cracks, loose connection and dissolved wire due to deterioration.
9) Check the power supply unit

CODE	
EQUIPMENT NAME	Steam Sterilizer (Autoclave)
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Steam Sterilizer (Autoclave) only		
1	Check water leakage from some joint of water circulation system	Good / Fail	
2	Check & clean scheelite accumulated inside of the plumbing	Good / Fail	
3	Check & clean some valves (Check, Safety, Solenoide, etc) to avoid dirt and collution.	Good / Fail	
4	Check the valve discs and seats for signs of deteriorate.	Good / Fail	
5	Check & clean the door gasket	Good / Fail	
6	Check and lubricate function of door clamps and door locks.	Good / Fail	
7	Check function of Heater	Good / Fail	
8	Check function of the manometer (pressure gauge).	Good / Fail	

REMARKS

Date inspected	/ / 2005	Inspector	
Room Temp.	℃	Approved by	

4-2. DRY OVEN (STERILIZER)

1. Introduction

Dry Oven is used for sterilization or drying surgical instruments, laboratory instruments, etc that could not burn and damage with the temperature rate from 50°C to 250°C or more. Mostly they fount it was used in minor surgical suite, operation room and laboratory in hospital and clinic.

It is running under high temperature that provided by heater element. The user or operator have to learn and understand the hazard that caused by dry oven before using it.

Here below is the sample of dry oven and parts name that user has to be learned:

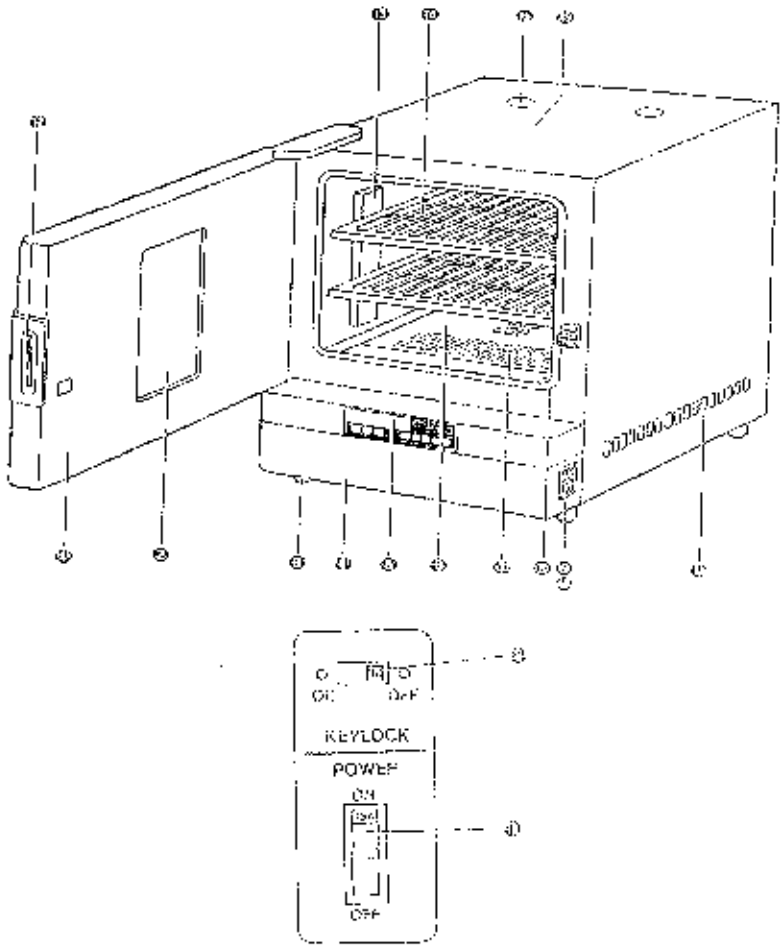


Figure 1. Structure drawing for the Sterilizer, Dry oven

Table 1. Description of each part

[1] Door
[2] Observation Window
[3] Regulating Legs
[4] Fan (Inside)
[5] Control Panel
[6] Separation Plates
[7] Heater Box
[8] Packing
[9] Key Lock Switch
[10] Main Power Switch
[11] Air Intake Vents
[12] Handle
[13] Rack Supports
[14] Racks
[15] Exhaust Vents
[16] Temperature Sensor

2. Principle of Operation

Loading the equipment suppose to sterile into dry oven. All equipment must be put on racks. Close the door and securely lock, turn on the power, setting & adjust appropriated sterile time and temperature. The heater element is heating up reach to setting temperature. The air is taken inside the oven from vents that can keep inside oven warm up. During running exhaust vent is controlled by opening or closing and temperature of this vent is extremely high. The inside temperature of oven is controlled by thermostat or temperature sensor so it will keep appropriated setting temperature. The sterilization time is controlled by timer, when setting sterilization time is finished, the power supply will be cut off automatically and then alarm buzzer will be giving sounds. So it means sterilization is completely finished.

3. General Precaution

3.1. Installation

When selecting the location to install the dry oven, the conditions must be considering as the following:

- The floor must be solid &level and not closed to vibration area.
- Where the unit will not be exposed to direct sunlight
- The ambient humidity & temperature room should be low
- The unit should not be installed closed to (near) the flammable things.
- Do not install the unit closed or against to wall, have to be keep some spare for air circulation
- Ground earth wire must be connected properly to ground earth terminal to avoid electric shock.

3.2 Hazards

- Plug properly to outlet
- Do not place materials which may generate flammable, inside oven
- Make sure door is closed and lock properly
- Do not open the door during oven is running
- Do not put your hands or touch to hot area such as exhaust vents, air intake vents

4. Maintenance

4.1. Daily Maintenance

- Every day (morning), clean the inside by using soft cloth damped with neutral detergent. Afterwards wipe off with clean water.
- Do not putting some things on the top of oven
- Cleaning the rack with neutral detergent and then wipe off with clean water.

4.2 Monthly Maintenance

- Check door & observation window, it is strong enough
- Check heater element and clean if it is necessary
- Check and clean air intake vents
- Check and clean exhaust vents

CODE	
EQUIPMENT NAME	Sterilizer, dry oven
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Sterilizer dry oven only		
1	Check & clean the heater element, heat up or not	Good / Fail	
2	Check the temperature sensor or thermostat and check temperature gauge properly.	Good / Fail	
3	Check function of the controller timer	Good / Fail	
4	Check the air intake vents; make sure they are not block by something's	Good / Fail	
5	Check & clean exhaust vent	Good / Fail	
6	Check & replace door gasket, silicon seal, etc.	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

5-1. INFANT INCUBATOR

1. Introduction

Infant incubator is used to keep unwell newborn or premature infants in controlled conditions of temperature, humidity, and oxygen level. Doors are provided in the sides to allow access to attend to the infant. The common types incorporate a low-power heater and a fan to circulate the air. There are warning alarms to draw attention to mains failure or overheating.

2. Principle of Operation

Air circulation system

1) Taking in fresh air, and the air is filtered.
2) Sending filtered air to heater
3) Sending heating and humidity following the indicator of thermostat sensor. By this operation, the inside of equipment is done of compulsive ventilation.
4) Using fan to send heating and humidity air
5) According to the condition of infant, it is also available to supply oxygen which required concentration

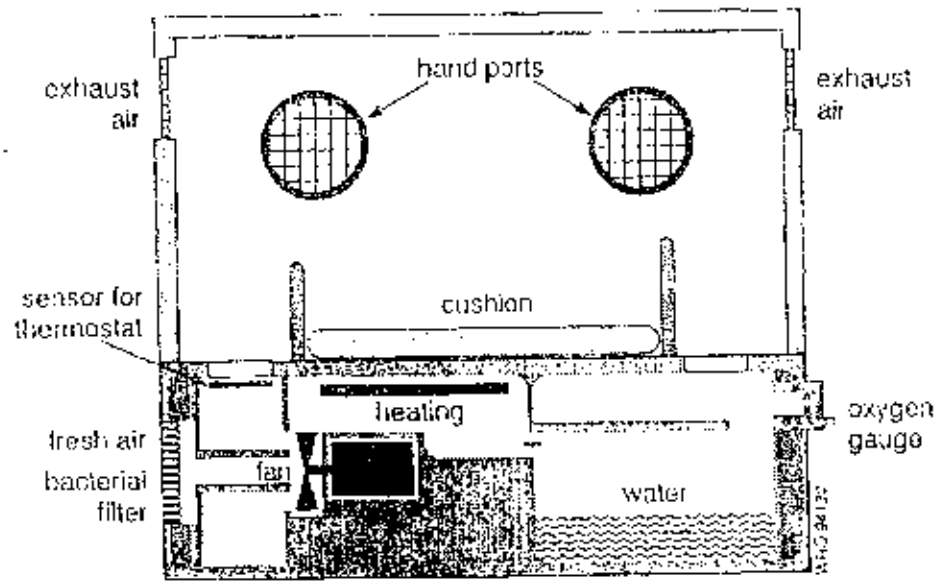


Figure 1. Schematic structure of Infant Incubator

3. General precaution

1) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
2) Do not install the equipment in a storage environment containing gas or other chemicals.
3) Make sure the main line voltage, frequency and power are correct for the operation pf the equipment.
4) Make sure the power system for the equipment is properly grounded.
5) Take care the place where the equipment in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, ventilation, sunlight and air containing dust, etc.
6) Do not keep for long time the sterilized water into the humidifier cup. It will be cause of contamination of bacteria.
7) Do not neglect to clean the equipment, because the dirt and dust will be not able to extract well, it cause of damage of heater and fan motor.
8) Check and replace the air filter periodically.

4. Maintenance and check

4.1 Inspection Requirements

Day-to-day care involves care of the door catches and seals. Like ventilations and anesthesia apparatus, the incubator needs to be thoroughly checked twice a year, and functioning should be checked after each cleaning. Check that:

- It warm up to and is able to maintain, the set temperature.
- The over-temperature alarm works at the correct setting.
- All dials read correctly.

Also, check the electrical safety of the machine. Problems are most likely to be of an electrical nature. If there is overheating, check that the ambient air temperature is not too high, and that the machine is not exposed to the sun. A fan-failure alarm may indicate that the bearings of fan motor need lubricating or replacing.

※ General cleaning

Cleaning may be carrying out with soap and clean water. All the surfaces and corners should be washed and dried thoroughly, using plenty of clean absorbent paper or clean cloth, to ensure that every corner is completely dry.

Any remaining moisture can promote the growth of bacteria.

Maintenance check required for this equipment is shown in Table 1.

Table 1. Visual inspection list for Infant Incubator

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dirt/dust and some moistures fixed on the surface
2.Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Air filter and humidifier chamber	- Check the condition of air filter to be dirt.
5. Humidifier chamber	- Cracked/ broken or dirt. - Remaining contaminated water into the chamber. Throw the water and clean the chamber after use this equipment.
6. Ventilation filter	- Cracked/broken - Fixed with dirt/dust.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell? - Adjust flow volume properly?
3. Check Iris door cover	- Iris door cover open or not smoothly.
4. Check the self diagnostic function	- After turn on, it should activate automatically.
5. Check Air circulation system	- Check ventilation fan. - Adjust to control the nebulizing volume?
6. Check Temperature control	- Check the function of increase and maintain to suitable temperature.
7. Check humidity control	- Check the function of increase and maintain to suitable humidity.
8. Check oxygen supply	- Supply and current properly oxygen from the in-port valve. - Exist any leakage from anywhere.
9. Check alarm function	- Activate the alarm for temperature probe, over heat and during electricity cut off, etc.

CODE	
EQUIPMENT NAME	Infant Incubator
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Infant incubator only		
1	Check & clean the air filter and humidifier chamber	Good / Fail	
2	Check & clean the ventilation filter	Good / Fail	
3	Check function of ventilation fan	Good / Fail	
4	Check performance of Iris door cover	Good / Fail	
5	Check the temperature control	Good / Fail	
6	Check the humidity control	Good / Fail	
7	Check the oxygen supply	Good / Fail	
8	Check activation of the alarm function	Good / Fail	
9	Check total performance	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

5-2. INFANT WARMER

1. Introduction

The infant warmer system provides a controlled source of radiant heat for infant and pediatric patients. The modern infant warmer, the control system uses a microprocessor and provide both manual and automatic controller.

It is controlled patient temperature skin (is around 36°C same as body temperature), air temperature (is a round 35.5°C) and operation time. The setting temperatures and operation time will be displayed on control panel that must be absolutely correct. If setting parameters are failed then alarm will be sounded. The infant warmer is combined of the following parts:

- Support structure
- Heater assembly
- Control unit
- Bed Platform
- Phototherapy

They fount that infant warmer is used in intensive care, delivery room or nursery in hospitals and clinics. Figure 1 is typical infant warmer is using incorporated computerized control and warming function which expand capability for infant care management.

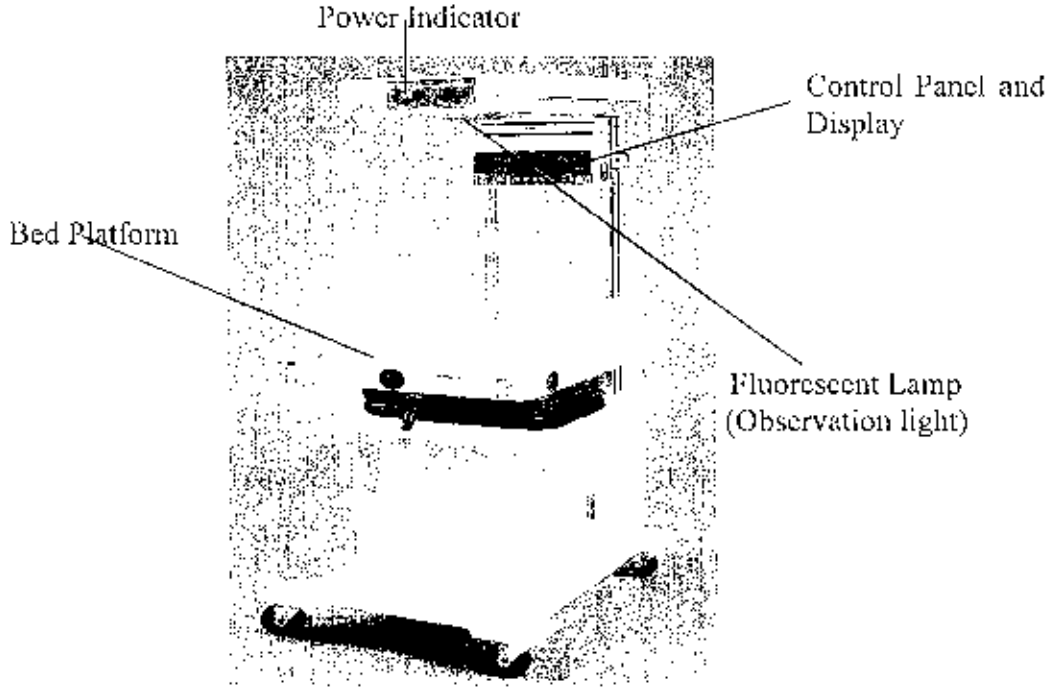


Figure: 1 (Infant Warmer Unit)

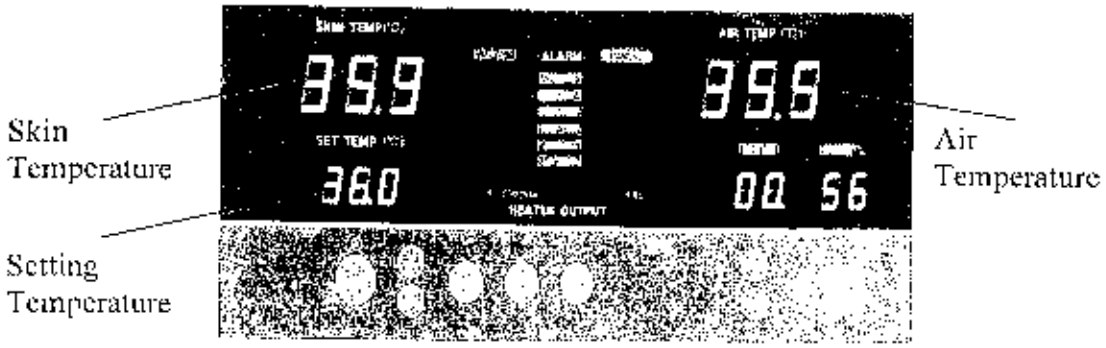


Figure: 2 (Control Panel & Display)

2. Principle of Operation

The modern infant warmer is run under computerized control system that uses an advance microprocessor to put operator in control of patient (infant) and system status while providing both manual and servo modes of operation to maintain precision thermoregulation.

2.1 Computer-controlled warming

The powerful cal-rod heating element directs controlled radiant heat evenly across the entire bed surface, warming up the baby but not operator. The agar timer sounds every few minutes showing lapse time of heating. All the transparent acryl baby guards but the one closed to the support pole may be down out of the way to provide quick infant access.

2.2 Alarm function for safety

The provided alarm are for power fail, sensor fail, High/Low temperature of skin & air and over temperature, alarm conditions occur and buzzer will sound or an appropriate indicator lamp will flash. If the skin temperature raises 1°C or more the preset level, power supply to the heater will be automatically cut off to prevent further temperature rise.

3. General Precaution

3.1 Installation

When selecting the location to install an infant warmer, the conditions must be considering as the following:

- Power supply should be constantly 220VAC/50Hz (Standard power supply in Cambodia). If power supply voltage is not constant, automatic

voltage stabilizer must bet used and included power supply back up unit to prevent city electricity cut off at any times.

- The infant warmer must be connected to ground to avoid electric shock or electrical leakage.
- Do not install the unit close to flammable materials or gas.
- The room temperature and should be appropriated.
- Do not install the unit closed or against to wall, have to be keep some spare for air circulation.
- Where the unit will not be exposed to direct sunlight.

3.2 Hazard

To prevent the accident and damage to equipment, patient and operator, some actions have to be taken care as following:

- Check all necessaries things to running infant warmer before using
- Do not move the warmer by pushing or pulling on the bed side panels. This action may be lead to deterioration and breakage of the components which form a safety barrier around the infant.
- Do not place foreign object on the warmer bed or in the under bed cavity while performing X-Ray procedures.
- Do not use warmer in presence of flammable of anesthetics, it is possible explosion hazard.
- Do not touch the protective grill under the radiant heater or the top of the heater assembly. These surfaces may be hot and burn could result.
- Disconnected power to infant warmer and allow the heater rod to cool before cleaning to avoid the possibility of burn.
- Disconnected the power cord to warmer and allow heater rod to cool before replacing observation lights.
- Do not leave the patient unattended when using the warmer. Check the patient's temperature regularly to ensure the comfort and the safety of the patient.
- Do not use warmer system if the system failure alarm is activated. Remove the unit from service and call for servicing.

** **NOTE** : The hazards may be more than above description so please try to learn more hazards from operation manual that it should be attached with the unit.

4. Maintenance & check

4.1. Daily Maintenance

- Every day (morning), clean the warmer by using soft cloth damped with neutral detergent. Afterwards wipe off with clean water.
- Do not put some things on bed platform and mattress.
- Make clean the surface of phototherapy.

4.2. Monthly Maintenance

- Checking heater element rod and make sure, it is clean not some things block.
- Checking phototherapy unit, especially fluorescent lamp. Replace them if necessary.
- Check mechanical forward up and down
- Check X-ray cassette tray to make it is clean and enable user to take accurate X-ray.
- Check mobile casters, they are properly movement and lock properly break.

※ **General cleaning**

Cleaning may be carrying out with soap and clean water. All the surfaces and corners should be washed and dried thoroughly, using plenty of clean absorbent paper or clean cloth, to ensure that every corner is completely dry. Any remaining moisture can promote the growth of bacteria.

4.3. Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. Visual inspection list for Infant warmer

Check Item	Description
1. External body and operation panel & display	- Cracked/broken panel and enclosure - Missing characters - Rusts/dents on the body - Dirt/dust and some moistures fixed on the surface
2. Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Heater element	- Cracked/broken - Rusts/dents on the body - Dirt/dust and some moistures fixed on the surface
5. Ventilation filter (If equipped with)	- Cracked/broken - Fixed with dirt/dust.

4.4. Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Table 2. Function check list for Infant warmer

Check Item	Description
1. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell? - Adjust flow volume properly?
2. Check the heater element	- The heater for radiant temperature heat up or not.
3. Check the self diagnostic function	- After turn on, it should activate automatically.
4. Check Temperature control, timer and display function	- Check function of increase and maintain to suitable temperature. - Check function of timer - Check the display indicates properly.
5. Check the phototherapy unit	- Check function of fluorescent lamp.
6. Check the mobile caster	- They move and lock properly.
7. Check alarm function	- Activate the alarm for temperature probe, over heat and during electricity cut off, etc.

CODE	
EQUIPMENT NAME	Infant Warmer
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Infant warmer only		
1	Check & clean the heater element	Good / Fail	
2	Check & clean the ventilation filter (if equipped with)	Good / Fail	
3	Check temperature and timer control	Good / Fail	
4	Check indication of display panel	Good / Fail	
5	Check performance of mechanical parts (if equipped with)	Good / Fail	
6	Check & lubricate the mobile caster movement	Good / Fail	
7	Check function of the phototherapy unit	Good / Fail	
8	Check alarm function	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

5-3. BILIRUBIN METER

1. Introduction

This equipment is used to find a symptom of newborn Jaundice. It measures the serum bilirubin of the newborn baby. Usually obstetric, neonatal, NICU and laboratory department may have installed it as emergency laboratory equipment.

2. Principle of Operation

This equipment measures yellow color tone of patient serum or blood plasma caused by density of the bilirubin.

Method of measurement is:

1) First, apply light source (wave range 551 or 575nm) to the hemoglobin in the patient's serum or blood plasma and completes calibration of absorption level.
2) Apply another light source (bilirubin's absorption wave range 455 to 460nm) to the sample and measures a density of bilirubin by absorption level.

※ Structure of Equipment

Figure 1. shows the structure of Main unit of bilirubin meter.

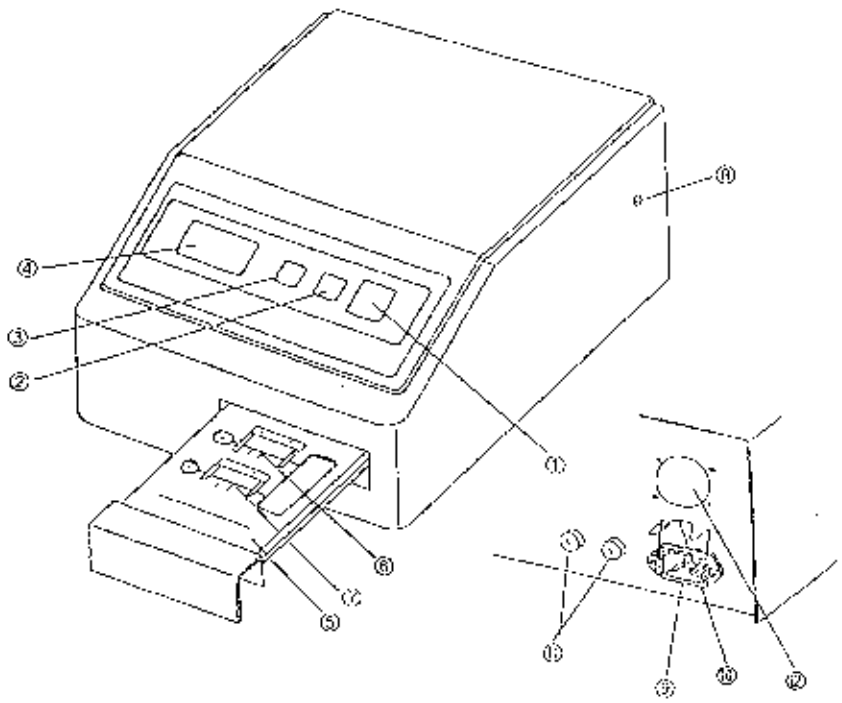


Figure 1. *Structure drawing of Bilirubin meter*

Description of each part:

1) Power switch
2) Checkout switch
3) Calibration switch
4) Display
5) Work table
6) V type groove (A)
7) V type groove (B)
8) Adjusting variable resister
9) Power connector
10) Power cord clamp
11) Fuse holder
12) Cooling fan

3. General precaution

1) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
2) Do not install the equipment in a storage environment containing gas or other chemicals.
3) Take care the place where the equipment in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, ventilation, sunlight and air contaminating dust, etc.
4) Make sure the main line voltage, frequency and power are correct for the proper operation of the equipment.
5) Make sure the power system for the equipment is properly grounded.
6) Do not keep dirt and liquid protein to fixed for long term otherwise, it will not be able to take them out completely. Therefore do not neglect cleaning periodically for the work table.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. Visual inspection list for Bilirubin meter

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dust/dirt on the surface of body and operation panel
2. Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Work table and grooves for setup the sample	- Injured, broken, dirt, fixed sample fluid, etc. - Check and clean always the work table.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for Bilirubin meter

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check initial calibration	- Measure and calibrate the sample value to be obtained correct result of measurement.
4. Check and Clean work table	- Clean the work table completely.
5. Replace the lamp	- When the lamp has been deteriorated in brightness or broken, replace it as soon as possible.

CODE	
EQUIPMENT NAME	Bilirubin meter
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Bilirubin meter only		
1	Check & clean the work table ad grooves for setup the sample	Good / Fail	
2	Check function of the ventilation fan	Good / Fail	
3	Check initial calibration	Good / Fail	
4	Check & replace the lamp	Good/ Fail	
5	Check total performance	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

5-4. PHOTOTHERAPY UNIT

1. Introduction

Phototherapy unit is used for the treatment of jaundice infant by using ray of light. The symptom of jaundice is happened by disorder metabolism of Bilirubin. The chemical reaction of light regards Bilirubin is occurred around 450nm and 280mn of ray of light. In order to this, it is normally used blue light or fluorescent light that is similar as daylight.

2. Principle of Operation

The structure of phototherapy unit is consisted of 4 to 6 fluorescent lights. These fluorescent lights are located in parallel. Some kinds of phototherapy unit have timer and hour meter. The quantity of light are approximate 6700lux (−4 ~ 6 fluorescent light), it keeps lightening this amount 24 hours.

The radiation energy decreases gradually, so that it is necessary to exchange lump each 3000 hour.

※ **Structure of Equipment**

Figure 1. shows the structure of Main unit of bilirubin meter.

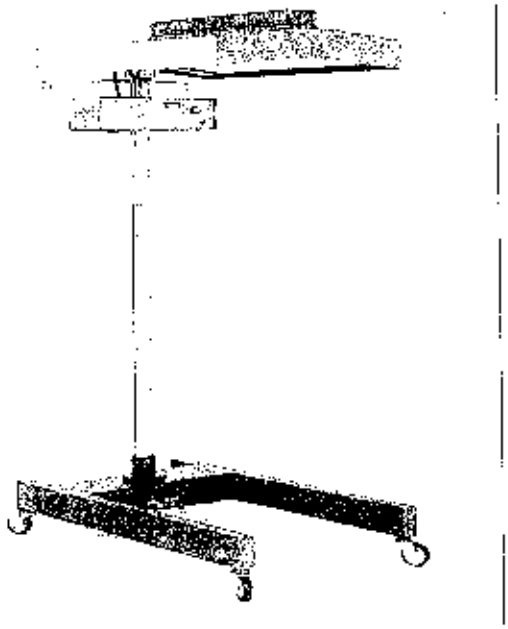


Figure 1. *Structure drawing of Phototherapy unit*

3. General precaution

1) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
2) Do not install the equipment in a storage environment containing gas or other chemicals.
3) Take care the place where the equipment in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, ventilation, sunlight and air contaminating dust, etc.
4) Make sure the main line voltage, frequency and power are correct for the proper operation of the equipment.
5) Make sure the power system for the equipment is properly grounded.
6) Do not keep dirt and liquid protein to fixed for long term on the surface of the unit, otherwise, it will not be able to take them out completely. And also, it cause of damage and deteriorate for the equipment.
7) Replace the fluorescent lamp every 3, 000 hours.
8) After replace it, do reset the hour meter counter.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table I. *Visual inspection list for Phototherapy unit*

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dust/dirt on the surface of body and operation panel
2. Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Fluorescent lamp condition	- Brightness, flushing, deteriorates.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.
Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for Phototherapy unit

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check and Clean the unit.	- Clean the unit properly with soft cloth. If heavy dirt clotted, use with neutral detergent or soft water, etc.
4. Replace the lamp	- Replace the fluorescent lamp every 3,000 hours used.
5. Reset Hour meter	- After replace the fluorescent lamp, do not forget to reset the hour meter to 0 positions.

CODE	
EQUIPMENT NAME	Phototherapy unit
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Phototherapy unit only		
1	Check & clean the fluorescent lamp condition	Good / Fail	
2	Check function of the ventilation fan	Good / Fail	
3	Check & clean the unit	Good / Fail	
4	Check & replace the lamp	Good / Fail	
5	Check to reset the hour meter	Good / Fail	
6	Check total performance	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

6-1. DOPPLER FETUS DETECTOR

1. Introduction

Confirmation of the life of fetus in early stage of pregnancy is a very important diagnostic practice in obstetrics. Ultrasonic Doppler method provides very useful and effective means for detective fetal heart beats in a stage of pregnancy as 11 weeks. The DOPPLER FETUS DETECTOR that applies such a method is now taking a very important role in the clinical obstetrics.

2. Principle of Operation

Figure 1. shows the principle of operation for the Doppler fetus detector. When the ultrasonic wave transmitted from the probe is reflected at the moving tissue such as fetal heart and blood flow, the frequency of reflected wave becomes different frequency from the frequency of originally transmitted wave due to the Doppler shift phenomenon.

The reflected wave received by the same probe is mixed with transmitted wave, and is fed to the detector to produce an audible output signal, frequency that corresponds to the difference between transmitted and reflected frequencies. The output of the detector is amplified, and is heard through a speaker or earphone.

In such a manner, by placing the probe on material abdominal wall, the audible signal due to the fetal heart beat or blood flow in placenta or umbilical cord is obtained, thus enabling the confirmation of the fetal life or location of the position of placenta.

A Pocketable Type Doppler Fetus Detector, the model which is referred in Figure 2., is a good example for explaining the theory of operation because it has simple circuits and constructions. Also, the block diagram of the apparatus is illustrated in Figure 3.

The unit is largely divided into the transmitting section, the probe, the receiving section and the power supply. The transmitting section (IC3) produces the high frequency electronic power of the high frequency (dependent on the model of equipment) to drive the transmitting transducer element in the probe, which generates the ultrasonic power to be transmitted into a patient.

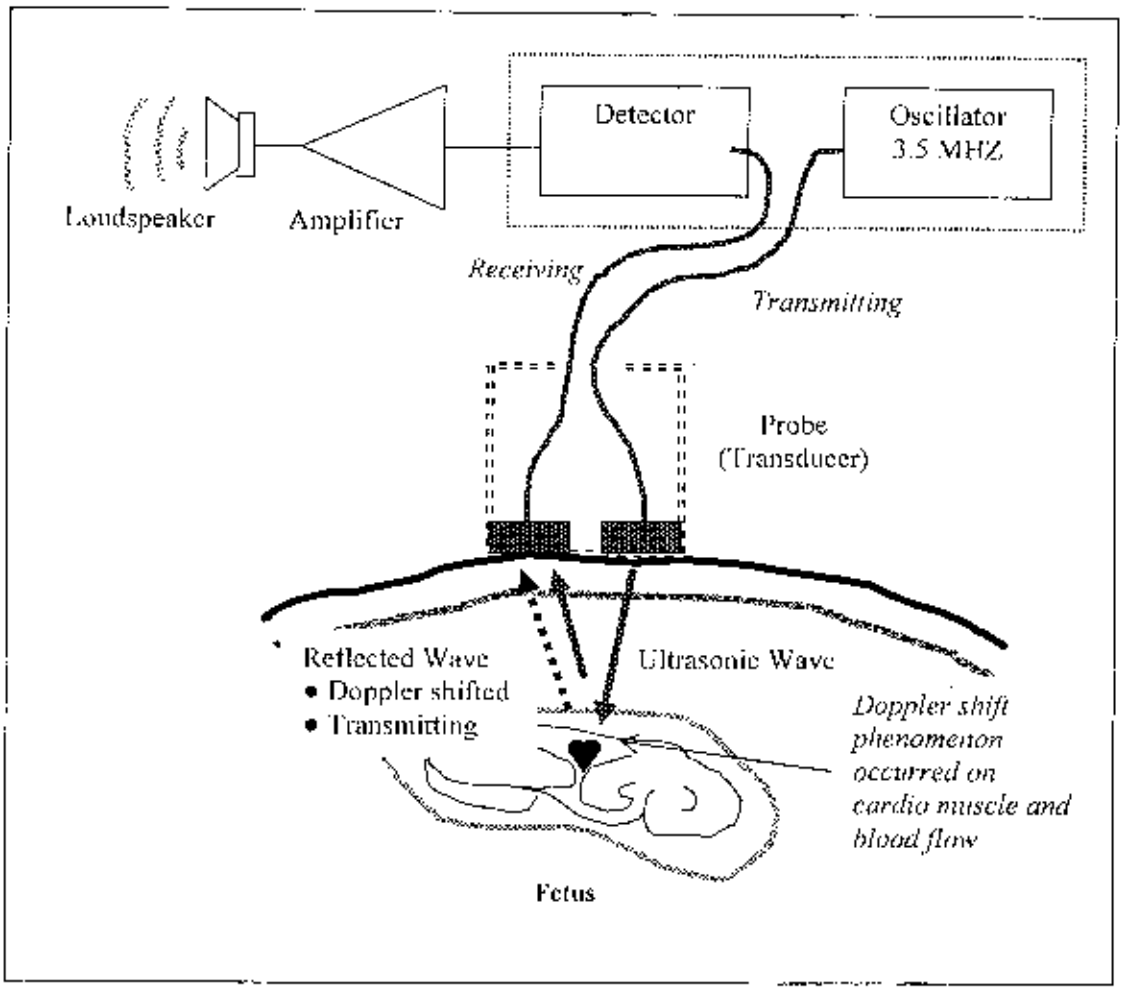


Figure 1. *Principle of operation for Doppler fetus detector*

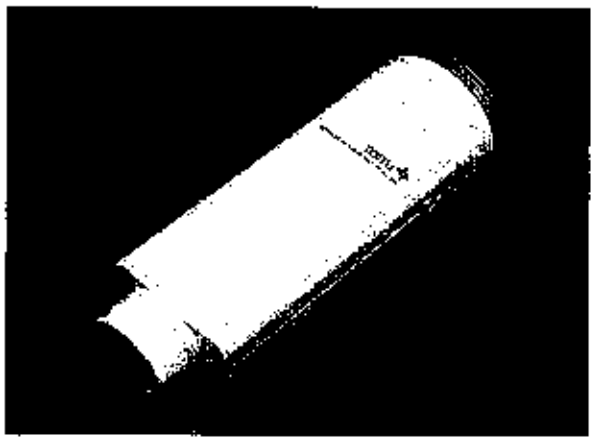


Figure 2. *Pocketable Doppler fetus detector, the Model TOITU/FD-300*

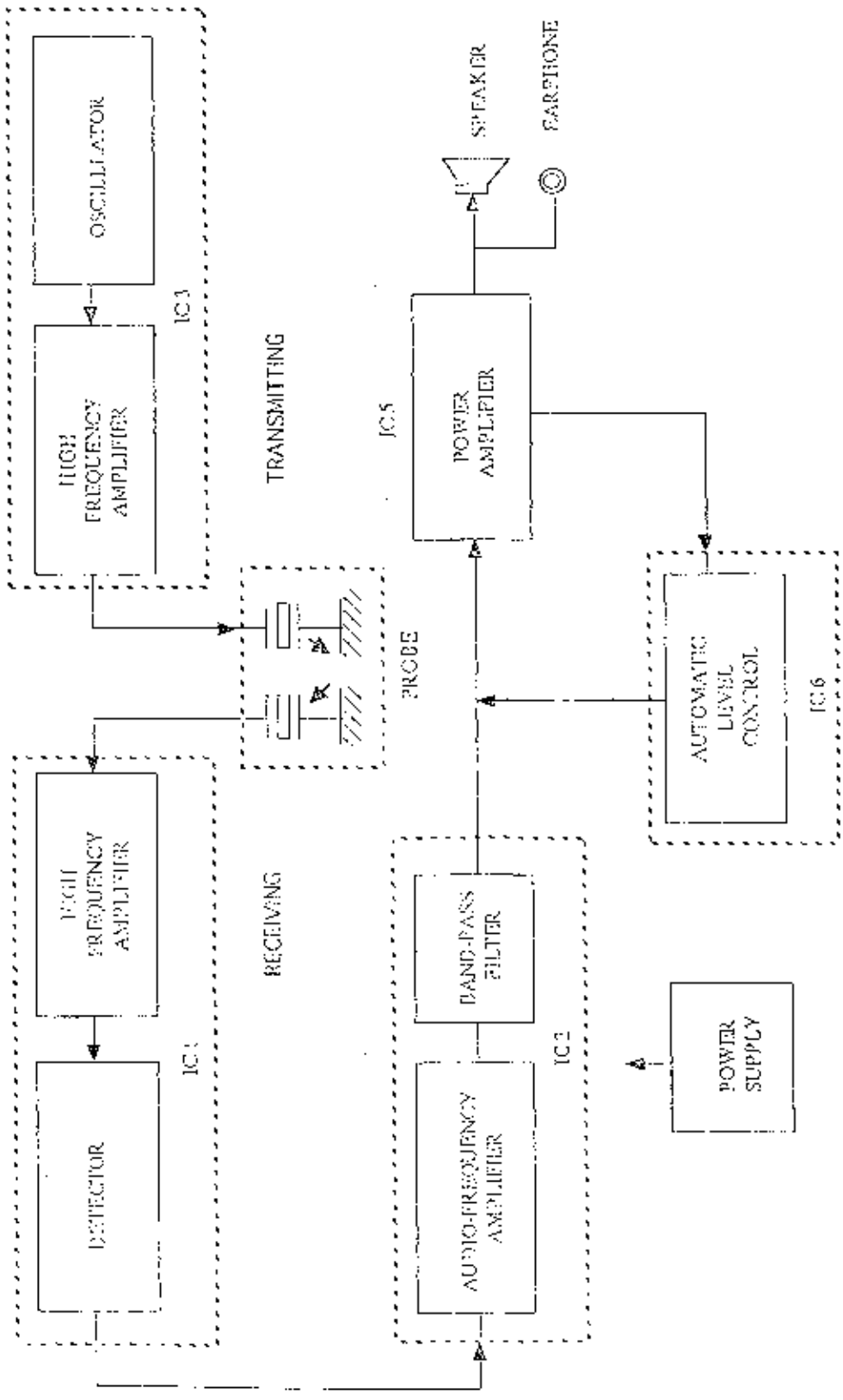


***Figure 3**. Handy type Doppler fetus detector*

Receiving transducer element in the probe receives the ultrasonic power reflected inside the patient body as well as the leakage of ultrasonic power from the transmitting element, and transducer them into electronic signal.

Output of the receiving transducer element is sent to the high frequency amplifier and the amplified signal is detected by the detector in IC1, output of which is an audible due to Doppler Shift. The audible signal is amplified by the AF amplifier and goes through a band-pass filter to eliminate noise.

Output of the band-pass filter is supplied to the power amplifier, which drives the speaker (or the earphone). Automatic sound level control is done by feedback to input of the power amplifier through the ALC (automatic level control) circuit.

3. General precaution

1) The probe should carefully be handled.
   - Never drop down the probe.
   - Never give any shocks to the probe.
   - Do not force to pull the probe's cable and connector.
2) Make sure the main line voltage, frequency and power are correct for the operation of equipment.
3) Make sure the earth line always be connected properly.
4) Install the equipment in an environment where it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, sunlight and dust, etc.

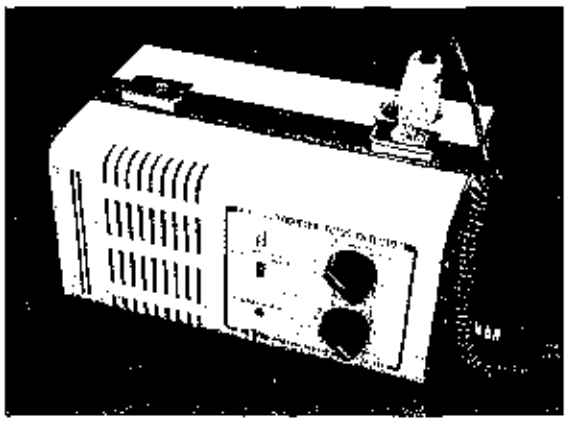


Figure 4. Doppler Fetus Detector

4. Maintenance

4.1 General Maintenance

General maintenance is carried out under responsibility of the operator. However, the biomedical engineering section should help the operator for this maintenance since they also carried out the regular maintenance. The following inspection items should be carried out:

1) Visual Inspection

Inspection of:

- appearance of the enclosure, e.g., dirt, corrosion, rust, injury.
- injury of power cable and plug
- loosen screws
- lose connection of any connectors
- probe, e.g., dirt, injury.

2) Functional Inspection

- Are all accessories required in operation completed ?
- When the Power (AC/DC) is ON, is the Green Lamp lit ?
- When AC switch on, are the Red lamp and the Green lamp lit ?
- When AC switch OFF, is Red lamp lit ?
- Are some noises heard excepting Doppler sound ? If "Yes ", contact the National workshop engineer.

3) Maintenance of Probe

Always clean up the surface of the probe by using dry cloth after using the equipment.

NOTE: *- The probe should carefully be handled.*
- Never drop down the probe.
- Never give any shocks to the probe.
- Do not force to pull the probe's cable and connector.

4) Maintenance of Main Body

Clean up the body of the equipment by using dry cloth.

4.2 Regular Maintenance

Regular maintenance is carried out under responsibility of technical personnel.

1) Visual/Functional Inspections

The inspections are recommended to be carried out at once every six months.

2) Performance Inspection

The inspection recommended to be carried out at once per annum. The following inspection items are performed:

- Working function test
- Battery condition

CODE	
EQUIPMENT NAME	Doppler Fetus Detector
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Doppler Fetus Detector only		
1	Check & clean the doppler probe (Transducer)	Good / Fail	
2	Check performance of rechargeable battery	Good / Fail	
3	Check conductivity of induction cord	Good / Fail	

REMARK

Date inspected	/	/ 2005	Inspector	
Room Temp.		°C	Approved by	

6-2. FETAL ACTOCARDIOGRAPH

1. Introduction

The Actocardiograph is equipment used to monitor the condition of fetus by measuring and recording Fetal Heart Rate (FHR), Fetal Movement (FM) and maternal uterine contraction (UC) simultaneously.

Ultrasound Doppler method is used for measurement of FHR and FM. Unique feature of the Actocardiograph is in detection of FM from the Doppler signal.

This method provides more reliable and objective means for detection of the fetal movement as cooped with conventional subjective fetal movement detection. Therefore, the Actocardiograph is suitable for the non-stress test (NST), which is an important practice, performed in middle ad later periods of pregnancy for prognosis of fetus. It is also useful for prediction of potential fetal distress and for detection of fetal distress before and during delivery.

Direct ECG method can also be used for FHR measurement. For UC measurement, external or internal method is used.

2. Principle of Operation

Fetal Actocardiograph is used for measurement of FHR by microphone or ultrasound dropper probe. As well as, to show the heart rate and ECG wave form on display by detecting signal of cardiogram through the abdominal wall.

In the labor curve measurement, labor wave that proportionate to maternal uterine contraction is detected by putting transducer, which is the one of electrode, on abdomen of pregnant woman.

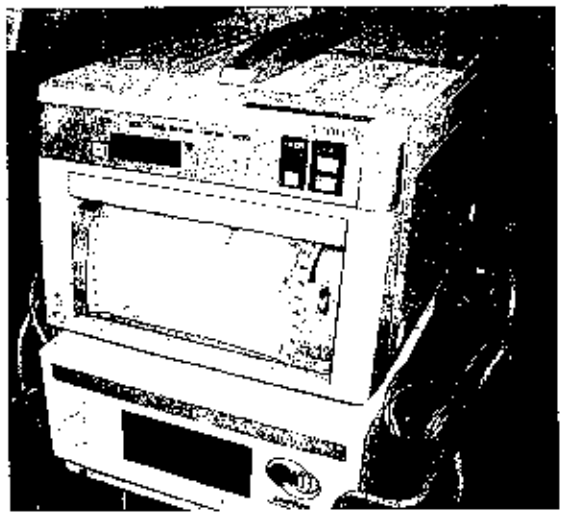


Figure 1. shows the external view of the Fetal Actocardiograph

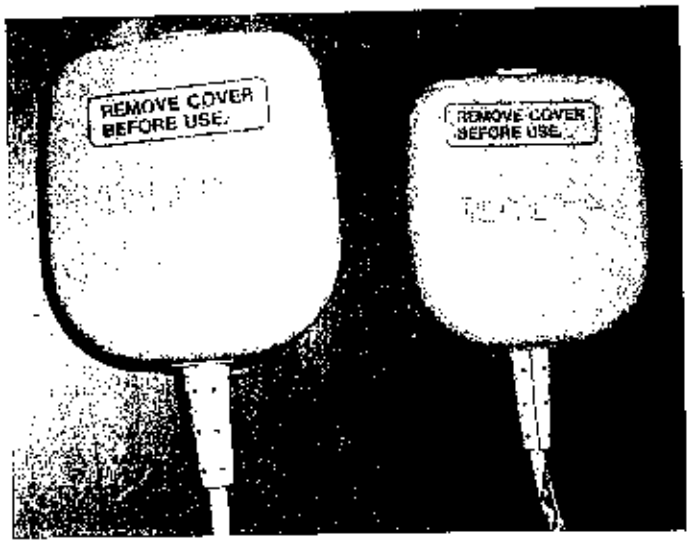


Figure 2. External view of the transducer

3. General precaution

1) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
2) Do not install the equipment in a storage environment containing gas or other chemicals.
3) Take care the place where the equipment in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, ventilation, sunlight and air contaminating dust, etc.
4) Make sure the main line voltage, frequency and power are correct for the operation pf the equipment.
5) Make sure the power system for the equipment is properly grounded.
6) Never splash water or some liquid directly onto the unit as this may cause electric shock or short circuit to break the equipment.
7) Do not hurt powers cord. It will be the cause of fire, electric leakage or short circuit.
8) During operation, do not plug off power cord to avoid future troubles. In this moment, make sure to turn off main switch before removing power cord.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. Visual inspection list for Fetal Actocardiograph

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dust/dirt on the surface of body and operation panel
2. Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Doppler transducer, ECG cable, and others accessories	- Crack, injured, broken, dirt, or deteriorates the material.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for Fetal Actocardiograph

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check Doppler sound	- After turn ON, carefully listen the Doppler sound.
4. Check ECG wave signal	- Inspect the ECG wave signal indicate on the display properly.
5. Check and clean the Doppler transducer and ECG electrode	- Check and clean any dirt, dust and clot some blood protein. - refer to cleaning method as follow.
5. Check and Clean the main body	- Check and clean any dirt, dust and clot some blood protein. - refer to cleaning method as follow.

※ Cleaning method

A) Cleaning the main unit

- Do not wipe cabinet, made of plastic, with benzene or thinner to avoid its deterioration.
- When use chemical cleaning duster, apply it according to the instruction.
- Wipe off spots on operation panel or cabinet with soft cloth. In case of heavy spots, remove with cloth, which is dipped with neutral detergent made thin and then sufficiently wrung. Finally wipe with another dry and soft cloth.

B) Cleaning the transducer

- Each time after the unit is applied on patient, wipe up the remained ultrasonic gel on surface of transducer probe with soft cloth or paper and put the probe cover on it.
- If it is difficult to wipe up as the gel has become hard, use the soft cloth immersed into warmer water and lightly wrung.
  Every time when apply to a new patient, clean and disinfect entire surface of probe with soft cloth or gauze immersed with alcohol.

C) Cleaning the ECG electrode

- To clean the ECG electrode, wipe up the remained ECG paste on the electrode with soft and damp cloth after applied on patient and clean and disinfect it every time when use to a new patient.

CODE	
EQUIPMENT NAME	Fetal Actocardiograph
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp and indicator properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Fetal Actocardiograph only		
1	Check & clean ECG patient electrode and cable	Good / Fail	
2	Check & clean transducer	Good / Fail	
3	Check function of operating panel, knob and switch	Good / Fail	
4	Check gripping force between mains plug and mains socket	Good / Fail	
5	Check contact between patient cable and electrode	Good / Fail	
6	Check the ventilation fan	Good / Fail	
7	Check function of thermal pen	Good / Fail	
8	Check function of recorder	Good / Fail	
9	Check & replace Rechargeable battery (If equipped with)	Good / Fail	

REMARKS

Date inspected	/	/ 2006	Inspector		
Room Temp.		°C	Approved by		

7-1. CENTRIFUGE

1. Introduction

Centrifuge is a rotating machine, which uses centrifugal force to separate molecules from solution, particles and solids from liquids, and immiscible liquids from each other.

※ Typical Centrifuges

Depending on the purposes, different types of centrifuge are available as given below:

- High-speed centrifuge
- High-speed refrigerated centrifuge
- Hematocrit Centrifuge
- Ultra centrifuge

2. Principle of Operation

Figure 1 presents schematic structure diagram of a High-speed centrifuge. Centrifuges mainly consist of rotor, motor and motor speed control circuit; it is a simple instrument but mechanically a high precision and sensitive instrument. In recent years, new developed centrifuges, which apply a highly advanced technology, are applied widely, i.e., new developed motors (e.g., inverter motor, brushless motor), and computerized motor speed control circuit.

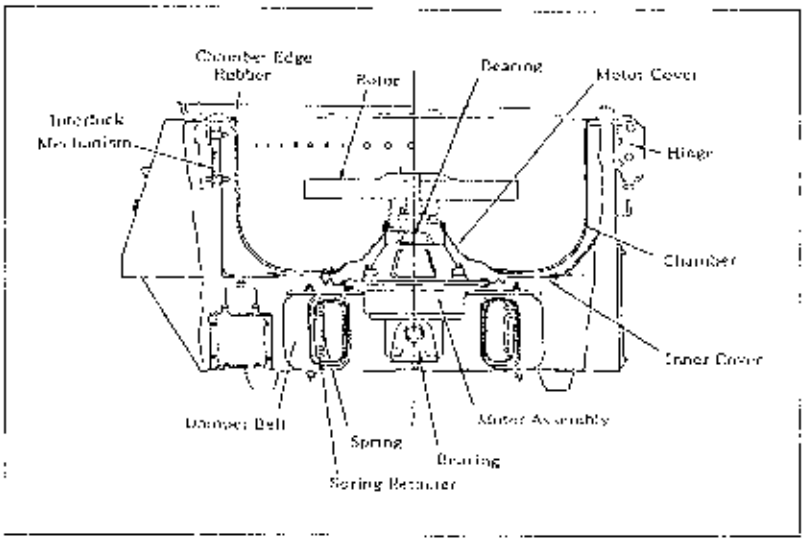


Figure 1. Schematic structure of a centrifuge

3. General Precautions

3.1 Installation

Centrifuges must be installed on a rigid horizontal table or bench. If the table or bench is not horizontal or snaky, the auto balancing effect will be diminished and imbalance detector will operate frequently.

3.2 Power requirement

The source voltage must be within the acceptable voltage range both under no load and at maximum load. Generally, the acceptable voltage range is ±10 % from rated source voltage which is indicated on the name plate located on the back of the centrifuge; but rapid fluctuation of power source voltage may cause of instrument's breakdown.

3.3 Connecting power safety

Securely plug the power cord to an outlet that delivers power source voltage and securely connect the ground wire (yellow and green striped pattern) to the ground terminal. For added safety, also ground the protective ground terminal on the rear of the centrifuge.

3.4 Handling of Chamber Lock

When the motor is rotating, the chamber lock always is locked in order to operator's safety. Therefore, do not handle it with excessive force in that time.

3.5 Ensure the Balance of the Motor

Operation of the centrifuge in an extremely unbalanced state will greatly shorten the life of the centrifuge motor and the centrifuge itself and involves danger.

3.6 Other

Normally, the centrifuge that consists of brush motor is not explosion-proof. So do not use it for centrifugal separation of inflammables.

4. Maintenance and check

4.1 General maintenance

[Inspection before and after operation]

1) Is the ground wire correctly connected?
2) Is the rotor-locking bolt completely tightened?
3) Is the bucket cushion installed in the correct direction?
4) Is the motor cover properly fixed?

5) Is not any foreign matter in the chamber interior?

6) Are the lamp indicator and switches normal?

4.2 Monthly Maintenance

1) Remove the chamber and clean it up.
2) Check the rotor, bucket, etc., for any scar, deformation and rust.
3) Conduct a test run and make sure that the equipment operates correctly.
4) Inspect the function of safety detectors such as over speed detector and imbalance detector if the equipment has such functions.

4.3 Yearly Maintenance

Check the motor carbon brushes. Afterward, inspect the items of monthly maintenance. Checking method of the motor carbon brushes is as follows:

1) Disconnect the power cord from the power outlet.
2) Remove the screws on the rear panel to open the panel (See Figure 2).
3) There are two carbon brushes in the bottom of the motor. Turn the cap counterclockwise to remove it (See Figure2), check the carbon brushes, and turn the cap clockwise to tighten it firmly.

***CAUTION**: When the carbon brush is pulled out for inspection, be sure to insert it in the original direction. If the direction is reversed, there will be noticeable sparking and the motor commutator will be deteriorated.*

4) Replace the carbon brush when it is worn to a length of 5mm as shown in Figure.

***CAUTION**: In such a case, genuine parts must be used; the other specified type will shorten the motor life considerably.*

5) When the carbon brush is replaced with a new one, conduct aging operation at approximately 500rpm for approximately 30 minutes.

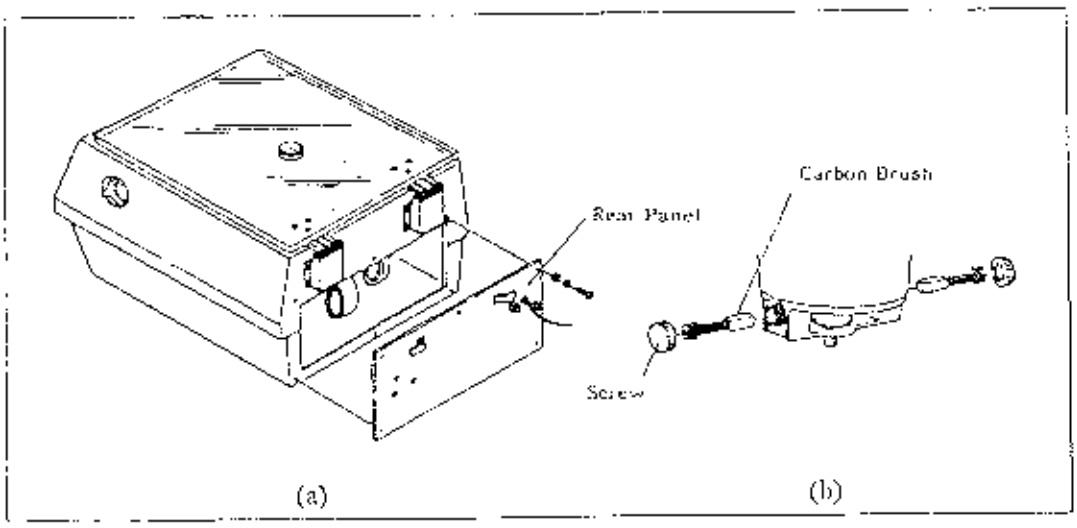


Figure 2. Removing carbon brushes

***CAUTION**: The oil content deposited on the surface of the commutator and the carbon brush will greatly lower commutation and deteriorate the motor. In the maintenance and replacement of the carbon brush, do not touch the surface of the contact with a material containing oil. If the surface of the commutator in contaminated with oil content, wipe it off by using alcohol.*

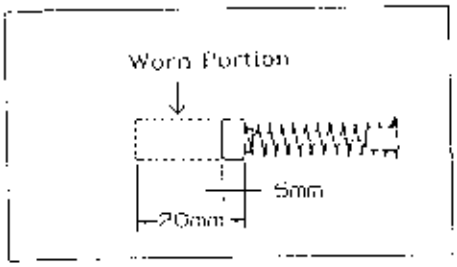


Figure 3. Guideline to replace the carbon brush

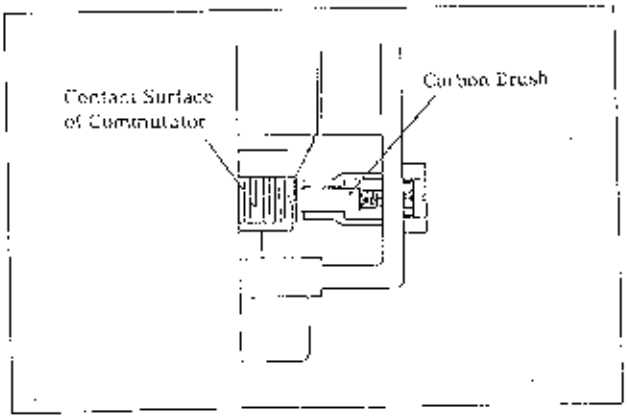


Figure 4. Commutator of motor

4.4 Lubrication

In case of modern type centrifuge, the motor bearing needs no lubrication because it uses a special bearing that needs any lubrication. Inappropriate lubrication may lead to trouble and it must be avoided.

4.5 Cleaning

1) If sample has split onto the rotor, bucket, chamber, etc., remove the contaminated part from the centrifuge, and wash it well with neutral detergent and then allow it to dry before reuse.
2) Sterilization of rotor and bucket: When sterilizing the rotor and bucket, do not heat them over 100°C. Do not use an autoclave for sterilization or conduct dry heat sterilization.

4.6 Regular Maintenance

The technical staff has responsibility of carrying out the regular maintenance that includes visual, functional, performance and electrical safety inspections.

1) Visual inspection

   Table presents items of visual inspection.
2) Functional inspection

   Read the instruction manual carefully, and carry out the following description of functions:

   a) Door open indicator lamp
   b) Imbalance detector and its indicator lamp
   c) Over speed detector and its indicator lamp
   d) Speed selector knob and setting potentiometer
   e) Time selector knob and setting potentiometer
   f) Test run in accordance with operating procedures
3) Performance inspection

   [Checking the motor brush]

   Refer to yearly maintenance

Table 1. Multi-purpose centrifuge check list in visual inspection

	Check item	Description
1	External packing	Broken cove, cracked/broken panel, rust/dents on the body
2	Knob and switch	Cracked/broken knobs and switches , loose fixing of switches / knobs, smooth movement of knobs/switches
3	Indicator	Broken digital indicator, broken meter cover
4	Electric cord	Injured/broken electric core/wire or cable insulation, strain, twist and hardness of electric core/insulation of cable or wire.
5	Power connector	Cracked/broken power connector, bent/cracked of power connector's pins.
6	Screws	Loose/missing screws/washers/bolts/nuts
7	Chamber and interlock	Contamination of chamber, injured/broken motor cover, loose interlock, broken/cracked chamber cover
8	Motor Axis	Inspection of injured motor axis, loose dumper of motor
9	Hinge	Inspection of loose hinge
10	Accessories	Inspection with reference to instruction manual

CODE	
EQUIPMENT NAME	Centrifuge
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for centrifuge only		
1	Check & clean inside of the rotor chamber	Good / Fail	
2	Check, lubricate & adjust the rotor shaft	Good / Fail	
3	Check the lid cover close properly	Good / Fail	
4	Check speed control & meter	Good / Fail	
5	Check the timer function	Good / Fail	
6	Check & replace carbon brush	Good / Fail	

REMARKS

Date inspected	/ / 2005	Inspector	
Room Temp.	°C	Approved by	

7-2. MICROSCOPE

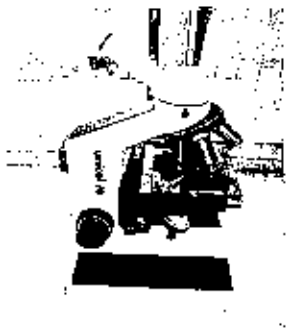
1. Introduction

Microscope is used in order to perform blood slide examination for many kind of diagnosis in medical laboratory.

※ Components and parts of microscope

There are a number of types of microscopes used in clinical laboratory. The microscopes typically used in several type of blood and urine samples diagnosis are classified into the following three types.

- ✧ Sunlight microscope (illumination light is provided by the sunlight)
- ✧ Electric microscope (illumination light is provided by electric light source)
- ✧ AO microscope (illumination light is provided by electric light source through excitation filter)



Sunlight type

Electric type

A.O. type

2. Principles of operation

In order to perform blood slide examination properly, microscopes must be used and handled in an appropriate manner. Failure to follow its guidance may not only incur incorrect diagnostic results but result in breakage of equipment. The standard procedures of microscope use in three stages: (1) preparation stage; (2) operation stage; and (3) wrap-up and storing stage.

All the main parts of a typical compound microscope (sunlight microscope) are illustrated in Fig. 1

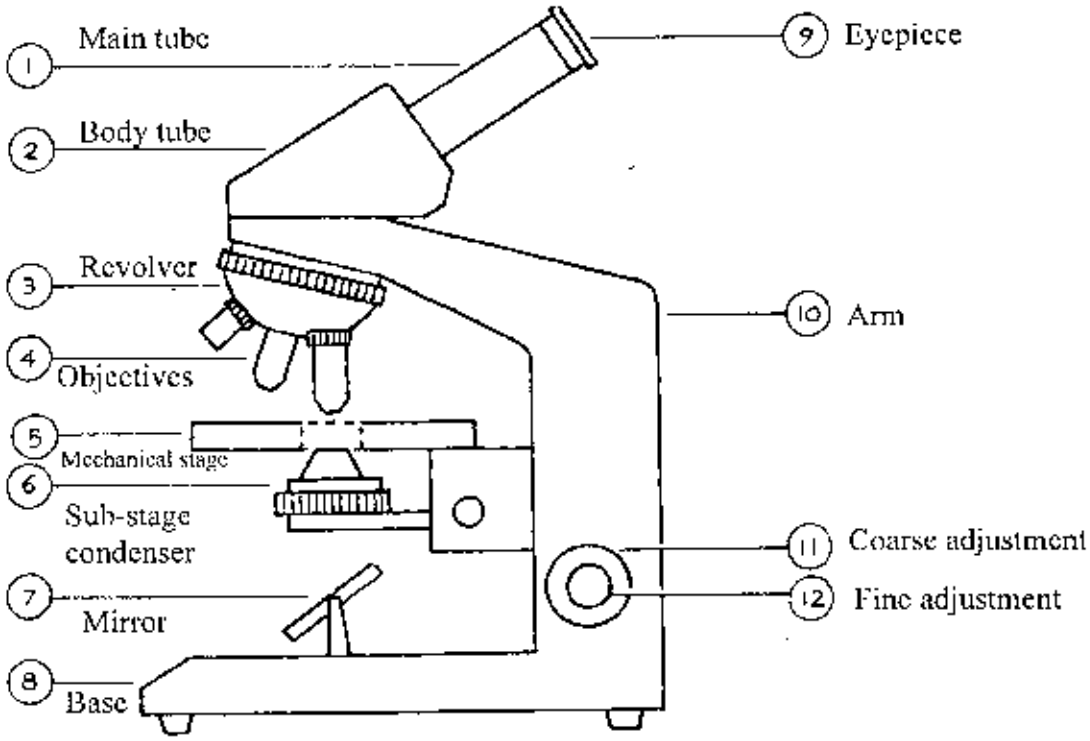


Fig. 1 **Parts of a typical compound microscope**

(1) Main tube and (2) body tube (Prism)

The main tube and body tube are often collectively called the head of the microscope. The eyepiece is located at the top of the main tube.

(3) Revolver

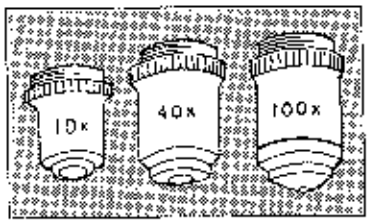
A number of objective lenses of different magnifications are screwed into the nosepiece of the microscope which can then be revolved to increase or decrease the magnification of the specimen being examined.

(4) Objectives

Objectives are referred to by their magnifying power (the number of times by which it will magnify the image produced by the objective), which is usually marked on the side. A microscope is typically equipped with a combination of several of the following objectives.

X10
X40
X60
X100

Fig. 2



Objectives , showing magnification

The x100 objective is often referred to as the oil immersion objective. It sometimes has a black or red ring around it for easy identification.

(5) Mechanical stage

The mechanical stage holds the slide secure and allows the specimen to be moved smoothly backwards, forwards or sideways.

(6) Sub-stage condenser (with iris diaphragm)

The sub-stage condenser is made up of a number of lenses. These centre the light from the mirror, or electric light source, to a central spot on the field. The sub-stage condenser can be raised or lowered to give maximum or minimum illumination.

Inside the condenser is the iris diaphragm. This is used to control the amount of light passing through the condenser. The iris diaphragm consists of a number of interlocking leaves made of a thin metal. It is adjusted by means of a lever.

(7) Mirror

The mirror is used to direct light from the light source to the microscopic field.

The mirror has two sides, one of which is a plane or flat surface and is used with the sub-stage condenser. The other surface is concave and is used without the condenser (the curved surface itself acts as a condenser).

(8) Base

Whatever the shape of the base of the microscope (usually U-shaped or rectangular), it must rest on a firm, flat bench or table. It is essential that the microscope does not wobble while it is being used.

(9) Eyepiece (Ocular)

The ocular or eyepiece fits into the upper end of the main tube and is what the microscope user (laboratory technician) looks through when using the

microscope. The ocular has its magnifying power marked on it. For instance, with an eyepiece of x7 and an oil immersion objective of x100, the total magnification of the specimen would be 7 x 100 = 700.

(10) Arm

The arm forms rigid support for the main tube and stage of the microscope.

(11) Coarse and (12) Fine Adjustment

The two adjustment system - coarse and fine – are used to focus the specimen being examined. The coarse adjustment is for rapid and relatively large movements of the stage.

The fine adjustment is for the finer focusing required when the higher powered objectives are used.

Note: Normally, the specimen is initially focused with the coarse adjustment and then with the fine adjustment when the specimen is being examined.

3. General Precautions

- Microscopes must be installed in a clean environment, away from chemicals.
- Workspaces should be well ventilated or permanently air-conditioned.
- Humidity and higher temperatures often result in the growth of a fungus that can corrode optical surfaces.
- Optical instruments should not be kept for long periods in closed compartments since these conditions encourage fungal growth.

4. Maintenance and check

In order to maintain the microscope in working order, measures to prevent it from failure and breakdown must be in place. Those measures include: (1) management of working environment in which the microscope is used; and (2) regular maintenance of the microscope. The latter approach is sometimes referred to as preventive maintenance.

Type of preventive measures	Measures/activities
Management of working environment	● Managing power supply ● Maintaining the room condition
Regular maintenance	Daily Maintenance (maintenance activities conducted on daily basis) ● Cleaning the equipment body and surface of the main parts of the microscope Periodic maintenance (maintenance activities conducted weekly, monthly or quarterly basis) ● Cleaning lens ● Lubricating mechanical parts (in most cases, conducted by service technicians) ● Cleaning filters (in most cases, conducted by service technicians)

The following section describes the preventive measures that can be undertaken by microscope users without specialized mechanical knowledge and skill.

CODE	
EQUIPMENT NAME	Microscope
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Microscope only		
1	Check & clean Eyepiece	Good / Fail	
2	Check & clean Tube head	Good / Fail	
3	Check & clean Objective lens	Good / Fail	
4	Check & clean Condenser lens	Good / Fail	
5	Check & clean Absorption filter and mirror	Good / Fail	
6	Check & replace Power fuse	Good / Fail	
7	Check & replace Halogen bulb	Good / Fail	
8	Check Bright volume control	Good / Fail	

REMARKS

Date inspected	/ / 2005	Inspector	
Room Temp.	°C	Approved by	

7-3. SPECTROPHOTOMETER

1. Introduction

Spectrophotometers are instruments that measure photometric intensity of each color or wavelength present in an optical spectrum. The colour is usually due to the formation of a coloured compound by the addition of an appropriate reagent or it may be inherent in the desired constituent itself. The intensity of the color may be compared with that obtained by treating a known amount of the substance in the same manner.

An optical spectrometer is an instrument processing an optical system, which can produce dispersion on incident electromagnetic radiation, and with which measurements can be made of the quantity of transmitted radiation at selected wavelength of the spectral range. A photometer is a device for measuring the intensity of transmitted radiation or a function of this quantity. When combined in the spectrophotometer, the spectrometer and photometer are employed conjointly to produce a signal corresponding to the difference between the transmitted radiation of a reference material and that of a sample at selected wavelength.

2. Principle of Operation

2.1 Ultraviolet and Visible Lights

Molecules and atoms absorb or emit light at characteristic wavelength. This both identifies the species and can be used for quantitative analysis. The other electrons of molecules or atoms are excites by ultraviolet or visible absorption. The most accessible spectral ranges are 185 to 400 nm for the ultraviolet, and 380 to 790 nm for the visible.

The absorption of visible light and color are listed in Table 1.

These properties are applied in absorption spectrophotometry as symbolic analytical equipment. The most popular type commercial spectrophotometer is designed for absorption analysis of liquid, solid and gaseous samples in ultraviolet, and near infrared spectra regions.

2.2 Structure

The latest model of spectrophotometer combines a modern semiconductor detector with electronic and a microcomputer (CPU), thus providing a good performance with excellent stability, high S/N ratio and a wide wavelength range covering 200 to 1 100nm with a band width 5 ± 0.5 nm.

Table I. Absorption of visible light and color

WAVELENGTH (nm)	*COLOUR (ABSORBED)*	*COLOUR ABSORBED OR COMPLEMENTARY HUE*
< 380	Ultraviolet	
380 - 435	Violet	Yellow with green
435 - 480	Blue	Yellow
480 - 490	Greenish blue	Orange
490 - 500	Bluish green	Red
500 - 560	Green	Purple
560 -580	Yellowish green	Violet
580 - 595	Yellow	Blue
595 - 650	Orange	Greenish blue
650 - 780	Red	Bluish green
> 780	Near-infrared	

Optical System

Figure 2 shows UV-visible spectrophotometer, and its optical diagram is shown in Figure 3. The light beam emitted from the light source is led through the light source mirror and filter to the entrance slit, focusing as an image of the light source. The light beam passing through the entrance slit is reflected by the mirror, being led by the collimating mirror (concave mirror) to the holographic grating, where being dispersed, and then coming to the exit slit as a continuous spectrum.

The monochromatic light beam passing through the exit slit is led through the sample compartment and the lens to the detector. The detector (Photo-cell) exchanges optical signal to electric signal.

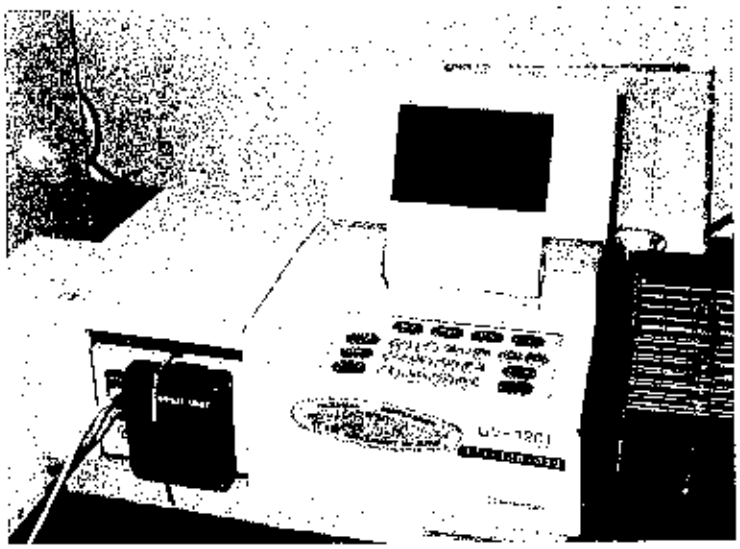


Figure 2. External view of spectrophotometer

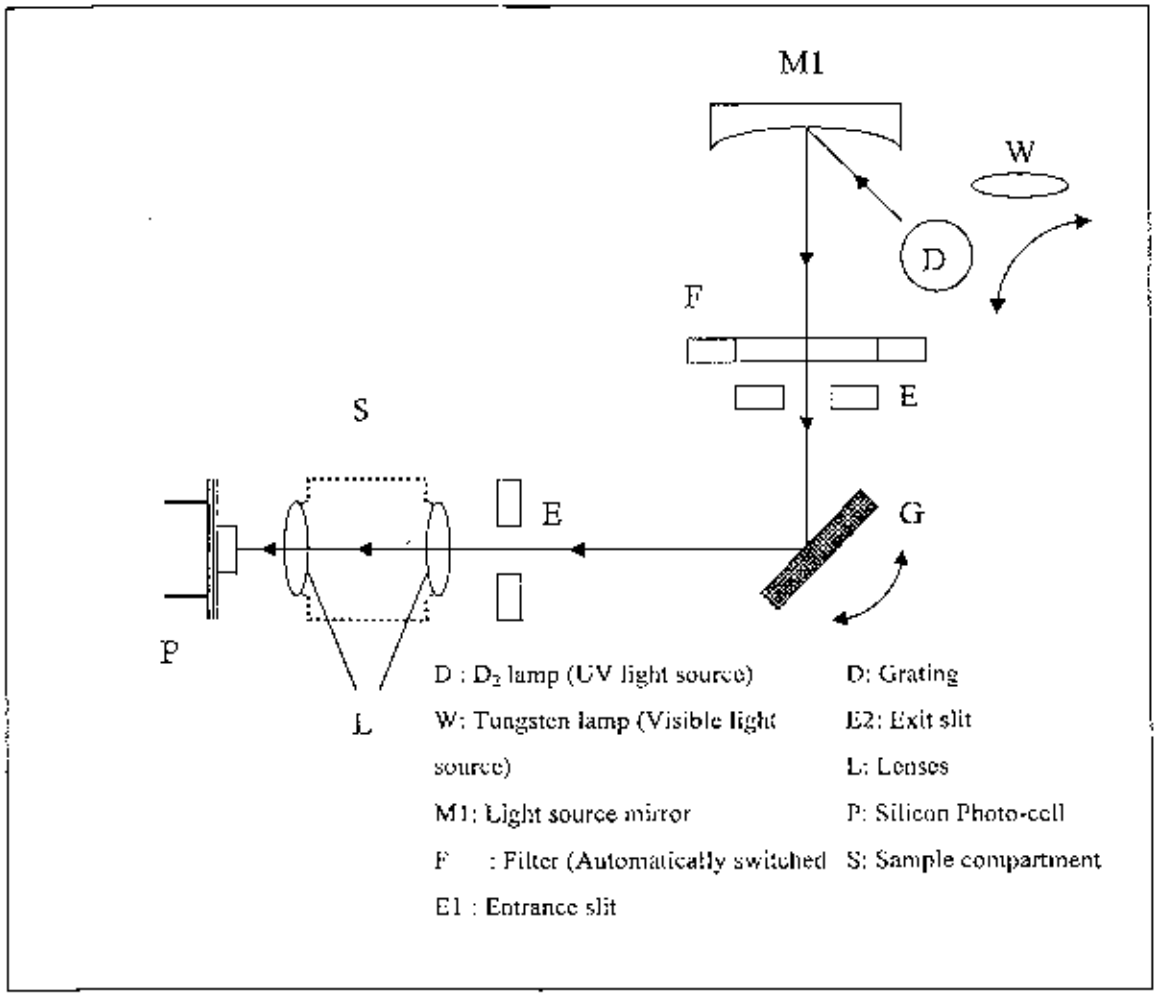


Figure 3. *Structure of optical systems*

3. General Precautions

3.1 Location

1) Install as far as possible from any other apparatuses, which generate strong magnetic, electric or high frequency field. Also, do not the same power outlet location that is used for one of the above apparatuses.
2) Install at a location free from violent vibration.
3) Avoid dusty atmosphere, corrosive gases, direct sunlight, and excessive temperature.
4) Do not expose the light source housing of the spectrophotometer directly to weight.
5) Install the spectrophotometer on a rigid desk capable of supporting 25kg weight.
6) To exchange a light source, place the spectrophotometer 20cm far away from the wall surface.

3.2 Power Requirement

1) The allowable fluctuation of the line voltage is ±10 %. However, if quick variation of the voltage is likely to occur even in the specified range of voltage regulation, it is recommended to use an AC stabilized power supply.
2) Be sure to ground the earth terminal. Use the grounding adaptor for dual-pin receptacle. In this case, connect the grounding wire of the grounding adaptor to the earth terminal of power source.

3.3 Operation

1) Warm up: In order to get accurate results, the instrument should be in warming up at 10 minutes after switched on.
2) When changing the wavelength, operate the wavelength counter and its knob gently. For CPU controlled instrument, the wavelength is automatically selected.
3) When over-flow: The meter indicates a meaningless value such as 00.0 or 0.00 and blinks, and most significant digit of printed value is "2".

4. Maintenance and check

4.1 Visual Inspection

Check list for visual inspection of spectrophotometer is shown in Table 2.

Table 2. *Check list for visual inspection of spectrophotometer*

Check Item	Description
1. External Packing	Broken cover, cracked/broken panel cover, missing characters, rust/dents on the body
2. Knob and Switch	Cracked/broken knobs and switches, loose connection of switches/knobs, smooth movement of knob/switches
3. Indicator/Screen	Broken digital indicator, broken indicator cover, injured LCD surface
4. Electric Core	Injured/broken electric core/wire or cable insulation, strain, twist and hardness of electric core/insulation of cable or wire
5. Connector	Cracked/broken connectors, bent/cracked connector's pins, broken power connector and its pins
6. Screws	Loose/missing screws/nuts/washers/knobs
7. Sample Compartment	Broken lid of sample compartment, smooth movement of sample compartment knob, loose fixing of cells
8. Wavelength Counter	Smooth movement of counter
9. Accessories	Inspection with reference to instruction manual

4.2 Functional Inspection

Description of functional inspection depends on the model and type of equipment. Here, descriptions for manual type spectrophotometer will be described. As manual type could be maintained, automatic type or latest model of instrument could be applicable.

1) Power switch for normal operation.
2) "SENS" switch for normal operation
3) "0% ADJ" knob for normal operation: "High" position is 8 times of "Low".
4) "COC" knob for normal operation: x1 - x30
5) "RANGE" selector knob for normal operation
6) 100%T or Abs. 0 adjusting knob for normal operation
7) "WAVELENGTH" dial for normal operation
8) Sample selection lever fro normal operation
9) Recorder output terminal for normal operation: 100 mV to 100%
10) "SPAN" variable resistor for normal operation
11) Light source position: Remove the top cover of the light source housing and confirm that a light beam from the W-lamp is focused on the centre of entrance slit of the monochromator as shown in Figure 4.5.

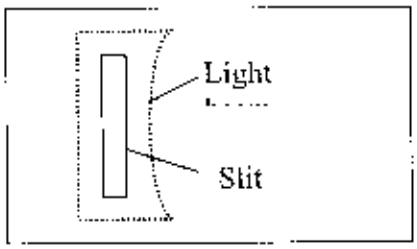


Figure 4 *Focus of W-lamp*

CODE	
EQUIPMENT NAME	Spectrophotometer
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Spectrophotometer only		
1	Check & clean measuring display	Good / Fail	
2	Check & clean sample compartment	Good / Fail	
3	Check & clean Cuvet cell	Good / Fail	
4	Check function of wavelength counter	Good / Fail	
5	Check function of Tungsten lamp	Good / Fail	
6	Check function of D2 lamp	Good / Fail	
7	Check Performance inspection (Stability)	Good / Fail	
8	Check Performance inspection (Repeatability)	Good / Fail	
9	Check Performance inspection (Sensitivity)	Good / Fail	

REMARKS

Date inspected	/ / 2005	Inspector	
Room Temp.	℃	Approved by	

7-4. WATER DISTILLER

1. Introduction

In water stills, water is purified by evaporation and condensation of the steam. Distilled water may be produced by simple distillation equipment on a small or large scale, according to the needs.

2. Principle of Operation

Figure 1. shows a schematic diagram for principle of water distiller. This equipment applies simple mechanical parts.

Water is supplied from water inlet, and goes to evaporator via cooling coil inside of the condenser then into the chamber. The evaporator keeps the water level inside of the chamber. Water becomes steam due to the heater and goes through condenser. While passing inside of the condenser, the steam is cooled down by cooling coil, and it will be changed to "water". Water came out from the condenser means that "Distilled Water", which impurities were removed.

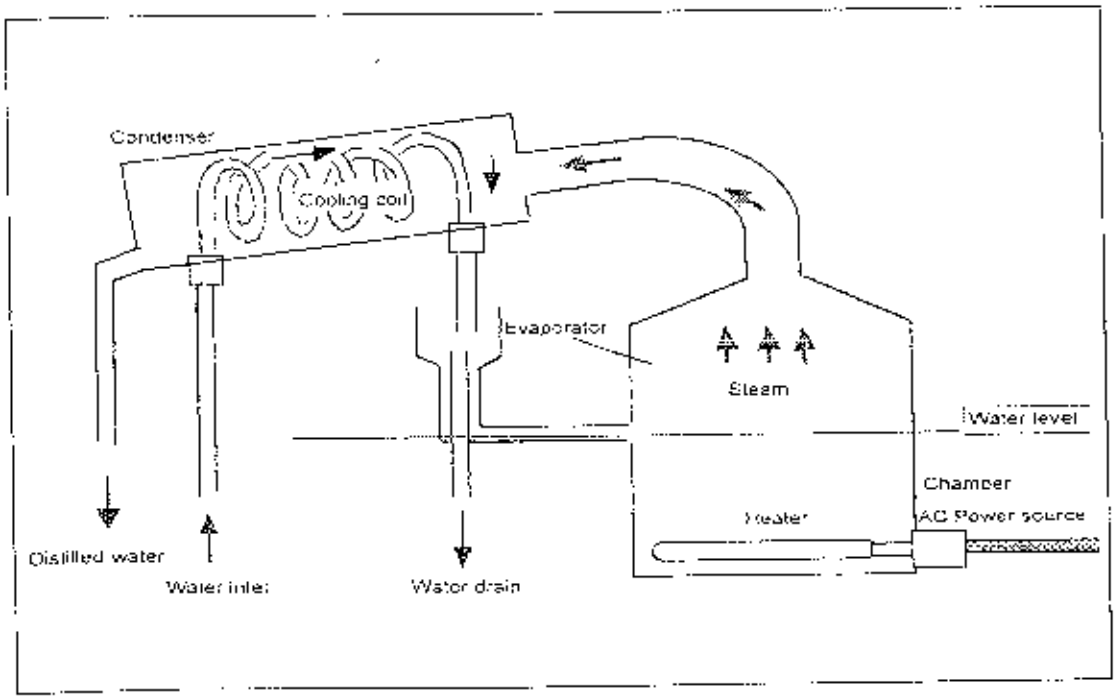


Figure 1. *Schematic diagram for principle of water distiller*

※ Structure of Equipment

Figure 2. shows the structure of this equipment and name of parts works as:

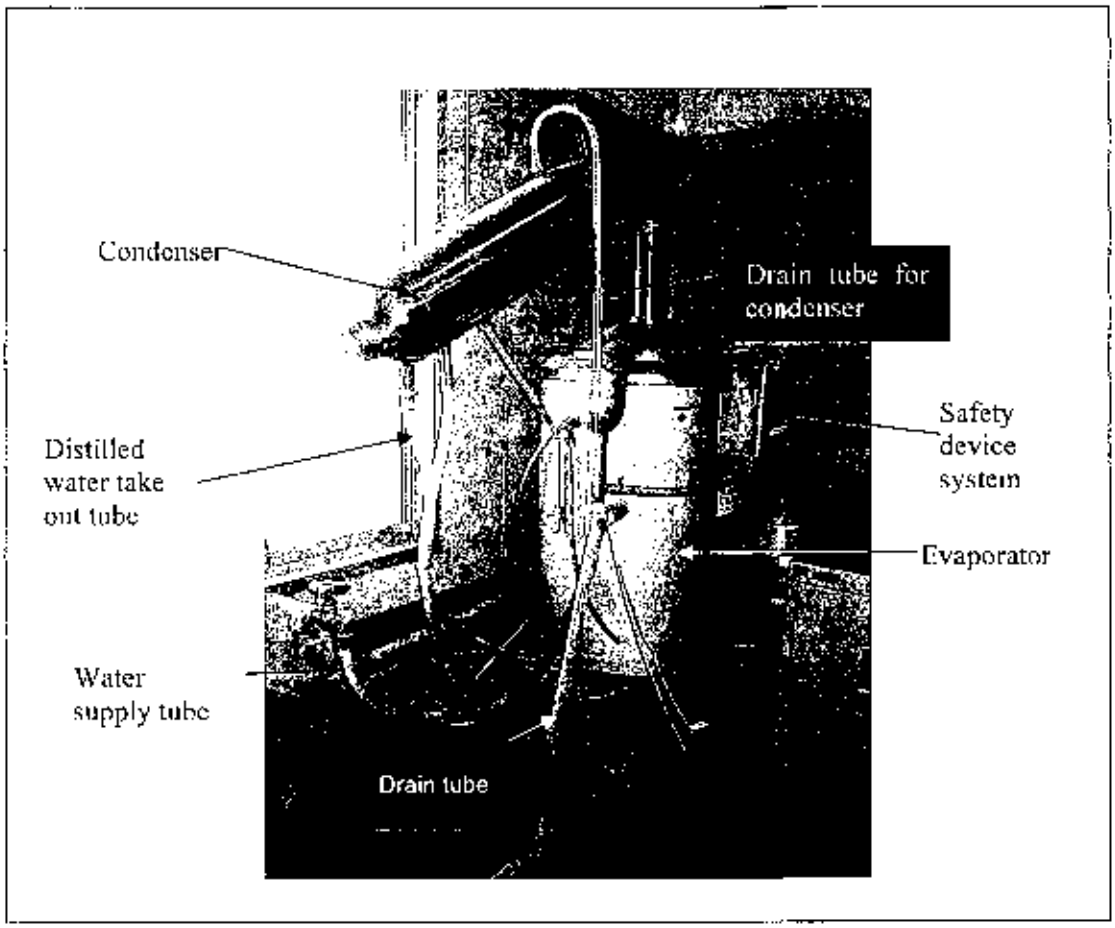


Figure 2. Structure of water distiller

Water Circuit Part

1) Water supply tube: connected with the water tap.
2) Drain tube for condenser: supplied water from the tap goes through the cooling coil in the condenser, and comes out from this.
3) Water level for evaporator: adjusts the water to be boiled.
4) Evaporator (chamber): keeps the water to be boiled.
5) Drain cock for evaporator: drains water from the chamber when maintaining the instrument
6) Drain tube for over-flow: drains water from the chamber when the water level is excessive.
7) Lid: protection for steam pressure.
8) Condenser: changes the steam generated from the boiler to water by its cooling coil.
9) Distilled water take out tube

Electrical and Mechanical Part

10) Electric cord
11) Main switch (no-fuse breaker)
12) Heater
13) Safety device system
14) keeping warm plate
15) metal clips for lid
16) Supporter for condenser

3. General precaution

1) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
2) Do not install the equipment in a storage environment containing gas or other chemicals.
3) Make sure the main line voltage, frequency and power are correct for the operation of the equipment.
4) Make sure the power system for the equipment is properly grounded.
5) Check constantly to ensure that there is a sufficient supply of cooling water, the boiling flask does not run dry ad receiver is not overfilled.

4. Maintenance and check

4.1 Inspection Requirements

Inspections required for this equipment are shown in Table 1.

4.2 Measures Against Faults Found by Means of Inspections

During the inspection, faults could often be found. In this case, remedial action may be performed as shown in Table 2.

Table 1. Inspections required for water distiller

TYPE OF INSPECTION	RESPONSIBLE	DESCRIPTION	FREQUENCY
Visual Inspection	Laboratory staff	Check the following descriptions: - Dirt, dust on the screws/body - Water leakage - Water flow from the drain - Is the earth wire connected properly?	Daily
Periodic Inspection	Laboratory staff	- Check all the descriptions carried out in visual inspection. - Open the lid and check the scheelite accumulated inside of the chamber. - Check scheelite and dirt inside of the evaporator. - Check the value of water flow. If the value is not appropriate, adjust it	Monthly
Regular Inspection	Engineering staff	Check the following safety descriptions: - Insulation resistance - Correct Earth connection - - Check all the descriptions carried out in visual/periodic inspections. - Check functions of the safety device system (micro switch, water level).	Once every three months

Table 2. Remedial action when faults are found

No.	FAULT FOUND ON	REMEDIAL ACTION
1	Dirt/dust on the body	Clean up dirt and dust by using a soft and dry cloth.
2	Rust on the screws/body	Call engineering staff for solution.
3	Water leakage	Call engineering staff for solution.
4	Drain clogged up	It is suspected that the drain valve/pipe is clogged up, or scheelite/dirt is accumulated inside of the chamber. Clean up inside of the drain valve/pipe as well as the chamber. If it could not solve out, call engineering staff for solution.
5	Earth connection	Call engineering staff for solution.
6	Scheelite and dirt accumulated inside of the evaporator	Remove the condenser with lid protection and clean up by using a hard cloth.
7	Scheelite and dirt accumulated inside of the chamber	Open the drain valve and drain all water from the chamber. Remove the scheelite and dirt by using hard cloth or wooden spatula. If it could not be moved out, call engineering staff for solution.
8	Water flow volume	Water flow volume should be kept in neither exceeding flow nor small amount of flow. The best way is to measure the temperature of the drain water. The drain water temperature at 40 - 45°C is to be suitable volume.

CODE	
EQUIPMENT NAME	Water Distiller
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Water Distiller only		
1	Check water leakage from some joint of water circulation system	Good / Fail	
2	Check & clean scheelite accumulated inside of the chamber	Good / Fail	
3	Check & clean scheelite and dirt inside of the evaporator	Good / Fail	
4	Check function of safety device system	Good / Fail	
5	Check function of Heater	Good / Fail	

REMARKS

Date inspected	/ / 2005	Inspector	
Room Temp.	°C	Approved by	

7-5. REFRIGERATOR

1. Introduction

Refrigeration is the result of the absorption of energy (heat) during the evaporation of a liquid. A refrigerant liquid is circulated through a closed system of pipes, in which on one side (refrigeration chamber) it is vaporized and on the other side (outside the refrigeration chamber) it is condensed. Common refrigerant liquids are ammonia (boiling point -33℃) and low relative molecular mass chlorofluorocarbon (boiling point near -30℃). The vaporization of the refrigerant liquid is thieved by either absorption or compression.

2. Principle of Operation

1. Compression system

Compression systems are used for cold rooms and for some small refrigerators and require mains electricity. They consist of an evaporator, an expansion valve or capillary pipe, a condenser, and a compressor.

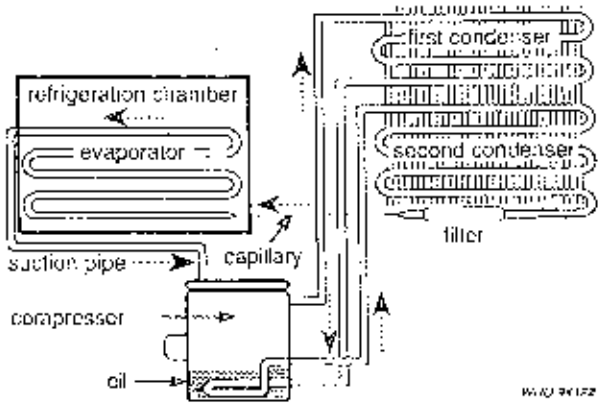


Figure 2. Working principles of a compression refrigerator

A compressor sucks the coolant liquid from the tubes of the evaporator, which are located inside the cooling compartment of the refrigerator. The residual coolant liquid in the evaporator evaporates and in doing so takes up latent heat from the cooling compartment. The vapour is compressed into pipes outside the refrigerator, where it condenses, liberating heat, which is dissipated to the surrounding air by the condenser fin. The condensed coolant liquid is forced through the capillary pipe and expands into the evaporator, from where the refrigeration cycle is repeated. In some refrigerators, the condensed coolant is circulated back to the compressor to tae up heat from the compressor oil, which

again causes evaporation of the refrigerant. In a second condenser, the coolant is condensed again prior to passing through the capillary tube for expansion and evaporation, while the liberated heat of condensation is dissipated to the environment.

3. General Precautions

3.1 Installation

Electrical compressor – operated refrigerators and freezers should be used only where there is a stable and reliable electricity supply. Fluctuations in the voltage ad frequent power interruptions are likely to result in damage to the compressor.

Equipment should be installed on a flat, horizontal surface, preferably slightly elevated (on pallet or feet) to avoid accumulation of water and moisture under the cabinet. This will prevent the formation of rust and allow easy access for cleaning.

3.2 Good practice

- Keep the surrounding are clean.
- Leave at least 20cm between the cabinet and the wall and other equipment and avoid exposure to heat and sunshine.
- Keep the refrigerator upright and level. If the cabinet needs to be moved, it should be transported in an upright position.
- Wash the door gasket with soap solution and rub with glycerol when the cabinet is defrosted.
- Do not re-open the door immediately after closing.
- Never use sharp instruments to remove ice. Defrosting may be quick ended by placing a container of warm water in the refrigerator or freezer after defrosting.
- Remove all water from the inside of the refrigerator or freezer after defrosting.
- Do not leave the refrigerator or freezer open un-necessarily.
- Open and close the door gently.

4. Maintenance

The following general advice may be helpful for maintenance:

- The refrigerator must be placed so that sufficient air can flow past the condenser (at the back of the refrigerator) for exchange of heat.
- The refrigerator door must seal perfectly to prevent warm outside air from entering the cool chamber.
- The refrigerator must have good insulating walls.

4.1 Daily checks

1) Check temperature daily.

4.2 Monthly checks

1) Check and clear the cool chamber and defrost the evaporator once a month.
2) Swab inside the cabinet with 70% ethanol while it is defrosting.
3) Clean the outside body of the refrigerator.
4) Check and clean any dust from the condenser.
5) Check and clean the door gasket (if some cracks or scratch find, it should be replaced).
6) Check for cooling gas leakage from compressor circuit.

4.3 Door gaskets

On domestic-type refrigerators, the gasket-holding mechanism is the inner shell of the door. This fastens to the outer casing with a ring of screws under the gasket. When this is disassembled in order to change the gasket, the rigidity of the door structure is lost. In order to ensure a good seal upon reassembly, the complete door must first be removed and placed on several boards to keep it as flat as possible. Then, remove the screws ad the old gasket, install the new gasket ad replace the screws before moving the door.

Reinstall the door, with the hinge screws snug but not tight. Shut the door with a piece of paper in the seal and test for tightness by pulling on the paper.

Do this all around the gasket. The hinges may be adjusted outwards by closing the door with a folded cloth in the seal or by bumping with a soft rubber mallet. Adjust until the paper indicates that the door is evenly tight all around, and then tighten the screws in the hinges.

4.4 Compressor-type refrigerators and freezers

1) Clean the condenser (in the compressor compartment) every 6 months with a brush or vacuum cleaner.
2) Oil the door fittings, locks and other moving parts.
3) Replacement of the compressor which would require recharging with refrigerant should be carried out only by a qualified refrigeration engineer.

4.5 Changing the heating element

1) Disconnect the refrigerator from the mains.
2) Remove the heating element from the chimney.
3) Disconnect from the thermostat.
4) Connect the new element at the ceramic connector or thermostat, using the same terminals.

5) Insert the element into the chimney aperture, making sure it is not placed beside the aperture.

Note: For security reasons the refrigerate liquid circuit is sealed by the refrigerator manufacturer. It should never be opened, because of the hazardous nature of the liquid.

4.6 Spare parts and tools

a. Spares

1) Bulb
2) Heating elements
3) Thermostats
4) Compressor
5) Evaporator

b. Tools

1) Vacuum cleaner and brush
2) Thermometer

CODE	
EQUIPMENT NAME	Refrigerator
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Refrigerator only		
1	Check & Clean the condenser unit (at the back of the equipment)	Good / Fail	
2	Check cooling temperature daily basis.	Good / Fail	
3	Check & Clean the cool chamber and defrost the evaporator monthly.	Good / Fail	
4	Check & clean the door gasket, if some cracks, replace it.	Good / Fail	

REMARKS

Date inspected	/	/ 2006	Inspector
Room Temp.		°C	Approved by

7-6. CLEAN BENCH

1. Introduction

Clean bench is the equipment for laboratory experiment.

This equipment is to avoid contamination by keeping positive pressure inside of operation space (Figure 1 and 2). To keep pressure brings to protect inflow of air from outside.

Clean bench supplies clean air to operation space by percolation of air. It is used "HEPA Filter" in percolation. HEPA Filter is made of fine glass fibers.

Clean bench is located in laboratory where examine of virus and bacteria.

2. Principle of Operation

Figure 1 and 2 shown the structure of the Clean bench.

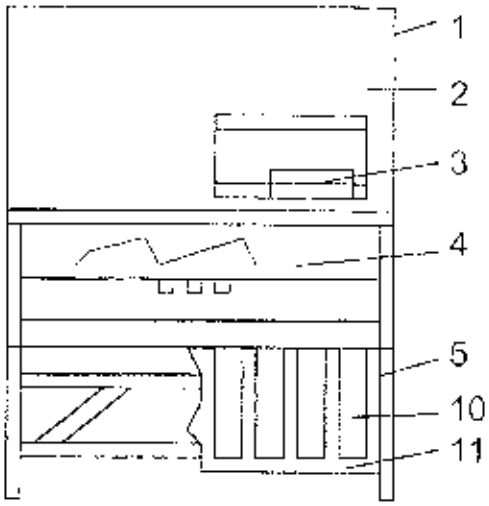


Figure 1. Device construction, front view

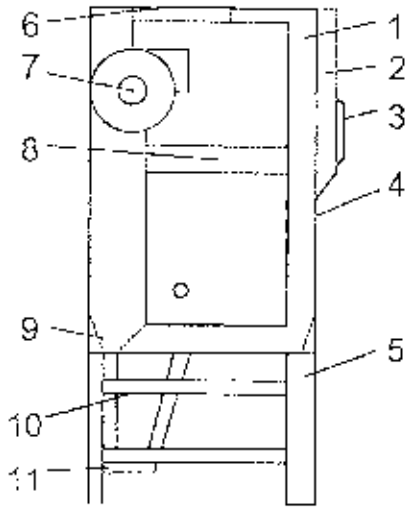


Figure 2. Device construction, Side view

The name of each part of structure is as following.

1. Housing
2. Control unit
3. Control panel
4. Front window
5. Base
6. Exhaust filter
7. Fan
8. Circulation filter
9. Catch tray
10. Pre-filter
11. Pre-filter box

1. Exhaust air stream
2. Exhaust filter
3. Low pressure area
4. Circulation filter element
5. Low-turbulence displacement stream
6. Supply air stream
7. Fan
8. Air channel
9. Pre-filtered re-circulated air
10. Pre-filter
11. Pre-filter box

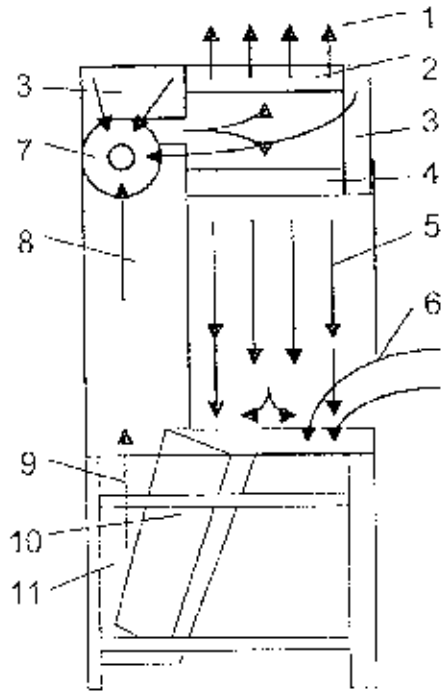


Figure 3. Airflow through the system

The clean bench is a laboratory device in whose test chamber a primarily low-turbulence (laminar) positive pressure displacement flow of air passed through high- performance, suspended particle filters is maintained. The exhaust air is also passed through high-performance, suspended particle filters.

The quality of the employed filter elements depends on the purpose for which the unit is being used. Basically, only selected filters of the highest quality are to be employed.

All channels and areas in the unit's interior that carry air and are in contract with the surrounding are under lower pressure than the laboratory area (low pressure encapsulation)

This minimizes the risk of contamination from unknown leaks in the unit housing.

3. General precaution

1) Never clean any glass areas with abrasives or agents that can lead to abrasion.
2) Take care the place were the equipment installed in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, etc.
3) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
4) Make sure the main line voltage, frequency and power are correct for the operation of the equipment.
5) Make sure the power system for the equipment is properly grounded.

Special note: HEPA Filter replacement

Because of the possibility of contamination, filter replacement may be the most serious maintenance task you will need to perform on this device with completed protection against contamination.

4. Maintenance and check

4.1 Visual Inspection

This inspection should be carried out at least once in every six months. Recommended items in this inspection are shown in Table 1.

Table 1. Visual inspection list for Clean bench

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body
2. Grounding connection	- Cracked, collation of the grounding terminal connector, etc. - Status of grounding cable
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Broken protective earth terminal

4.2 Cleaning method

For cleaning, use only small amount of detergent, dissolved in water.

4.3 Daily or weekly, depending on utilization level

Disinfect and clean the test chamber.

Clean the exterior bench surfaces and glass areas with a mild detergent solution or glass cleaner.

4.4 Monthly level

Using lint-free cloth and the above-described cleaners, remove any dust accumulation from the exterior of the unit.

Perform disinfection of the interior.

Perform a functional inspection and check the safety equipment during normal operation.

4.5 Six month level

Check and replace following parts.

1) UV radiation element (if equipped with).
2) Fluorescent lamp.
3) Air blowing fan
4) HEPA filter

HEPA filter replacement must be performed every 5,000 operating hours or annually, recommended by manufacture.

CODE	
EQUIPMENT NAME	Clean bench
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Clean bench only		
1	Check & clean the test chamber	Good / Fail	
2	Check & replace the UV radiation element (if equipped with)	Good / Fail	
3	Check & clean the unit	Good / Fail	
4	Check & replace the fluorescent lamp	Good / Fail	
5	Check function of air blowing fan	Good / Fail	
6	Check & replace the HEPA filter	Good / Fail	
7	Check total performance	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	°C	Approved by	

7-7. PH METER

1. Introduction

pH meter measures characteristic (acid or alkaline) of sample solution. Normal human body maintains its blood and urine in constant pH level. Especially in the hospital, this equipment uses to find an abnormal pH level of patient blood.

2. Principle of Operation

Most popular way to measure today is using theory of grass electrodes.

This method is to get pH level of sample solution by measuring the potential difference between the grass electrode and the reference electrode.

※ Structure of Equipment

Figure 1. shows the structure of method of glass electrode:

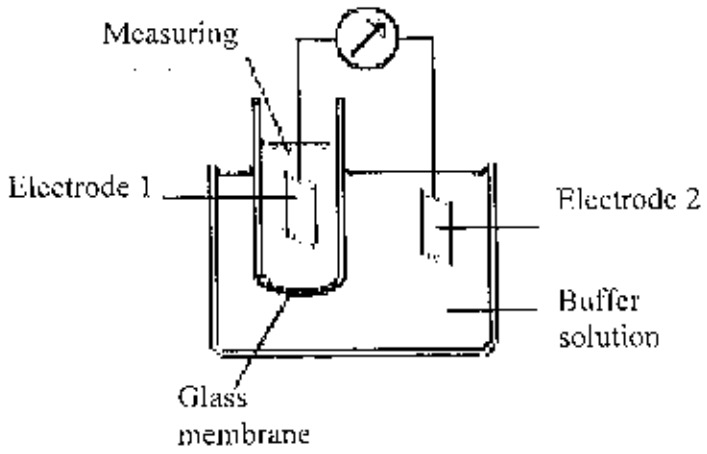


Figure 1. Schematic diagram for principle of pH meter

3. General precaution

1) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
2) Do not install the equipment in a storage environment containing gas or other chemicals.

3) Take care the place where the equipment in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, ventilation, sunlight and air contaminating dust, etc.
4) Make sure the main line voltage, frequency and power are correct for the operation pf the equipment.
5) Make sure the power system for the equipment is properly grounded.
6) Electrode should be used as recommended for the specified purpose, and the recommended procedure for equilibration should be followed when new electrodes are installed.
7) New glass electrode must be soaked in a buffer solution (pH 4- 8) for at least 24 hours before use to obtain a stable potential. They should be calibrated at two values, using the manufacture's calibration materials or solutions prepared from pH buffer tablets.
8) Make sure that the electrode is always filled with electrolyte according to the manufacturer's instructions.
9) Do not touch the electrode membrane, since it can be easily damaged.
10) Glass electrodes should be kept immersed in a standard salt solution for long-term storage.
11) Protein precipitates on the electrode must be carefully removed by digestion with pepsin solutions, at pH 2 for a few hours. Thereafter, the electrode must be rinsed thoroughly with distilled water.

※ Useful notes

- Glass electrode will usually maintain their properties for many years if used appropriately and stored correctly. Aging of an electrode is indicated when a constant potential does not develop within a few seconds after insertion into an ionic solution.
- Repair: If electrodes are stored incorrectly the membrane may dry out.
- Hazards: If electrodes are used for measuring biological fluids, they must be cleaned and disinfected according to the manufacturer's recommendations.
- Electrodes are very fragile and must therefore be packed correctly accordance with manufacturer's instructions.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. Visual inspection list for pH meter

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dust/dirt on the surface of body and operation panel
2. Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. pH Electrode	- Injured, broken, dirt, deteriorate of function. - Conductor/wire and cable insulation - Stain, twist and hardness of insulation of cable or conductor - Keep soaking electrode during store.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for pH meter

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check calibration of two points pH	- Measure two point pH values. - Calibrate two point pH value until obtain correct value.
4. Check and Clean pH electrode	- Rinse electrode after use. For short-term storage, it may be kept in a plastic beaker filled with distilled water to prevent damage. - Check contact between electrode, plug and instrument. - Avoid contact between electrode and glass beaker. - If applicable, remove the rubber stopper during measurement and refit to electrode after use.

CODE	
EQUIPMENT NAME	pH meter
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for pH meter only		
1	Check & clean the pH glass electrode	Good / Fail	
2	Check function of the ventilation fan	Good / Fail	
3	Check & clean the unit	Good / Fail	
4	Check calibration of two pint pH	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

7-8. WATER BATH

1. Introduction

Water bath is the equipment to keep and maintain blood or urine sample and some reagent fixed temperature by using warm water. Water bath is used for the clinical examine, biochemistry, and culture of bacteria, etc.

2. Principle Operation

Water bath is consisted of water tank, heating and cooling system, temperature detector, alarm for heating an empty water tank, and circulation pump.

There are several types of Water bath, and they are made of different material; vinyl chloride, acrylic, plastic, and stainless steel, etc. When use this equipment, it is necessary to recognize the purpose of use such as heat-resistant or acid-resistant, and to make proper use of each case. The temperature range is from room temperature to around 300℃ and it is possible to control.

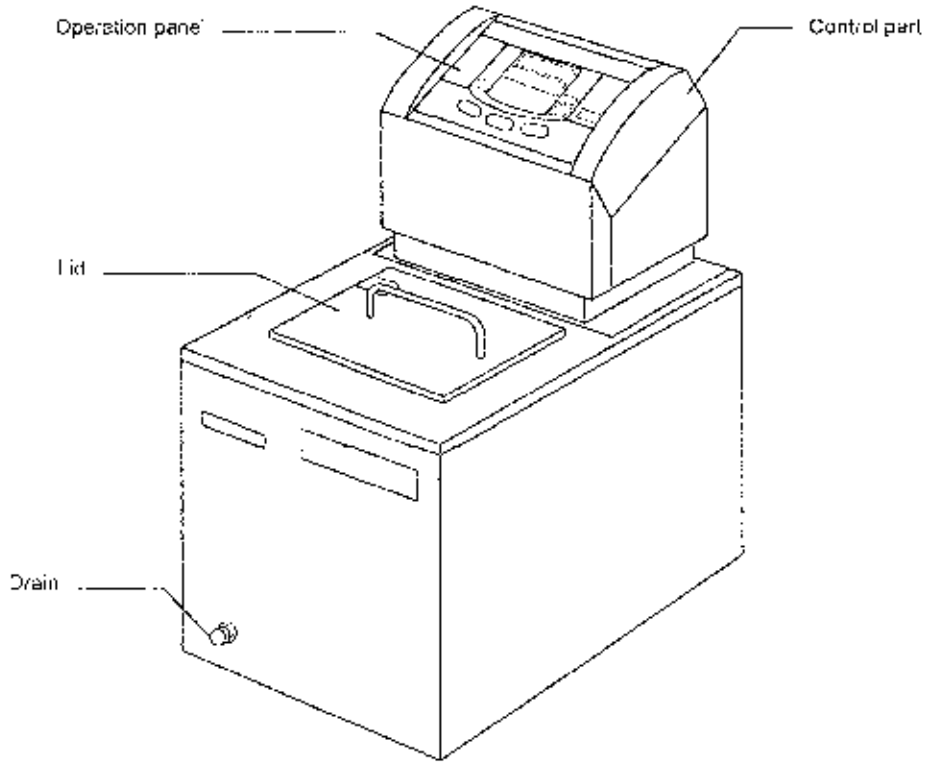


Figure 1. The example of structure drawing for Water bath

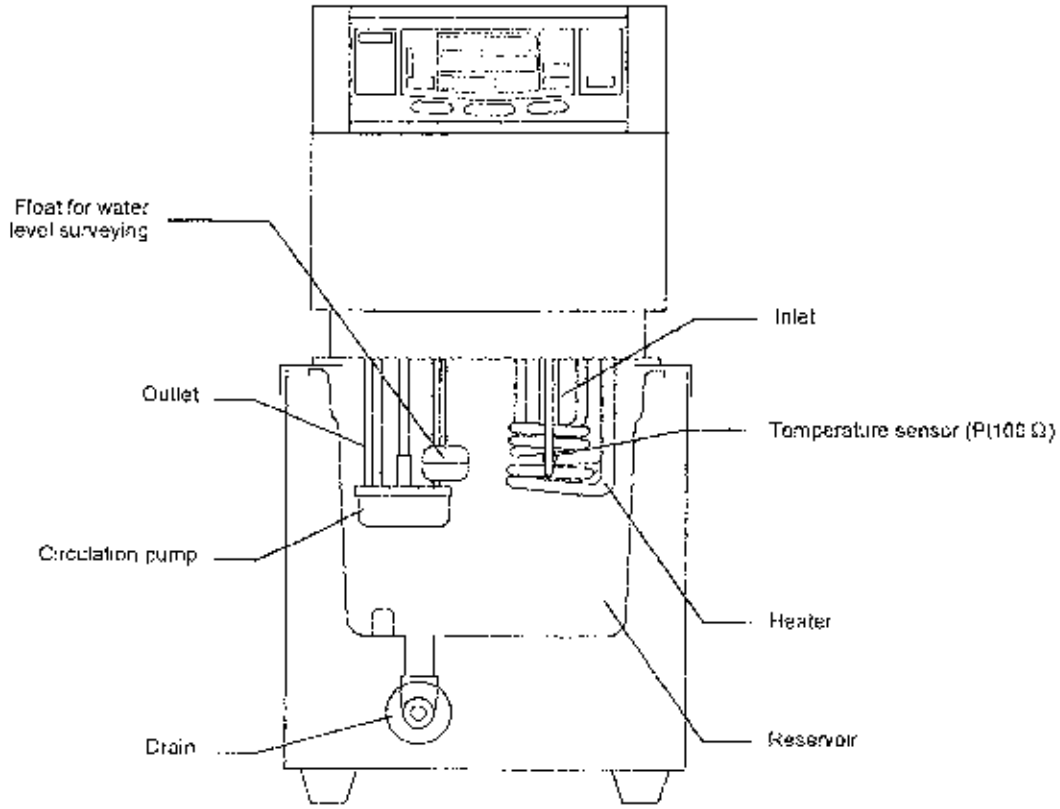


Figure 2. *Structure drawing of inside the chamber for Water bath*

3. General precaution

1) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
2) Do not install the equipment in a storage environment containing gas or other chemicals.
3) Take care the place where the equipment in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, ventilation, sunlight and air contaminating dust, etc.
4) Make sure the main line voltage, frequency and power are correct for the operation of the equipment.
5) Make sure the power system for the equipment is properly grounded.
6) Never splash water directly onto the electrical unit as this may cause electric shock or short circuit to break the equipment.
7) If a problem occurs, you should: If smoke or strange odor should come out of the unit for some reason, **turn off** the power switch right away, then **turn**

off the earth leakage breaker and the main power. Immediately contact a National workshop staff for detail inspection.

8) Do not use the power cord if it is bundled or tangled. If it is used in this manner, it can overheat and fire may be caused.

9) Do not disassemble or modify the unit. Fire or electrical shock may be caused.

10) Do not keep the used water for long term period, it may be cause of damage of heater element, circulation pump or temperature sensor, etc. with effect of rust, bleed some bacteria collation, that's why it should be drained out after use every time.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. *Visual inspection list for Water bath*

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dust/dirt on the surface of body and operation panel
2.Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Inside of water reservoir chamber	- Crack, injured, broken, dirt, scheelite or deteriorate checking for the heater, circulation pump, temperature sensor and water floater, etc.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for Water bath

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check temperature control into the water reservoir chamber	- After turn ON, temperature rise up well? - Does maintain suitable the temperature to setting temperature. - Check and record the indicating temperature actual every one hour.
4. Check the function of circulation pump	- Inspect the pump is operating properly. - If abnormal function, it should be dismantled and cleaned it.
5. Check the activation of the low water level alarm	- When water's level is lower than proper position, inspect the alarm activate sound or indicator.
6. Check and Clean the main body and inner chamber, heater surface, temperature sensor, etc.	- Check and clean any dirt, dust and clot some blood protein. - refer to cleaning method as follow.

※ **Cleaning method**

A) Cleaning the water reservoir chamber

- Remove all parts where equipped with inside of the chamber.
- Clean the inside using a soft cloth damped with neutral detergent or similar material.
- Afterwards, wipe off with clean water.
- Remove any particles or some dirt in the heater box, circulation pump, etc.

B) Cleaning the frame

- Clean the frame using a soft cloth damped with neutral detergent. Afterwards, wipe off with dry cloth.

C) Keep the equipment under the dry condition.

CODE	
EQUIPMENT NAME	Water bath
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good/ Fail	
2	Check Power supply voltage	Good/ Fail	
2	Check Earth (GND) connection properly	Good/ Fail	
3	Check turn ON the switch properly	Good/ Fail	
4	Confirm to indicate the lamp properly	Good/ Fail	
5	Check abnormal noise	Good/ Fail	
6	Check abnormal smell or smoke	Good/ Fail	
	Maintenance for Water bath only		
1	Check & clean the main body	Good/ Fail	
2	Check function of the ventilation fan	Good/ Fail	
3	Check & clean inner water resevoir chamber	Good/ Fail	
4	Check & clean heater and temperature sensor	Good/ Fail	
5	Check the temperature control	Good/ Fail	
6	Check & function of circulation pump	Good/ Fail	
7	Check & activation of the low water level alarm	Good/ Fail	
8	Check total performance	Good/ Fail	

REMARKS

Date inspected	/	/ 2006	Inspector
Room Temp.		°C	Approved by

7-9. INCUBATOR (FOR LABORATORY)

1. Introduction

Incubator is widely accepted as thermal equipment for keeping fixed temperature. Most of them are used circulation blow methods, and it distributes fixed temperature in high accuracy.

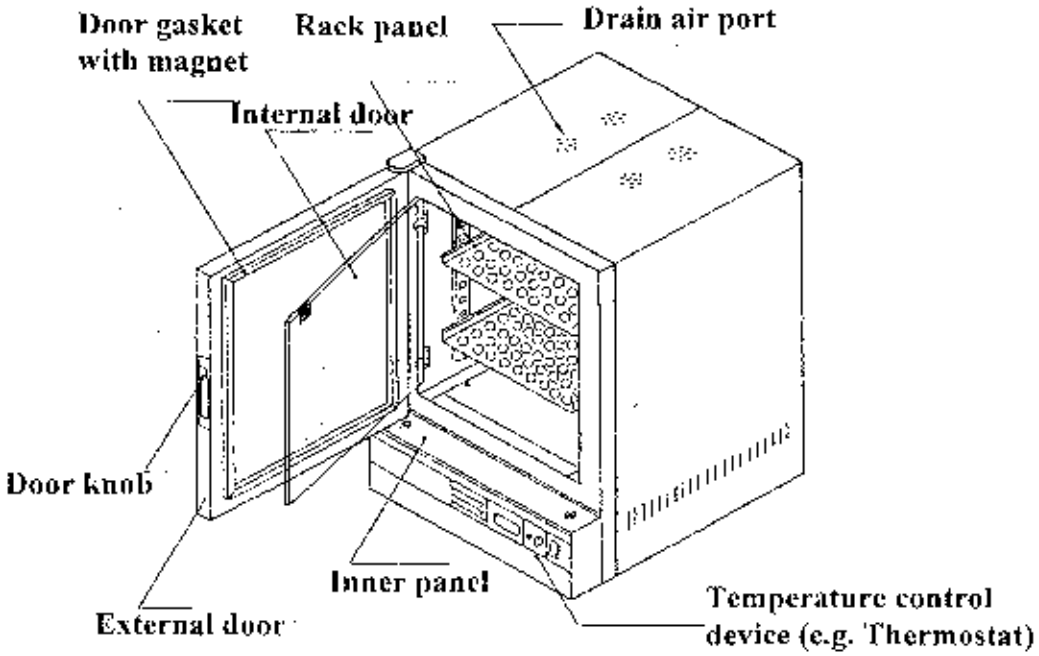
It is mainly used for the culture of bacteria in the field of clinical laboratory.

2. Principle of Operation

Heater heats the waving panel that located inside incubator. At the time, air and CO2 is used as medium, and this medium also is heated. It is possible to keep and fix temperature by using thermostat and temperature controller with micro-computer. This incubator can keep fix temperature continuously for long time (the range between room temperature and 60 ℃). It is available to make proper purpose of use by this system.

This incubator has double doors (Figure 1). This structure works effectively to minimum change of room temperature. The internal door is transparency so that it can observe inside of incubator.

Figure 1. *Structure drawing for Incubator (Laboratory use)*



3. General precaution

1) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
2) Do not install the equipment in a storage environment containing gas or other chemicals.
3) Take care the place where the equipment in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, ventilation, sunlight and air contaminating dust, etc.
4) Make sure the main line voltage, frequency and power are correct for the operation pf the equipment.
5) Make sure the power system for the equipment is properly grounded.
6) Never splash water directly onto the unit as this may cause electric shock or short circuit to break the equipment.
7) Do not open the door for long time, because it may be loose control of the temperature.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. Visual inspection list for Incubator (Laboratory use)

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dust/dirt on the surface of body and operation panel
2. Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Door gasket (Outer and inner, if they exist.)	- Crack, injured, broken, dirt, or deteriorate the material.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.
Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for Incubator (Laboratory use)

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check temperature control into the camber	- After turn ON, temperature rise up well? - does maintain suitable the temperature to setting temperature. - Check and record the indicating temperature actual every one hour.
4. Check and Clean the body and inner chamber	- Check and clean any dirt, dust and clot some blood protein. - refer to cleaning method as follow.

※ Cleaning method

A) Cleaning the inside

- Remove all racks from the inside.
- Clean the inside using a soft cloth damped with neutral detergent.
- Afterwards, wipe off with clean water.
- Remove the separation plate at the bottom of the oven and wipe off any particles in the heater box, using a soft cloth damped with water.

B) Cleaning the frame

- Clean the frame using a soft cloth damped with neutral detergent. Afterwards, wipe off with clean water.

C) Cleaning the rack

- To clean the rack, place it in a tub of warm water mixed with neutral detergent and wipe with a sponge or soft cloth. Racks subject to high temperature will naturally become colored.

CODE	
EQUIPMENT NAME	Incubator for Laboratory
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Incubator for Laboratory only		
1	Check & clean Door gasket (outer and inner, if equipped with)	Good / Fail	
2	Check function of ventilation fan	Good / Fail	
3	Check performance of temperature control into the chamber	Good / Fail	
4	Check & clean the body and inner chamber	Good / Fail	
5	Check activation of the alarm function	Good / Fail	
6	Check total performance	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

7-10. HEMOGLOBIN METER

1. Introduction

The Hemoglobin meter is used for the measurement of Hemoglobin where is inside blood by quantitative method. The quantitative measurement of Hemoglobin is effective examine way to determine diagnosis for anemia and dehydration.

As a reference, the normal rate of Hemoglobin is 12. 4~17. 0g/dL for the ordinary male, and 12. 0~15. 0 g /dL for the ordinary female. The measurement of Hemoglobin is indispensable examination among subjects of blood test in laboratory.

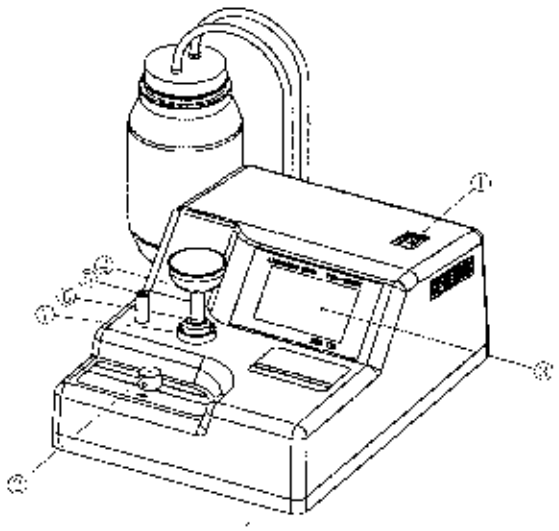
2. Principle of Operation

The common principle measurement of Hemoglobin is the Cyanmet-hemoglobin method.

The operation order is as follows:

1. Mix blood which take as a sample and reagent that react to Hemoglobin.
2. Set up cell for extinction of dilution liquid.
3. Put wavelength (550nm), which most effective wavelength for absorption light, on detector unit.
4. Measure density of absorption.

The structure of Hemoglobin meter is as follows (Figure 1).



※ **Structure of Equipment**

Figure 1. shows the structure of Main unit of Hemoglobin meter.

Table 1. Example of description and function for each part

No.	Description	Function
1	Power switch	Turn ON the equipment to ready for operation
2	0-Adjustment knob	0 adjustment knob for blank solution
3	Meter (Digital or Analogue)	Indicates concentration of Hemoglobin
4	Drain Cell	Flow cell for Hemoglobin measurement
5	EJECT	Press by finger when discharge blank, sample solution
6	Cell position	Position where drain cell is set
7	Drain rubber	Rubber which fix the drain cell

3. General precaution

1) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
2) Do not install the equipment in a storage environment containing gas or other chemicals.
3) Take care the place where the equipment in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, ventilation, sunlight and air contaminating dust, etc.
4) Make sure the main line voltage, frequency and power are correct for the proper operation of the equipment.
5) Make sure the power system for the equipment is properly grounded.
6) Do not keep dirt and liquid protein to fix for long term otherwise; it will not be able to take them out completely. Therefore do not neglect cleaning periodically for the work table.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. Visual inspection list for Hemoglobin meter

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - Dust/dirt on the surface of body and operation panel
2. Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal
4. Parts of Drain cell	- Injured, broken, dirt, fixed clotted blood, sample fluid, etc. - Check and clean always the parts of drain cell, at least after use the equipment.

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Table 2. Equipment functional check list for Hemoglobin meter

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the ventilation fan	- The ventilation fan operates properly? - Does exist abnormal sound or smell?
3. Check initial calibration Or 0 adjustment	- Measure and calibrate the sample value to be obtained correct result of measurement.
4. Check and Clean the main body	- Clean the main body with soft cloth and some neutral detergent, etc.
5. Check and clean the parts of Drain cell	- Clean the main body with soft cloth and some neutral detergent, etc.
6. Replace the lamp (Depend on model /type)	- When the lamp has been deteriorated in brightness or broken, replace it as soon as possible.

- Note: It is recommended that accuracy of the Hemoglobin meter should be checked every three month or when measurement result is not reliable. Use Hemoglobin standard solution that you currently use for standard solution.

CODE	
EQUIPMENT NAME	Hemoglobin meter
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Hemoglobin meter only		
1	Check & clean the parts of drain cell	Good / Fail	
2	Check function of the ventilation fan	Good / Fail	
3	Check initial calibration or 0 adjustment (If necessary)	Good / Fail	
4	Check & replace the lamp (If necessary)	Good / Fail	
5	Check total performance	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

7-11. MAGNETIC MIXER

1. Introduction

Purpose of this equipment is to mix the sample solutions at laboratory. In the equipment, there are a motor in vertical potation, which drive a magnet. The magnet stirrer consists client magnet and putting in the sample solution with some grass recipient (beaker etc.). The magnet stirrer rotates synchronizing with revolution of motor's drive magnet. Then sample solution may be mixed by stirrer.

2. Principle of Operation

The figure shows typical magnetic mixer. The motor installed inside of equipment and rotating magnetic field transfers to the stirrer through top plate of the equipment. This is very simple equipment. Usually AC motor is used therefore it is very rare to have a serious trouble.

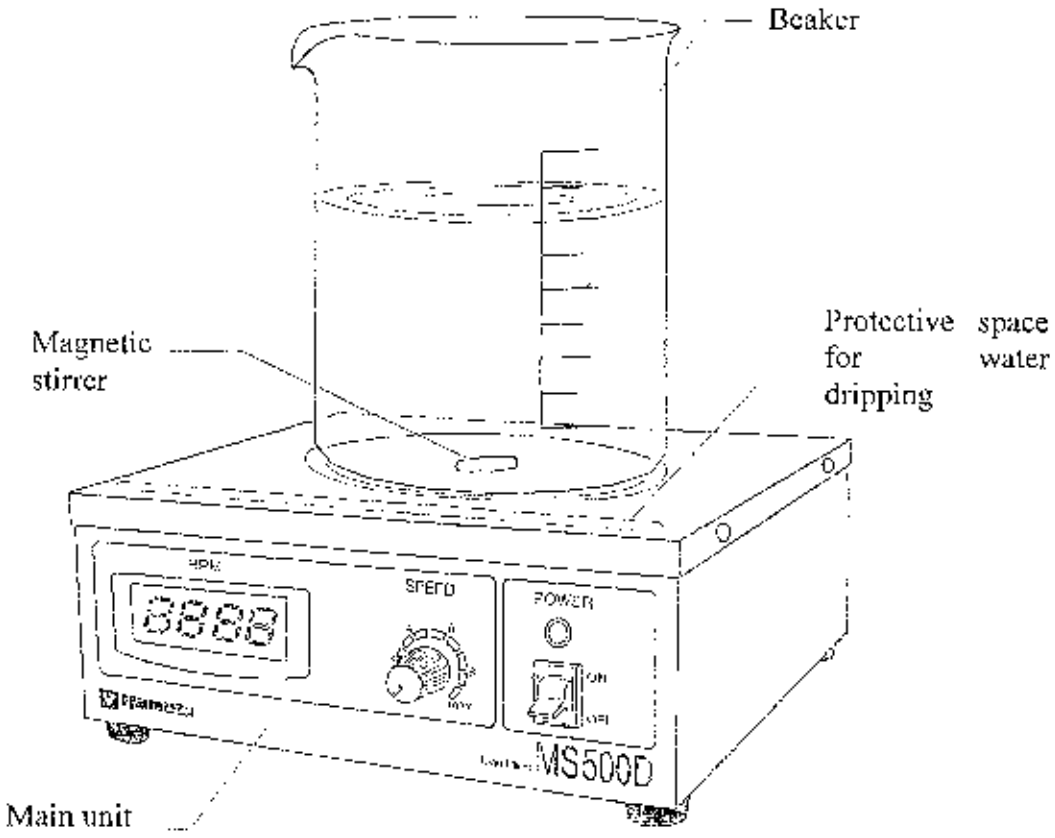


Figure 1. *Structure drawing of Magnetic stirrer*

3. General precaution

1) Make sure the power connection for the equipment is properly connected to the ground (GND) to avoid AC noise.
2) Take care the place were the equipment installed in an environment, it is not unfavorably affected by atmospheric pressure, temperature, humidity, salt, ventilation, sunlight and air containing dust, etc.
3) Install the equipment to keep stable and avoid tilting vibration and shock as much as possible.
4) Make sure the main line voltage, frequency and power are correct for the operation pf the equipment.
5) Make sure the power system for the equipment is properly grounded.
6) Do not pour or drop water inside of the main unit, also do not operate with wet hand, it will be caused of electric shock.
7) Do not keep water or liquid medicine away for long term because it is cause of breeding of bacteria.
8) Clog of the fan filter (If equipped with)will decrease ventilation flow, thus during regular maintenance always check and clean.

4. Maintenance and check

4.1 Visual check

These checks should be carried out at least once in every three months. Recommended items in these checks are shown in Table 1.

Table 1. *Visual inspection list for Magnetic stirrer or mixer*

Check Item	Description
1. External body and operation panel	- Cracked/broken panel and enclosure - missing characters - Rusts/dents on the body - dust/dirt and moisture on the plate.
2. Grounding connection	- Cracked, rust grounding terminal and connector - Status of contact between the ground wire and earth terminal correctly
3. Knob and Switch	- Cracked/broken knobs and switches - Loose connection switches/knobs - Smooth movement of switches/knobs - Equivalence/comparison with scale - Broken protective earth terminal

4.2 Equipment Functional checks

This inspection should be carried out at least once a three month.

Recommended items in these checks are shown in Table 2.

Check Item	Description
1. Turn On the Power switch	- Lit power indicator?
2. Check the stirrer operation	- The stirrer turns properly? - Does exist abnormal sound or smell?
3. Check the speed control	- Adjust the speed control according with volume knob. - Equivalent RPM indicator and speed control knob position.

CODE	
EQUIPMENT NAME	Magnetic mixer
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
2	Check Earth (GND) connection properly	Good / Fail	
3	Check turn ON the switch properly	Good / Fail	
4	Confirm to indicate the lamp properly	Good / Fail	
5	Check abnormal noise	Good / Fail	
6	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Magnetic mixer only		
1	Check the stirrer operation	Good / Fail	
2	Check function of speed control	Good / Fail	
3	Check & clean the unit	Good / Fail	
4	Check total performance	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

8-1. DENTAL UNIT

1. Introduction

The dental unit is used in dental clinic for treatment and surgery tooth. The dental unit is constructed of the following parts:

1. Dental chair included hydraulic system
2. Delivery system
3. Light
4. Cuspidor
5. Assistant instrument
6. Utility box
7. Air compressor
8. Clean water & hoot water system
9. Power supply & controller

The Figure 1 is the sample of modern dental unit.

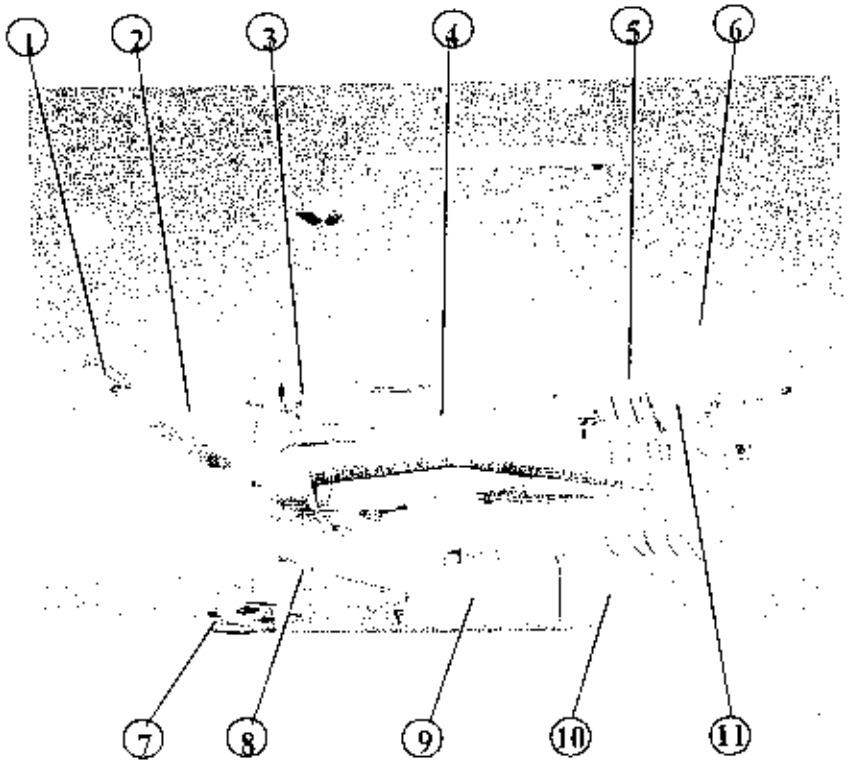


Figure 1. Dental chair unit (External view)

[1]- HEADREST
[2]- BACKREST
[3]- ASSISTANT INSTRUMENT
[4]- CUSPIDOR
[5]- UNIT
[6]- PANORAMA FILM VIEWER
[7]- FOOT CONTROL
[8]- BEAM SAFETY S/W
[9]- MOTOR COVER
[10]- UTILITY COVER
[11]- PAD SWITCH

2. Principle of Operation

As the dental unit is constructed of many parts, so each part's function is operated by user need, here are the all parts function as below:

- Dental Chair can be up and down by hydraulic system that is driven by driving motor as well backrest can be forwarded or backed by hydraulic system.
- Delivery system (Figure2), it is very important parts and consisted of many pieces for dentist job, (1) film viewer is light up and views dental X-ray film for diagnostic. Low speed and high speed hand piece are running under high pressure is provided by air compressor and water system supplies water to them to make them cool during working with tooth. Scalar is running under electric and water makes it cool due to working on tooth.

Figure 2. Delivery system of Dental chair unit

[1]- PANORAMA FILM VIEWER

[2]- TOUCH PAD

[3]- UNIT GRIP

[4]- INSTRUMENT HOLDER

[5]- HANDPIECE RPM GAGE

[6]- MAIN ON/OFF TOGGLE VALVE

[7]- MANUAL BREAK ON/OFF TOGGLE VALVE

[8]- SCALER, WATER FLOW CONTROL NEEDLE VALVE

[9]- COOLING AIR FLOW CONTROL NEEDLE VALVE

[10]- COOLING WATER FLOW CONTROL NEEDLE VALVE

[11]- HANDPIECE 1,2,3 AND SCALAR DRIVE AIR PRESSURE ADJUST KNOB

[12]- POLYURETHANE TRAY

[13]- HANDPIECE WATER ON/OFF VALVE

- Assistant instrument (Figure 3) is part that dentist assistant can be give hand to dentist during working. 3 way syringes is for cleaning tooth by water and air. Saliva ejector is working as the suction for suction liquid from mouth.

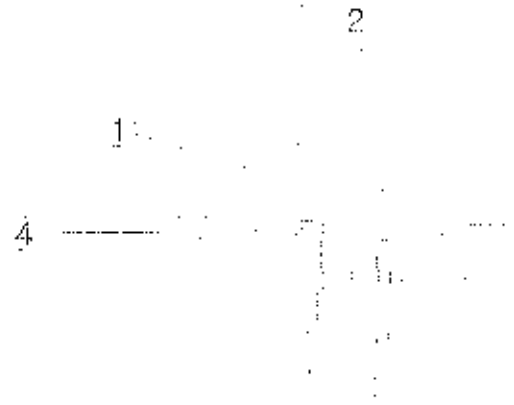


Figure 3. Structure of assistant instruments in Dental chair

[1]- 3 WAY SYRINGE

[2]- SALIVA EJECTOR

[3]- HVE VALVE

[4]- PAD SWITCH

- Cuspidors (figure 4), consisted of (1) bowl for west water, (2)cup filter is for supplying water for washing mouth, warmer is warm up water, suction hose is suction liquid from mouth, drain hose id drain out west water.

Figure 4. Structure of Cuspidors in Dental chair unit

[1]- BOWL
[2]- CUP FILLER
[3]- OPTIC SENSOR
[4]- BOWL FLUSH TIMER (SEC)
[5]- CUP FILLER TIMER (SEC)
[6]- FUSE 1 AC250V 1A(AC220V)
[7]- FUSE 2 AC250V 1A(AC17V)

- Air compressor is supplied air to low speed, high speed hand pieces, scalar, suction, 3 way syringes.
- Water system is supplied water to low speed, high speed hand pieces, scalar, 3 way syringes.
- Light is provide cool light and corrected illumination.
- All parts are worked by power supply and controller system.

3. General Precaution

The dental unit is run under electric (power supply) 220VAC, and under high air pressure that can cause injure to operator (dentist) and patient, so some actions must be taken to avoid danger:

- All parts must be properly installed
- Connect metal parts to ground terminal to avoid electric shock.
- High air pressure pipe must be securely connected not allow air leakage.
- Low speed & high speed hand pieces and scalar must be check they are working properly before using with patient.

4. Maintenance

4.1 Daily maintenance

- Clean the seat cover with house hold cleaner or mild soap and warm water at least once a day
- Check all components, low speed & high speed hand pieces, scalar, suction unit, light, cuspidor, water supply system before using.
- Clean vacuum filter everyday
- Check the cuspidor drain
- Keep hand pieces, scalar, suction clean
- Do not place excessively heavy loads on tray
- Check chair operation and position before using.
- Check appropriated air pressure
- Check distilled water in clean water bottle

4.2 Monthly Maintenance

- Check hydraulic system and it's motor drive
- Check water supply and air pressure system to avoid leakage
- Change & clean vacuum filter and air filter
- Check air & water regulators
- Check and clean cuspidor drain

CODE	
EQUIPMENT NAME	Dental chair unit
MAKER / MODEL	
SERIAL No.	

No.	CHECK ITEM	CHECK	MAINTENANCE
	General Maintenance		
1	Check visual status (Main frame, Switch, Dial, Power cable, etc.) check	Good / Fail	
2	Check Power supply voltage	Good / Fail	
3	Check Earth (GND) connection properly	Good / Fail	
4	Check turn ON the switch properly	Good / Fail	
5	Confirm to indicate the lamp properly	Good / Fail	
6	Check abnormal noise	Good / Fail	
7	Check abnormal smell or smoke	Good / Fail	
	Maintenance for Dental chair unit only		
1	Check the hydraulic system and motor driver	Good / Fail	
2	Check air pressure system and pressure pipes (to avoid leakage)	Good / Fail	
3	Check & clean the air filter & vacuum filter	Good / Fail	
4	Check performance of the air & water regulators	Good / Fail	
5	Check the cuspidor drain	Good / Fail	
6	Check water supply system	Good / Fail	

REMARKS

Date inspected	/ / 2006	Inspector	
Room Temp.	℃	Approved by	

Medical Equipment could be divided Three Categories:

Medical Instrument

Medical Furniture

Medical Equipment