

# SERVICE MANUAL

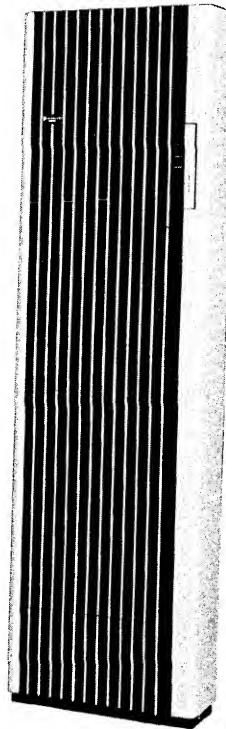
SPLIT-TYPE  
AIR CONDITIONER



**SANYO**

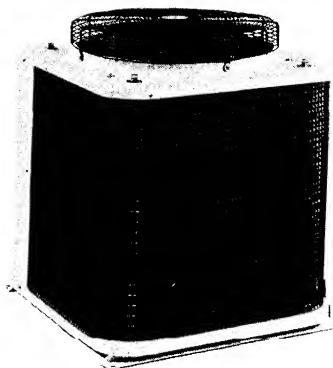
**SAP241VC**

(U.S.A.)



Indoor Unit

SAP241V



Outdoor Unit

SAP241C



## HVAC

### LIMITED WARRANTY OF ORIGINAL PURCHASER

Sanyo Electric Inc. takes pride in its products and believes they are manufactured to the highest possible standards. Consequently, Sanyo warrants to the original consumer its Air Conditioner for one (1) year for parts only. Sanyo will repair or replace (at its option) at no charge any part(s) found to be defective during the warranty period. In addition, Sanyo warrants the compressor for a total of five (5) years, and will cover labor charges on compressor replacement only for a period of thirty (30) days.

### OBLIGATIONS OF THE ORIGINAL OWNERS

Warranty repair must be performed by a qualified HVAC contractor. The dealer's original dated bill of sale must be retained as proof of purchase and must be presented to the qualified HVAC contractor.

### EXCLUSIONS OF THE WARRANTY

The warranty does not cover accident, misuse, fire, flood and other Acts of God, incorrect line voltage, damage caused by improper installation, labor cost of removing or reinstalling of product for repairs, improper or unauthorized repair, broken or marred cabinet, accessories, knobs, filters, customer adjustments which are not covered in instruction book.

Warranty is void and of no effect if serial numbers on the Sanyo product are missing or altered. This warranty is valid on products purchased and used in the United States of America only.

This is the entire Sanyo warranty and it may not be changed or amended by any person, agency, distributor, dealer, or company without prior written authority from Sanyo Electric Inc., and Sanyo does not authorize any party to assume for it any obligation or liability.

This warranty gives the consumer specific legal rights but he may have other legal rights which may vary from state to state. In no event shall Sanyo be liable and specifically denies responsibility for any consequential damages arising from the use of this product beyond the repair or replacement of the Air Conditioner, or for any delay in the performance of this warranty due to causes beyond our control.

Some states do not allow limitations on how long an implied warranty last and/or do not allow the exclusion or limitation of consequential damages, so the above limitations on implied warranty and consequential damages may not apply to you.

Should the consumer need repairs or assistance in locating his nearest qualified HVAC contractor, contact dealer of purchase or call/write to Sanyo Electric Inc. as follows:

**Sanyo Electric Inc.**  
200 Riser Road  
Little Ferry, NJ 07643  
(201) 641-2333

**SANYO SPLIT-TYPE AIR CONDITIONER  
SERVICE MANUAL  
MODEL: SAP241VC**

**—Table of Contents—**

	<b>Page</b>
<b>1. SPECIFICATIONS . . . . .</b>	<b>1</b>
1.1 Unit Specifications . . . . .	1
1.2 Major Component Specifications . . . . .	2
1.3 Compressor Identification . . . . .	4
<b>2. CONSTRUCTION OF THE UNIT . . . . .</b>	<b>5</b>
<b>3. DIMENSIONAL DATA . . . . .</b>	<b>6</b>
<b>4. PERFORMANCE CHARTS . . . . .</b>	<b>8</b>
<b>5. OPERATING INSTRUCTIONS . . . . .</b>	<b>10</b>
<b>6. INSTALLATION INSTRUCTIONS . . . . .</b>	<b>12</b>
<b>7. TROUBLESHOOTING . . . . .</b>	<b>26</b>
<b>8. CHECKING AND REPLACING ELECTRICAL COMPONENTS . . . . .</b>	<b>37</b>
<b>9. DISASSEMBLY AND SERVICE PROCEDURES . . . . .</b>	<b>46</b>
<b>10. PARTS LIST . . . . .</b>	<b>62</b>
<b>11. REFRIGERANT FLOW DIAGRAM . . . . .</b>	<b>66</b>
<b>12. ELECTRIC WIRING DIAGRAM . . . . .</b>	<b>67</b>
<b>13. APPENDIX (Conversion Tables) . . . . .</b>	<b>70</b>

# 1. SPECIFICATIONS

## 1.1 Unit Specifications

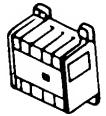
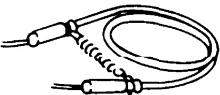
Model No.	SAP241VC	
Unit Model No.	Indoor Unit	SAP241V
	Outdoor Unit	SAP241C
<b>PERFORMANCE &amp; ELECTRICAL RATINGS</b>		
Capacity -Cooling	BTU/hr	24,000/23,800
-Heating	BTU/hr	—
Moisture Removal (High)	Pints/hr	8.6
Air Circulation (High)	Cu.ft/min.	565/530
SEER (EER)	BTU/whr	8.3/8.4 (8.0/8.1)
COP		—
Frequency	Hz	60
Rated Voltage	V	230/208
*Running Amps	A	13.5/14.3
Power Input	W	3,000/2,940
Back-up Heater	Kw	—
Fuse (or Circuit Breaker) Capacity	A	30
<b>FEATURES</b>		
Controls	Microcomputer	—
	IC	Yes
Fan Speeds		2
Timer		—
Ventilator		—
Air Deflection	Horizontal	Automatic
	Vertical	Manual
Air Filter		Washable, Easy Access
Temperature Control		IC Thermostat
Compressor		Rotary
Refrigerant (R22)	Ibs. (g)	(5.74) 2,600
Refrigerant Tubing Connections		Flare Type
Refrigerant Line Length	Ft. (m)	50 (15)
Max. Outdoor Unit Height	Ft. (m)	33 (10)
Refrigerant Tube o.d.	Narrow Tube In. (mm)	1/4 (6.35)
	Wide Tube In. (mm)	5/8 (15.88)
Drain Pipe o.d.	In. (mm)	3/4 (26.67)
Refrigerant Tubing Kit		Optional
<b>DIMENSIONS &amp; WEIGHT</b>		
Dimensions	Height In. (mm)	74-13/16 (1,900)
	Width In. (mm)	21-1/9 (540)
	Depth In. (mm)	7-13/32 (188)
Net Weight	Ibs. (kg)	90.4 (41)
Shipping Size	Cu.ft. (Cu.m)	13.8 (0.39)
Shipping Weight	Ibs. (kg)	103.4 (47)
Indoor Unit		Outdoor Unit

\* Without electric heater

DATA SUBJECT TO CHANGE WITHOUT NOTICE

## 1.2 Major Component Specifications

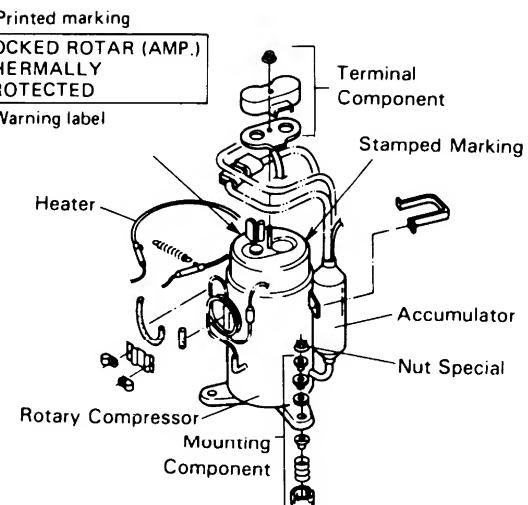
Unit Model No..	SAP241C				
Compressor	Hermetic Rotary Type				
Compressor Model No.	C-R190 H6N				
Source	230V/208V, 60 Hz, Single Phase				
Pole	2				
Nominal Output (W)	1,900				
Displacement (cc/rev.)	41.6				
Amps.-Full Load (A)	12.7/14.0				
-Locked Rotor (A)	84 (240V)				
Type of Oil	Special Oil for Rotary Compressor				
Compressor Oil Amount (cc)	1.350				
Coil Resistance ( $\Omega$ ) (Ambient Temp. 77°F)	C-R: 0.66 C-S: 1.968				
Protective Device	Internal Protector (15HM2505)				
Run Capacitor,	MFD	35			
	VAC	370 or 400			
Unit Model No..	SAP241V	SAP241C			
Fan Motor	Capacitor-Run Induction Motor				
Fan Motor Model No.	KFC8S-61A6P	KFC8-101A6p			
Source	230V/208V, 60 Hz, Single Phase				
Pole	8				
Nominal Output (W)	60	20			
Amps.-Full Load (A)	1.2/1.2	0.5/0.5			
-Locked Rotor (A)	—	—			
Protective Device	Internal Protector (17AM033A5-4)		Internal Protector (17AM 035A5-4)		
Run Capacitor,	MFD	4.5	5		
	VAC	440			
Coil Resistance ( $\Omega$ ) (Ambient Temp. 68°F)	WHT-BRN WHT-YEL WHT-PNK	66.8 23.9 80.8	WHT-BRN WHT-PNK	24.1 53.8	
Auto Deflector Motor	Synchronous Motor				
Motor Model No.	M001-1				
Source	230V/208V, 60 Hz, Single Phase				
Pole	-				
Nominal Output (W)	3				
Amps.-Full Load (A)	0.017				
-Locked Rotor (A)	-				
Protective Device	Impedance Protector				
Run Capacitor,	MFD	-			
	VAC	-			
Coil Resistance ( $\Omega$ ) (Ambient Temp. 68°F)	10.629				

Unit Model No.	SAP241C	Figure
Magnet Relay	CLK-16E3-21	
Unit Model no.	SAP241C	Figure
Crankcase Heater	CH 5700	
Rating	230 V, 30 W	
Unit Model No.	SAP241C	Figure
Outdoor Coil Thermostat	RTB-4U201	
Operating Temperature	ON: 75°F, OFF: 78°F	
Unit Model No.	SAP241C	Figure
Solenoid Valve	NEV-603DXFU (Valve) NEVAC208 (Coil)	
Rating	230 V/208 V, 5.5 W/5 W	
Unit Model No.	SAP241V	Figure
Room Temp. Sensor *1	OCS-5K	Sensor is incorporated in the remote control unit
Resistance (kΩ)	69°F: 6.6-5    86°F: 3.9-4.2 77°F: 4.9-5.2	
Note: *1 = Thermistor		
Unit Model No.	SAP241V	Figure
Power Transformer (for controller PCB)	ATR-J122U	
Resistance (Ω)	Primary: WHT-WHT 143.5 Secondary: BRN-BRN 1.2	

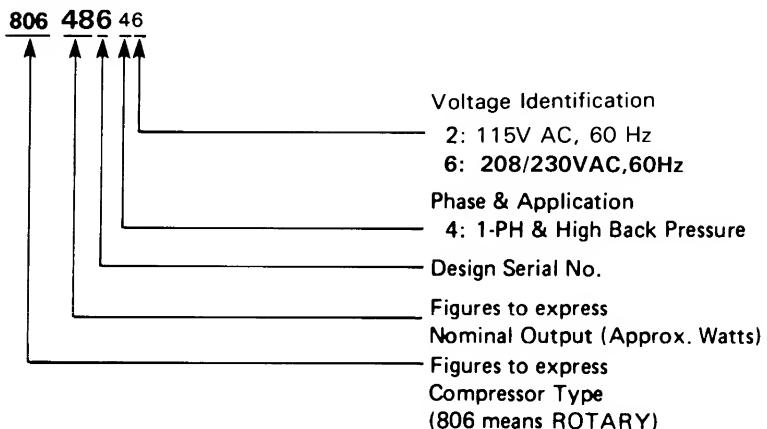
### 1.3. Compressor Identification

#### 1. Marking (Stamped)

Compressor code No. → 806 486 46      Manufacturer: T = Tokyo  
 Model No. → C-R190H6N      S = Sanyo  
 E = Electric.  
 Production Date → 30 01 5 ← (= 30 Jan., 1985)  
 Ratings (V) → V230/208  
 Frequency (Hz) → HZ60 PH1  
 and Phase



#### 2. Compressor Code No.



#### WARNING-SERVICEMAN

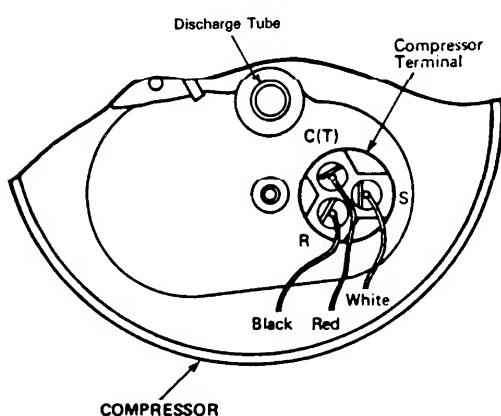
- FIELD SERVICE LEAK TEST PRESSURE MUST NOT EXCEED 150 P.S.I.G.
- THIS COMPRESSOR MUST BE GROUNDED.
- DO NOT OPERATE WITHOUT PROTECTIVE COVER OVER TERMINALS: DISCONNECT ALL POWER BEFORE REMOVING THE PROTECTIVE COVER.

#### CAUTION

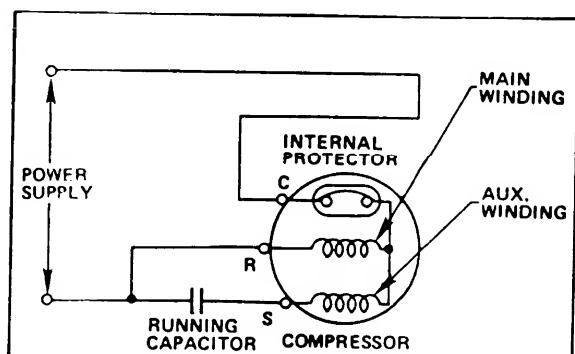
COMPRESSOR HOUSING MAY REACH 302°F (150°C) WITH TERMINAL PROTECTOR APPROVED BY TOKYO SANYO AND TESTED IN ACCORDANCE WITH UL984-1981.

TOKYO SANYO ELECTRIC CO., LTD.

### 3. Compressor Wire Orientation



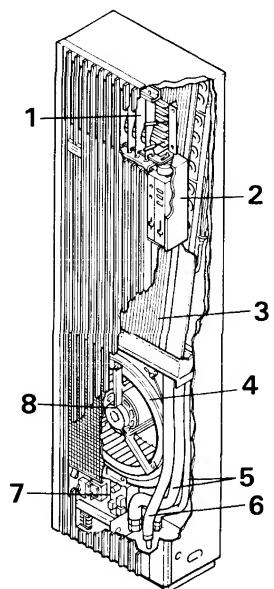
Wiring Diagram



## 2. CONSTRUCTION OF THE UNIT

INDOOR UNIT

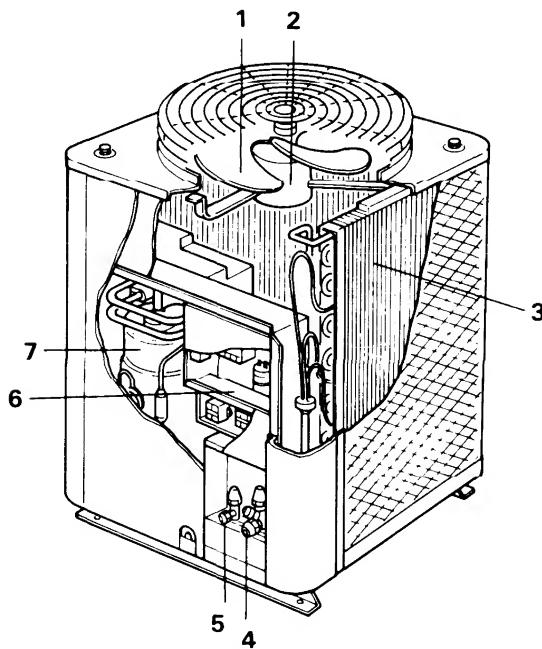
SAP241V



1. Auto air deflector
2. Control panel
3. Evaporator (=Indoor heat exchanger)
4. Indoor fan
5. Refrigerant tubing
6. Drain hose
7. Electrical component box
8. Fan motor

OUTDOOR UNIT

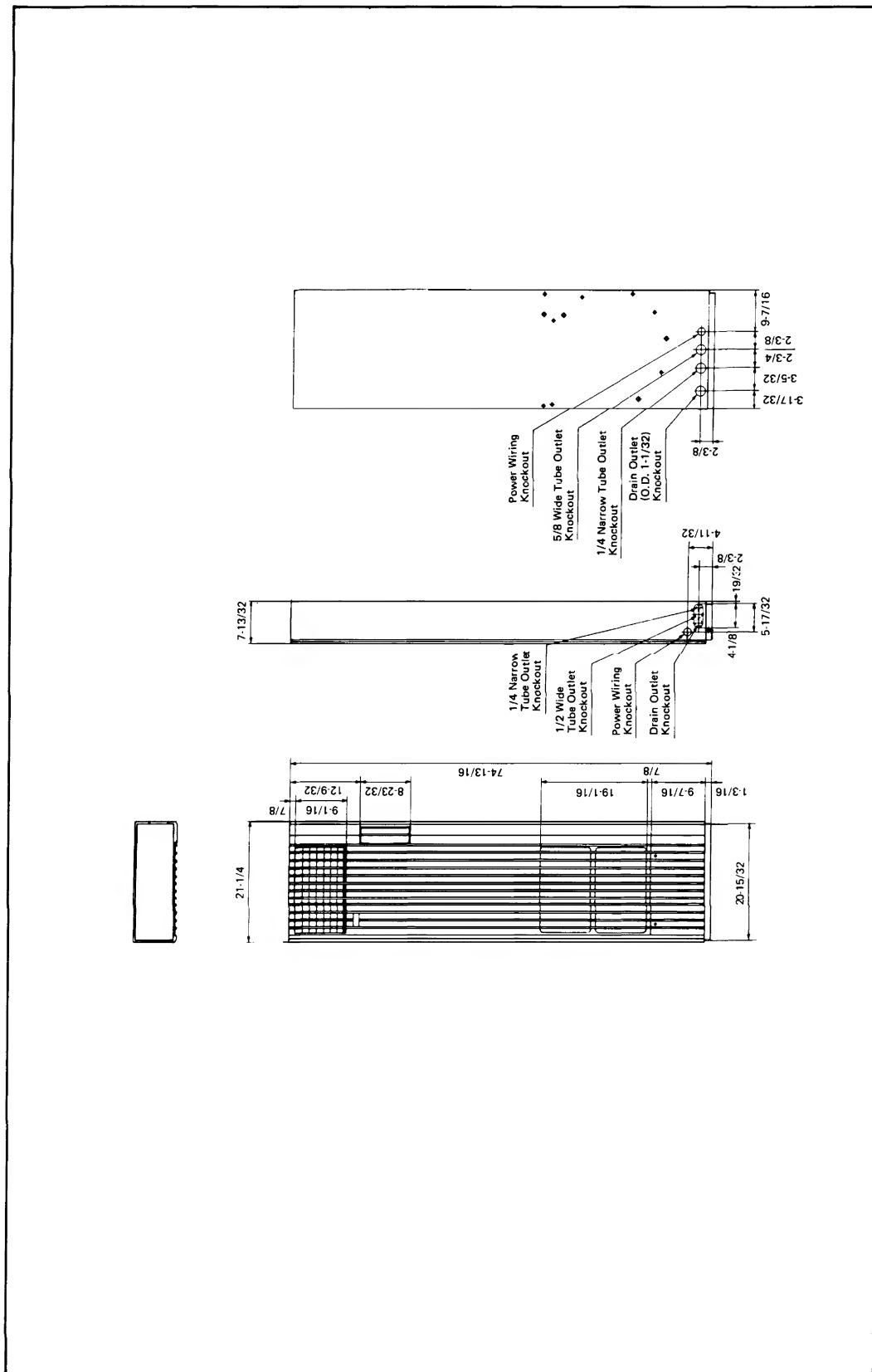
SAP241C



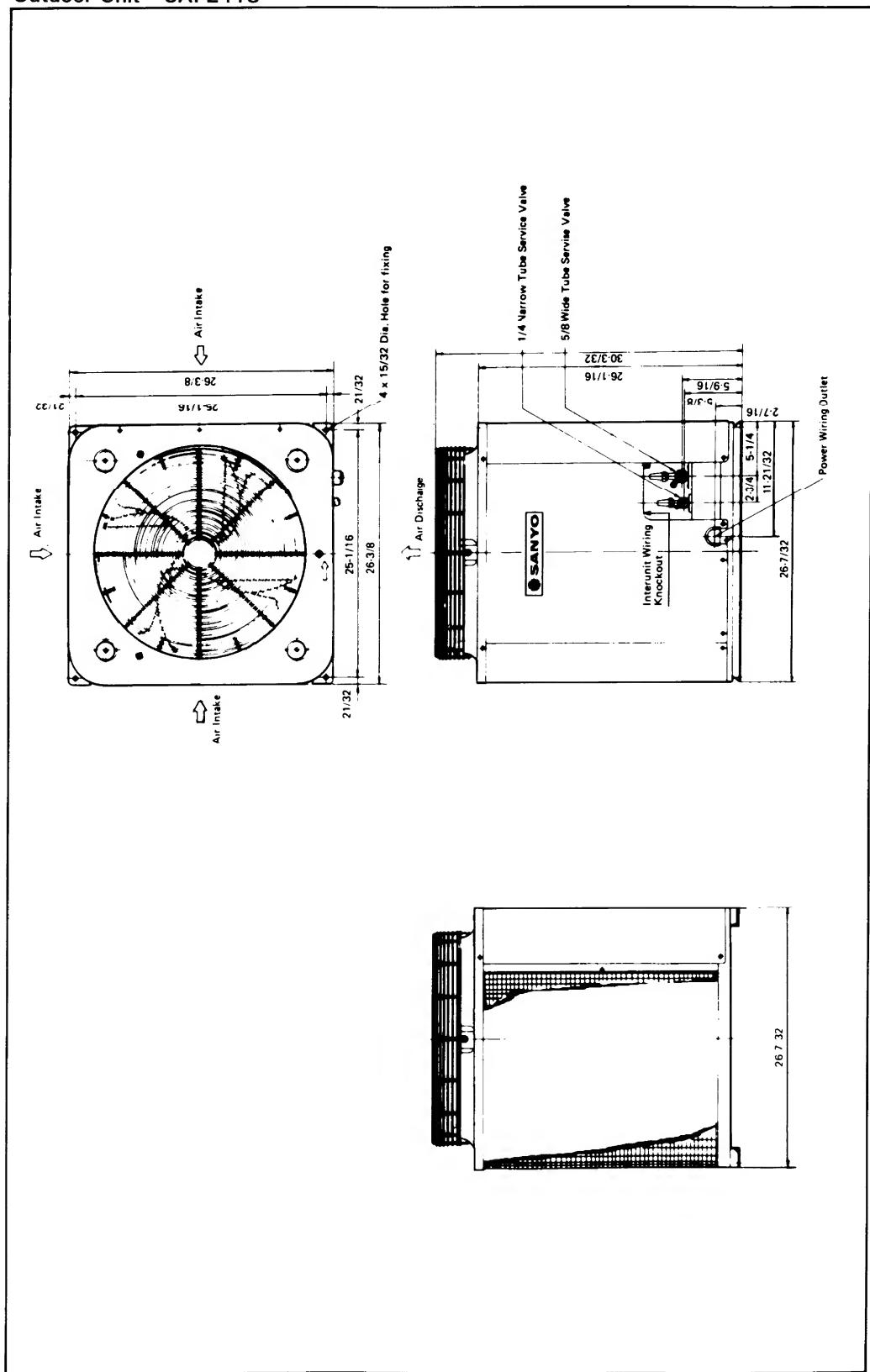
1. Outdoor fan
2. Fan motor
3. Heat exchanger (=Outdoor heat exchanger)
4. Wide tube service valve
5. Narrow tube service valve
6. Electrical component box
7. Compressor

### 3. DIMENSIONAL DATA

Indoor Unit SAP241V



Outdoor Unit SAP241C

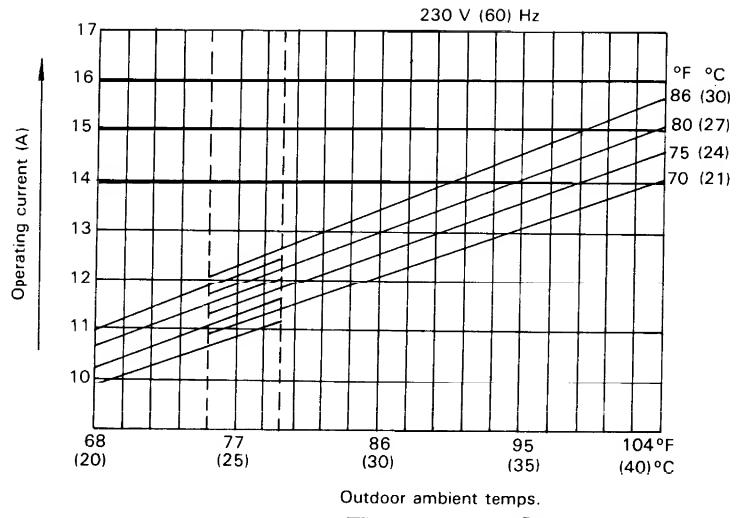


## 4. PERFORMANCE CHARTS

### Cooling characteristics

Operating current characteristics versus outdoor ambient temperature and indoor temperature (Indoor relative humidity: 50%, indoor air velocity: Strong, overall value for indoor and outdoor shown.)

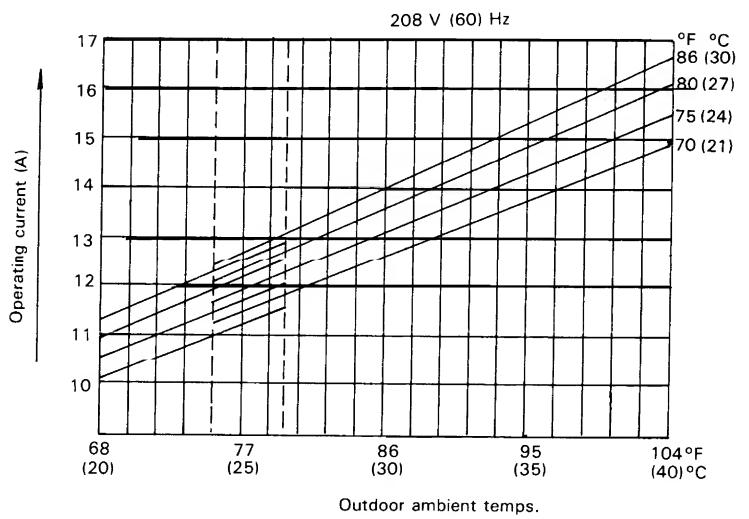
**NOTE:** The solenoid valve opens to by-pass refrigerant flow when the outdoor ambient temperature stays within the dotted-line range.



### Cooling characteristics

Operating current characteristics versus outdoor ambient temperature and indoor temperature (Indoor relative humidity: 50%, indoor air velocity: Strong, overall value for indoor and outdoor shown.)

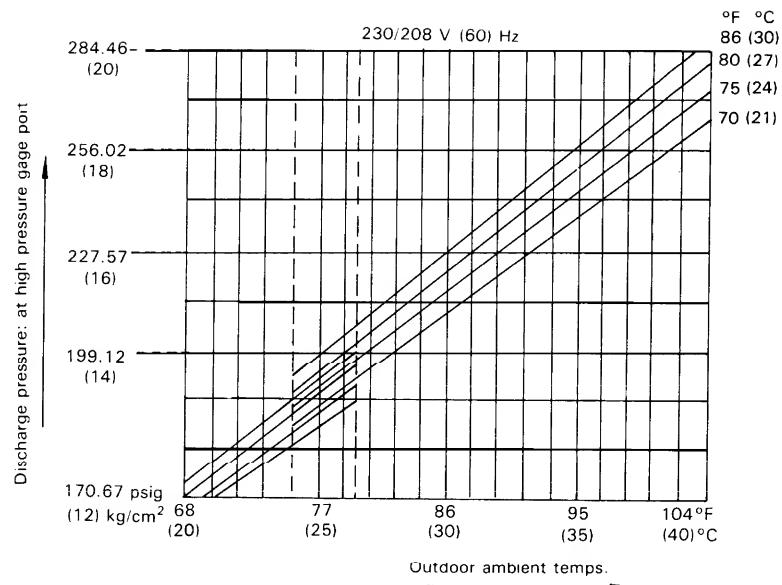
**NOTE:** The solenoid valve opens to by-pass refrigerant flow when the outdoor ambient temperature stays within the dotted-line range.



## Cooling characteristics

High pressure characteristics versus outdoor ambient temperature and indoor temperature (Indoor relative humidity: 50%, indoor air velocity: Strong.)

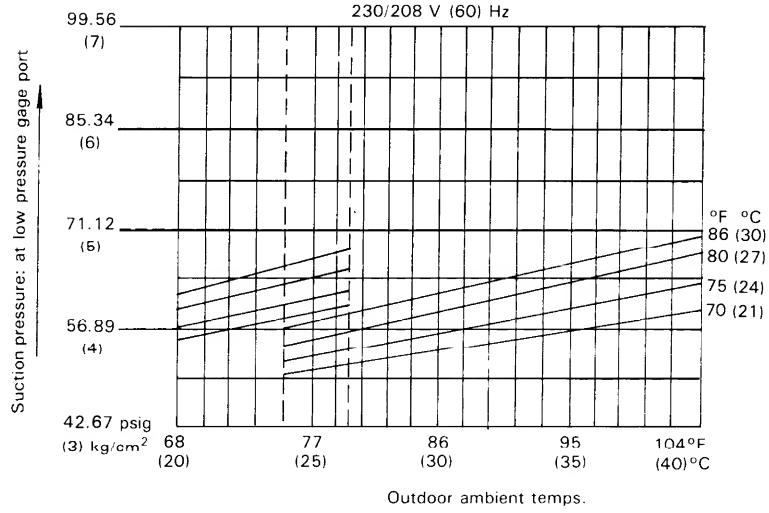
**NOTE:** The solenoid valve opens to by-pass refrigerant flow when the outdoor ambient temperature stays within the dotted-line range.



## Cooling characteristics

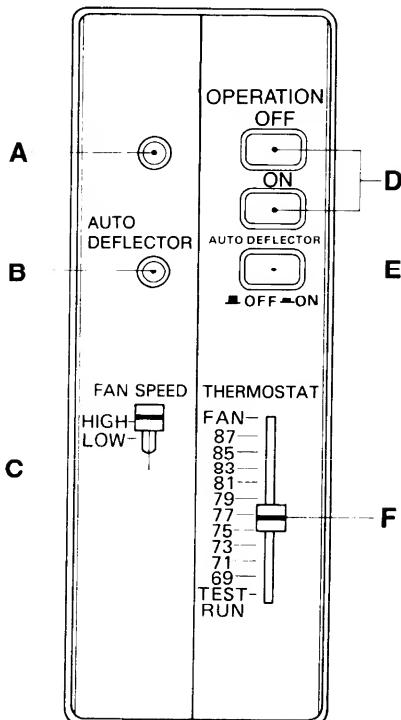
Low pressure characteristics versus outdoor ambient temperature and indoor temperature (Indoor relative humidity: 50%, indoor air velocity: Strong.)

**NOTE:** The solenoid valve opens to by-pass refrigerant flow when the outdoor ambient temperature stays within the dotted-line range.



## 5. OPERATING INSTRUCTIONS

### 1. CONTROLS



- A. OPERATION INDICATOR LAMP**
- B. AUTO DEFLECTOR LAMP**
- C. FAN SPEED SELECTOR**
- D. OPERATION SWITCH**
- E. AUTO DEFLECTOR SWITCH**
- F. THERMOSTAT, FAN AND TEST RUN SLIDE SWITCH**

#### • OPERATION SWITCH

SWITCH	KIND OF OPERATION	OPERATION INDICATOR LAMP
OFF	Stops operation.	Operation lamp goes out.
ON	Starts operation.	Operation lamp lights.
AUTO DEFLECTOR	Starts auto deflector (=vertical blades) to sweep cool air in the room.	Auto deflector lamp lights.

Note: If the lamp goes out and the air conditioner stops operating, refer to the section entitled "REMEDIES".

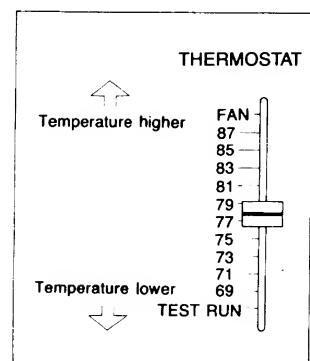
#### • THERMOSTAT

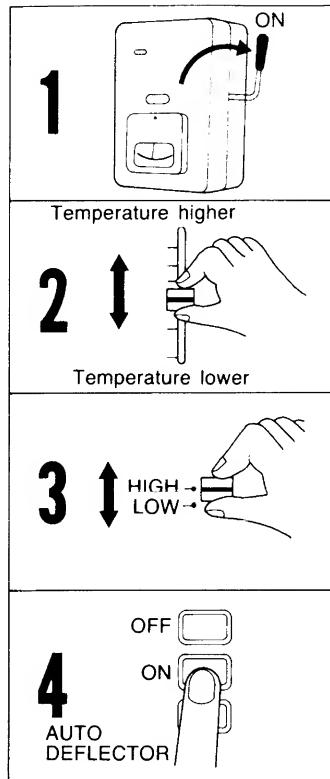
The thermostat maintains the room temperature automatically at the desired level and ensures economical air conditioner operation. Just set the thermostat lever for the temperature level you want.

**NOTE:** The numbers on the graduated scale are meant to serve as a guideline only. The actual room temperature may differ from the thermostat setting depending on room size and the heating or cooling load.

**FAN:** Set thermostat lever to the position when FAN operation only is needed.

**CAUTION:** TEST RUN; This position is to be used for test operation only after installation or during service operation. Normally it should be locked.





## 2. HOW TO OPERATE

- 1) Turn on the power supply at least five hours before starting the air conditioner.
- 2) Adjust the position of the thermostat lever.
- 3) Set the FAN SPEED selector to the desired speed.
- 4) Press the ON button.

- HOW TO STOP

Press the OFF button to stop the air conditioner.

- EMERGENCY SHUTDOWN

If the air conditioner does not stop even when the OFF button is pressed, disconnect the power supply.

- POWER SUPPLY

Be sure to supply power at least five(5) hours before operating the air conditioner at the beginning of the season. During the period of service, leave the power supply ON and let the current flow in the crankcase heater to warm up the compressor.

## 3. AIR FLOW DIRECTION

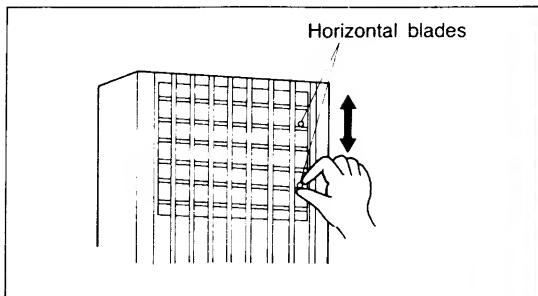
- Vertical adjustment (Manual)  
Move the horizontal blades at the air outlet by hand.
- Horizontal adjustment (Automatic)

**Variable mode**

Press AUTO DEFLECTOR pushbutton to start automatic air sweep. AUTO DEFLECTOR LAMP lights during operation.

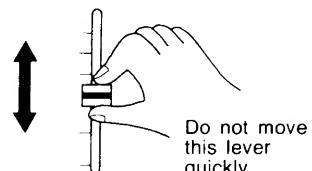
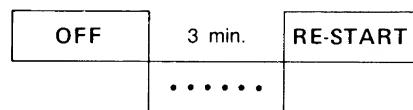
**Fixed mode**

To fix the air orientation, press the pushbutton again. The lamp goes out at fixed mode.



## 4. CAUTION

- SAFETY INTERVAL RESTARTING  
After pressing the OFF button, the air conditioner stops and will not start for three minutes. To start the air conditioner again after three minutes, press the ON button.
- THERMOSTAT SETTING  
Inadvertently moving the thermostat lever quickly up and down will cause the compressor to stop for three minutes.  
Set the lever to the desired temperature and the unit will operate normally after three minutes.



## 6. INSTALLATION INSTRUCTIONS

### Table of Contents

	Page
<b>1. GENERAL . . . . .</b>	<b>13</b>
1-1. Tools Required for Installation (not supplied)	
1-2. Accessories Supplied with Unit for Installation	
1-3. Optional Copper Tubing Kit	
1-4. Type of Copper Tubes and Insulation Material	
1-5. Additional Materials Required to Give Installation a Professional Appearance	
<b>2. INSTALLATION SITE SELECTION . . . . .</b>	<b>14</b>
Indoor Unit	
Outdoor Unit	
<b>3. HOW TO INSTALL INDOOR UNIT . . . . .</b>	<b>15</b>
3-1. Mount the unit	
3-2. Use L-shaped tube	
3-3. Wiring instruction for interunit connections	
3-4. Drain piping	
<b>4. HOW TO INSTALL OUTDOOR UNIT . . . . .</b>	<b>19</b>
4-1. Wiring Instruction on Outdoor Unit	
<b>5. REFRIGERANT TUBING . . . . .</b>	<b>20</b>
5-1. Use of the Flaring Method	
5-2. Flaring Procedure with a Flaring Tool	
5-3. Caution before Connecting Tubes Tightly	
5-4. Connecting Tubes between Indoor and Outdoor Units	
5-5. Insulation of Refrigerant Tubing	
5-6. Taping the Tubing	
5-7. Finishing the Installation	
<b>6. AIR PURGING . . . . .</b>	<b>22</b>
■ <b>TUBING DIAGRAM FOR AIR PURGING</b>	
6-1. Quick Air Purge System	
6-2. Air Purging Procedure	
■ <b>SERVICE VALVE CONSTRUCTION</b>	
■ <b>PUMP DOWN</b>	
<b>7. PRECAUTIONS BEFORE STARTING . . . . .</b>	<b>25</b>
<b>8. TRIAL RUN . . . . .</b>	<b>25</b>

# 1. GENERAL

Here is a brief outline of where and how to install the unit. Please read over entire set of instructions for indoor and outdoor units and make sure all accessory parts listed are with the unit before beginning.

## 1-1. Tools Required for Installation (not supplied)

Drill, 3-5/32" dia. hole saw or key hole saw for normal walls. However, chisels or core bits will be required for brick, concrete, or similar walls.

- |                             |                        |
|-----------------------------|------------------------|
| • Regular Screwdriver       | • Tube Cutter          |
| • Phillips Head Screwdriver | • Flaring Tool         |
| • Knife or Wire Stripper    | • Torque Wrench        |
| • Level                     | • Adjustable Wrench    |
| • Tape Measure              | • Reamer or Small File |

## 1-2. Accessories Supplied with Unit for Installation

Description		Shape	Q'ty	Remarks
Fitting	For wall		1	Fall-down preventive fittings (with screw & washer)
	For floor		4	
INS. Nipple			3	
Drain hose adaptor			1	
L-shaped tube			1	Use for wide tube connection

## 1-3. Optional Copper Tubing Kit

Copper tubing for connecting outdoor unit to indoor unit is available in kits which contain the narrow and wide tubing, fittings and insulation.

## 1-4. Type of Copper Tubes and Insulation Material

If you wish to purchase these materials separately from a local source, you will need:

- Deoxidized annealed copper tube 1/4" outside dia. with a 0.0314" wall thickness, and an equal length of 5/8" outside dia. with a 0.0394" wall thickness.

Cut to the appropriate lengths + 12" to 20" on each to dampen vibration between units.

- Foamed insulation 1/4" I.D., or 5/8" I.D. as required to precise length of copper tubing, wall thickness of insulation should be 5/16" to 1/2" thick. (Refer to page 21.)
- Copper Wire  
Inter Unit: Min. AWG 14 in appropriate length.  
Power Supply: Min. AWG 10
- 3" O.D. (I.D. 2-13/16", wall thickness 3/16") PVC pipe length to match thickness of wall.

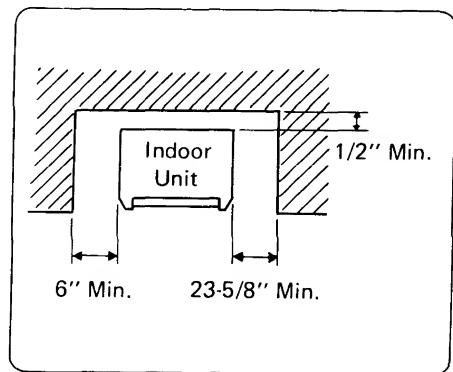
### 1-5. Additional Materials Required to Give Installation a Professional Appearance

• Refrigeration (armored) tape	• Refrigeration Oil
• Insulated staples or clamps for connecting wire (Refer to local codes)	• 3-1/2" clamp — use 1 every 4 ft. (To secure copper tubing).
• Putty (1/2 lbs.)	

## 2. INSTALLATION SITE SELECTION

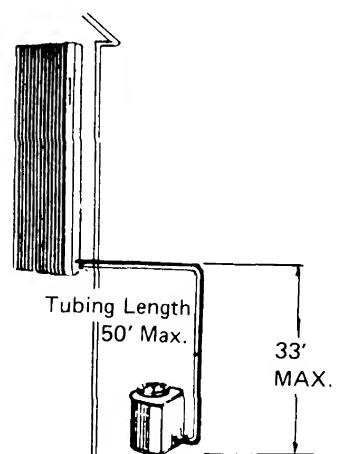
### **Indoor Unit :**

- AVOID:**
- areas where leakage of flammable gas may be expected.
  - places where large amounts of oil mist exist.
  - direct sunlight.
  - nearby heat sources that may affect performance of the unit.
  - locations where remote control will be splashed with water or affected by dampness or humidity.



**Fig. 1**

- DO:**
- select an appropriate position from which every corner of the room can be uniformly cooled.
  - select a location that will hold the weight of the unit.
  - select a location where tubing and drain pipe have shortest run to the outside.
  - allow room for operation and maintenance as well as unrestricted air flow around the unit. Fig. 1
  - install unit within 33' up or down of outdoor unit and within a total of 50' from outdoor unit. Fig. 2



**Fig. 2**

### Outdoor Unit :

**AVOID:**

- heat sources, exhaust fans, etc., Fig. 3
- damp, humid or uneven locations.

**DO:**

- choose a place as cool as possible.
- choose a place that is well ventilated and outside air temperature does not exceed 115° F constantly.
- allow enough room around unit for air intake/exhaust and possible maintenance. Fig. 4
- provide a solid base; about 4" above ground level to reduce humidity and possible water damage in unit and decrease service life. Fig. 5
- use lug bolts or equal to bolt down unit, reducing vibration and noise.

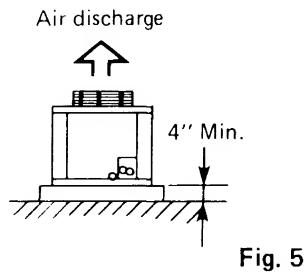


Fig. 5

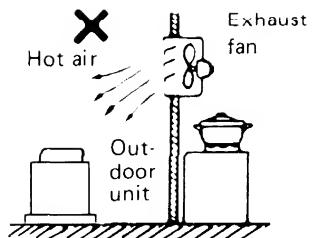


Fig. 3

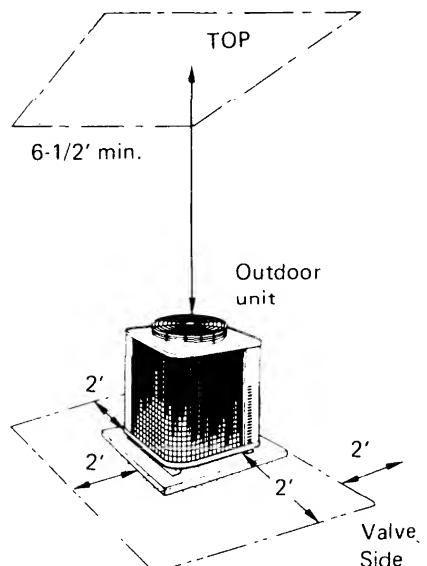


Fig. 4

## 3. HOW TO INSTALL INDOOR UNIT

### 3-1. Mount the Unit

- Using the accessory fitting plate, secure the unit firmly with the wall. Fig. 6.

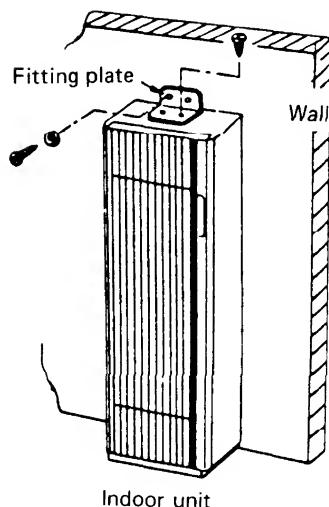
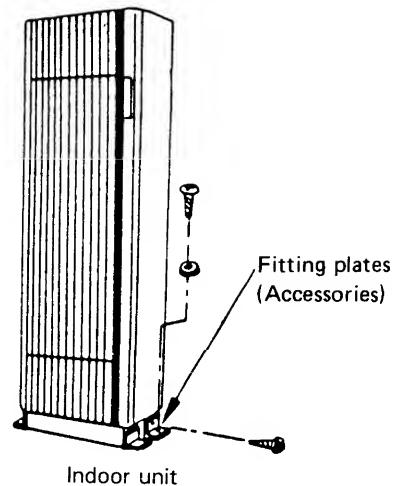
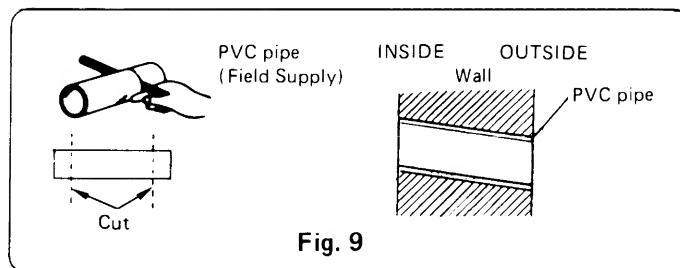
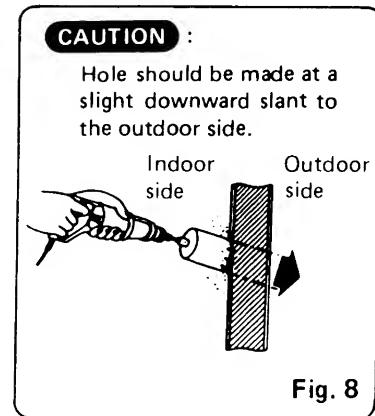


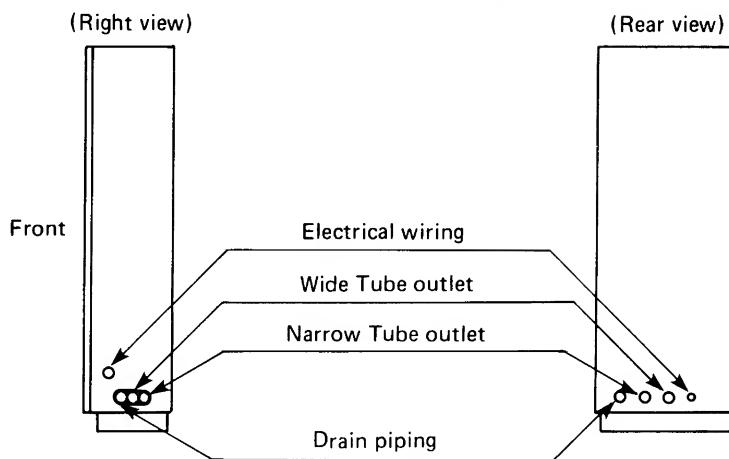
Fig. 6

- b) When it is not possible to fix the unit to the wall, fix it to the floor using another fitting plates.  
Fig. 7
- c) If tubing and wire pass through the wall, make hole on the wall. Fig. 8
- d) Measure thickness of wall from inside edge to outside edge and cut PVC pipe at a slight angle. Insert PVC pipe in wall. Fig. 9


**Fig. 7**

**Fig. 9**

**Fig. 8**

- e) The refrigerant tubing, drain piping and electrical wiring can be connected up in one of two directions (Right and Rear), depending upon the installation location. Fig. 10

**NOTE** : All holes are knockout.


**Fig. 10**

### 3-2. Use L-shaped tube

- a) Tubing to the rear (Fig. 11)

Use the L-shaped tube provided for wide tube line.

**NOTE :**

Wrap heat insulating material around the tube connected to the L-shaped tube (\* mark), up to the point where it enters the unit.

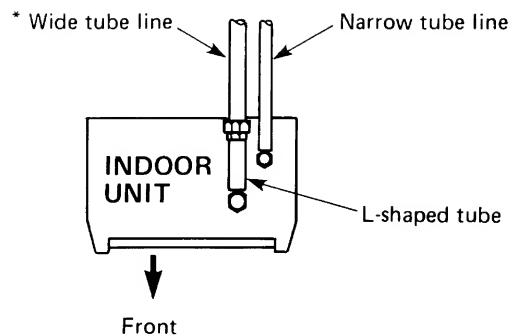


Fig. 11

- b) Tubing to the right (Fig. 12)

Use the L-shaped tube provided for wide tube line.

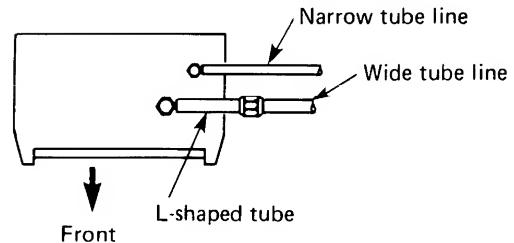


Fig. 12

### 3-3. Wiring instruction for interunit connections

- a) Insert the interunit wiring (according to local codes) into through-the-wall PVC pipe. Run the wiring toward indoor unit. Fig. 13

**CAUTION :**

Never fix the wiring by any means before the indoor unit is fully seated.

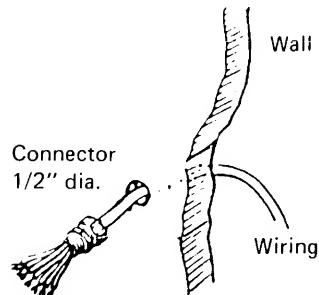


Fig. 13

- b) Remove the front panel.  
Fig. 14

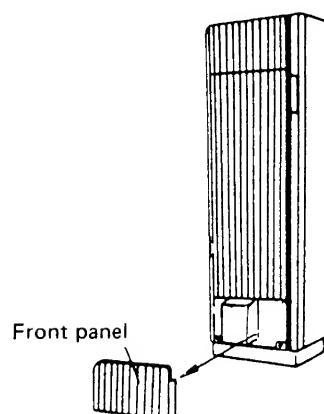


Fig. 14

- c) Unscrew the cover plate of the electrical component box. Fig. 15
- d) Temporarily set the wiring connector in the hole at the electrical component box.
- e) Secure the conduit connector to the electrical component box with a lock nut. Fig. 16
- f) Give some play to the interunit wiring from the outdoor unit to the corresponding terminal on the terminal base.

**CAUTION :**

Be sure to refer the wiring system diagram labelled on the electrical component box and carry out correct field wiring. Wrong wiring causes malfunction of the unit.

Check local electrical code and also any specific wiring instructions or limitation.

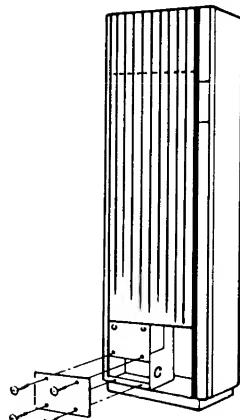


Fig. 15

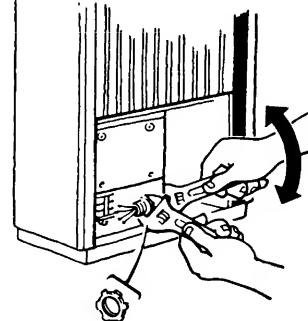


Fig. 16

### 3-4. Drain piping (Fig. 17)

- a) Drain piping should be slanted downward to outdoor.
- b) Never form a trap in the course of piping.
- c) If the drain pipe will run in the room, insulate the pipe with an insulation material\* lest chilled sweat should damage furniture or floors.

\*Formed polyurethane or polypropylene is recommended.

- d) Use adhesive at the connection part.

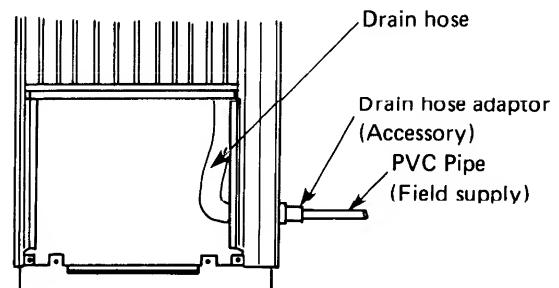


Fig. 17

### 3.5 **WARNING**

Do not supply power to the unit or operate until piping and wiring to the outside unit is completed.

## 4. HOW TO INSTALL OUTDOOR UNIT

- Place unit on level pad, blocks or equal and anchor.

Refer to INSTALLATION SITE LOCATION given in page 14.

### 4-1. Wiring Instructions on Outdoor Unit

- Remove access panel "C" and punch knockout holes on the panel. Fig. 18
- Connect interunit power line and power supply line per drawing on inside of the panel "C". Fig. 19
- Be sure to size each wire allowing several inches longer than the required length for wiring.
- When connections are completed secure both connectors on the panel with lock nuts and then close the panel.
- Ground unit in accordance with local codes.

**CAUTION :**

- Be sure to comply with local codes on running the wire from the indoor unit to outdoor unit. (size of wire and wiring method etc.)
- Every wire must be connected firmly.
- No wire should touch refrigerant tubing, compressor or any moving part.

CONNECTOR SIZE		
MODEL	POWER LINE CONNECTOR SIZE	INTERUNIT LINE CONNECTOR SIZE
SAP241C	1/2"	1/2"

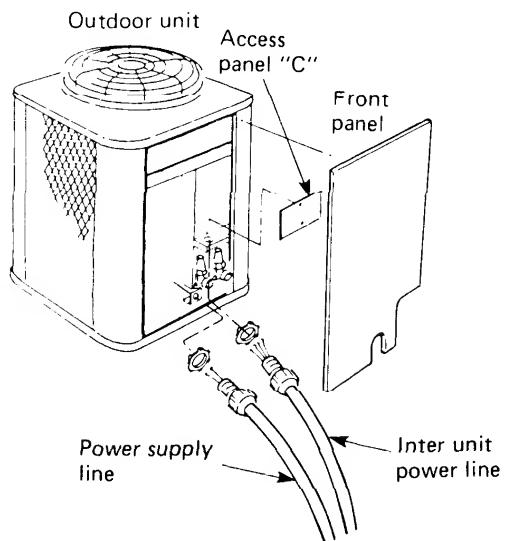


Fig. 18

### WIRING SYSTEM DIAGRAM

SAP241VC

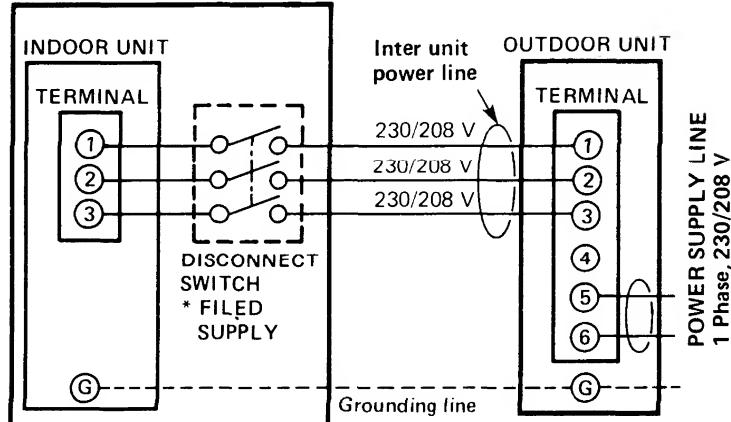


Fig. 19

## 5. REFRIGERANT TUBING

### 5-1. Use of the Flaring Method

The refrigerant tubing for every split type air conditioner must be connected by flaring. In this method, the copper tubes are flared at each end and connected with flare nuts.

### 5-2. Flaring procedure with a Flaring Tool

- a) Cut the copper tube to proper length with a tube cutter. It is recommended to cut approx. 12 ~ 20 in. longer than the estimated tubing length.
- b) Remove burrs at the end of the copper tube with a reamer or a file. This process is important and should be done carefully to make a good flare. Fig. 20

**NOTE** : When reaming, hold the copper tube end downward and be sure that no copper scraps fall into the tube. Fig. 21

- c) Remove the flare nut from the unit and be sure to mount it on the copper tube.
- d) Make a flare at the end of copper tube with a flaring tool\* Fig. 22 (\*Use "RIGID" or equivalent.)

**NOTE** : Good flare should have following conditions:

- Inside surface is glossy and smooth.
- Edge is smooth.
- Tapered sides are in uniform length.

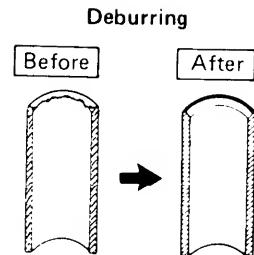


Fig. 20

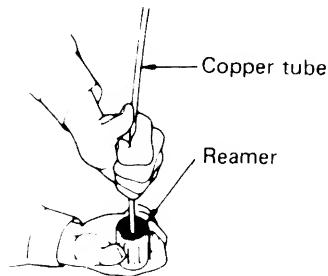


Fig. 21

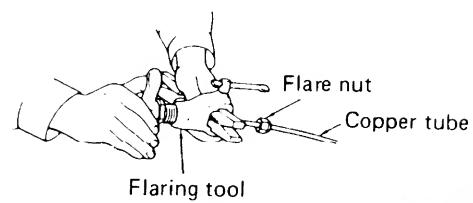


Fig. 22

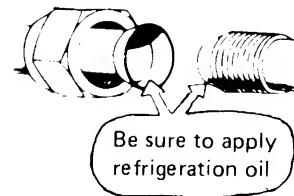


Fig. 23

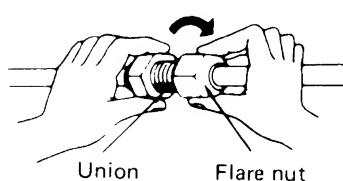


Fig. 24

#### 5-4. Connecting Tubes between Indoor and Outdoor Units

1. Connect the indoor side refrigerant tubing extended from the wall with the outdoor side tubing tightly.
2. Flare nut on large dia. tube should be torqued to 510 ~ 550 lbs. in. Flare nut small dia. tube should be torqued to 130 ~ 170 lbs. in. Fig. 25
3. After performing a leak test on the connecting part, insulate it with INSUL. NIPPLE and finish with a vinyl masking tape over it. Fig. 26

**NOTE :** Never connect up tubes by brazing them. If it is inevitable, be sure to blow nitrogen gas while brazing to avoid oxidation of inside copper tube.

#### 5-5. Insulation of Refrigerant Tubing

Because the capillary tubing is installed in the outdoor unit, both wide and narrow tubes of this air conditioner become cold. Therefore, to prevent heat loss and wet floors due to dripping of chilled sweat, both tubes must be well insulated with proper insulation material. Thickness of insulation material should be min. 5/16". Fig. 27

- **Insulation material**

The material must of course have good insulation characteristics, be easy to use, age resistant, and must not easily absorb moisture. The following is recommended; foamed polyurethane or polypropylene.

#### 5-6. Taping the Tubing

- a) At this time, the two refrigerant tubes (and electrical wire if code permits) should be taped together with armoring tape. The drain pipe may also be included and taped together as one bundle with the tubing.
- b) Wrap the armoring tape from the bottom of the outdoor unit to the top of the tubing, where it enters the wall. As you wrap the tubing cover half of each previous tape turn.  
Fig. 28
- c) Clamp tubing bundle to wall, one clamp every 4' approx.

**NOTE :** Do not wind the armoring tape around too tightly since this will impair the heat insulation effect. Also be sure condensation drain hose splits away from bundle and empties clear of unit and tubing.

#### 5-7. Finishing the Installation

After finishing insulation and taping over tubing, fill the void space with putty to prevent rain and draft from entering. Fig. 29

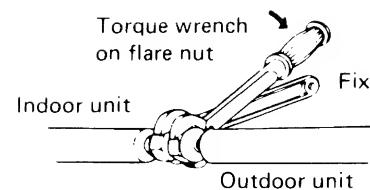


Fig. 25

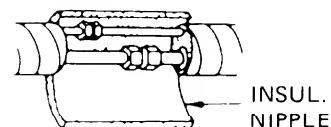


Fig. 26

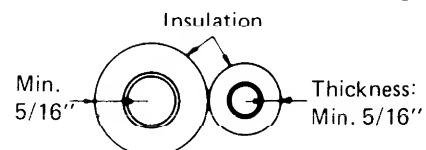


Fig. 27

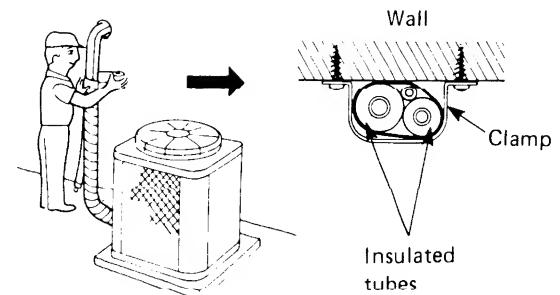


Fig. 28

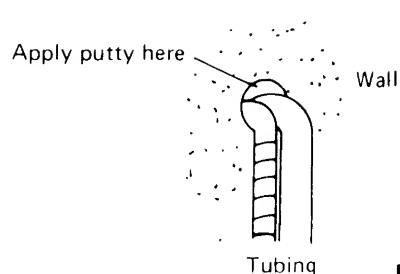


Fig. 29

## 6. AIR PURGING

Air does not function as a refrigerant, because it cannot be liquefied in the condenser. Air and moisture remaining in the refrigerant system have undesirable effects as indicated at right. Therefore, they must be purged completely.

- The pressure in the narrow tube rises.
- The operating current rises.
- Cooling efficiency drops.
- Water contained in the air may freeze and block the capillary tubing.
- Water may lead to corrosion of parts in the refrigerant circuit.

### ■ TUBING DIAGRAM FOR AIR PURGING

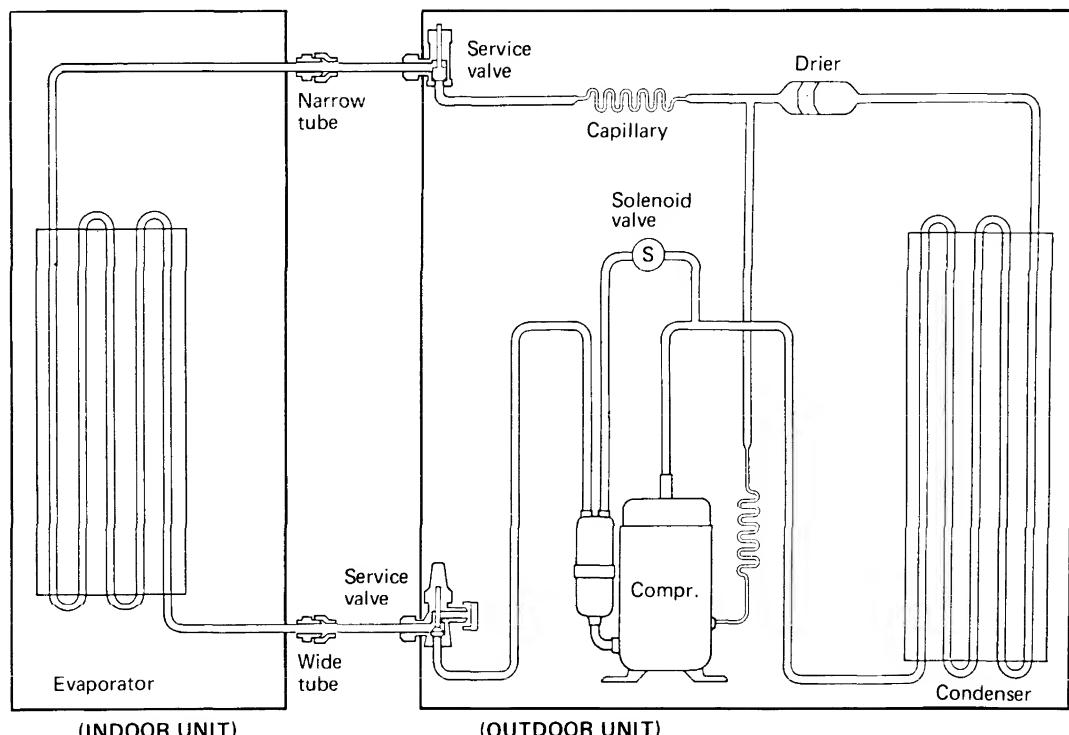


Fig. 32

#### 6-1. Quick Air Purge System

New quick air purge system represents purging the air in the indoor unit and connection tubes with the aid of refrigerant gas pre-charged in the outdoor unit.

By this system, air purging has become much simpler and installation time has become shorter than conventional methods.

**NOTE :** Outdoor unit is pre-charged at the factory. Don't open valves until tubing is hooked up and you are ready to proceed with purging procedure.

## 6-2. Air Purging Procedure

- a) Remove the valve caps from the service valves on the narrow tubes.
- b) Loosen the flare nut (A) of wide tube by 180 degrees (1/2 turn). Fig. 30
- c) Open the spindle of the narrow tube by 90 degrees (1/4 turn) for 15 seconds and close it to the original position.
- d) After 45 seconds, fasten the flare nut (A) of wide tube tightly as it was. Fig. 31
- e) Open the wide tube service valve by a quarter turn and close it as soon as hissing stops. This indicates that tubings are filled with the refrigerant gas of the outdoor unit.
- f) Leak test the joints with liquid soap. If no leakage, wipe off the soap. Fig. 32
- g) Turn the valve stems all the way out to Back Seat on both service valves, then, tighten the valve seal caps with the copper gaskets.
- h) The all air purge procedure has been completed and the unit is ready for trial operation.

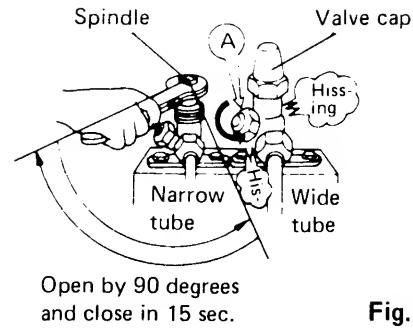


Fig. 30

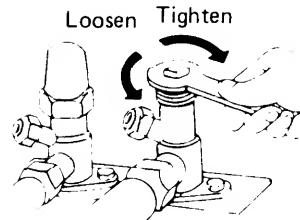


Fig. 31

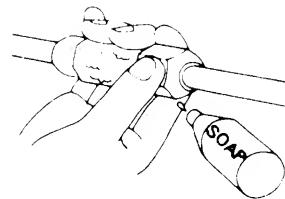


Fig. 32

## ■ SERVICE VALVE CONSTRUCTION

### • Valve Position -a-

The valve stems of both wide & narrow tubes are turned all the way in. The unit is shipped from the factory in this position and it is also used for PUMP DOWN. (Fig. 33-a)

### • Valve Position -b-

The valve stems of both wide & narrow tubes are turned all the way out ("BACK SEAT" position). This is the normal operating position. (Fig. 33-b)

### • Valve Position -c-

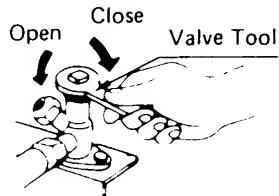
With the narrow tube valve kept at BACK SEAT, only the wide tube valve stem is turned halfway-down position. This position is used for pressure measurement and gas charging. (Fig. 33-c)

### • Valve Position -d-

Like position -a-, but with the flare nut of wide tube open. This position is used for air purging. (Fig. 33-d)

#### **CAUTION :**

Be sure to use the valve tool or ratchet wrench when opening or closing the shut-off valve spindle.

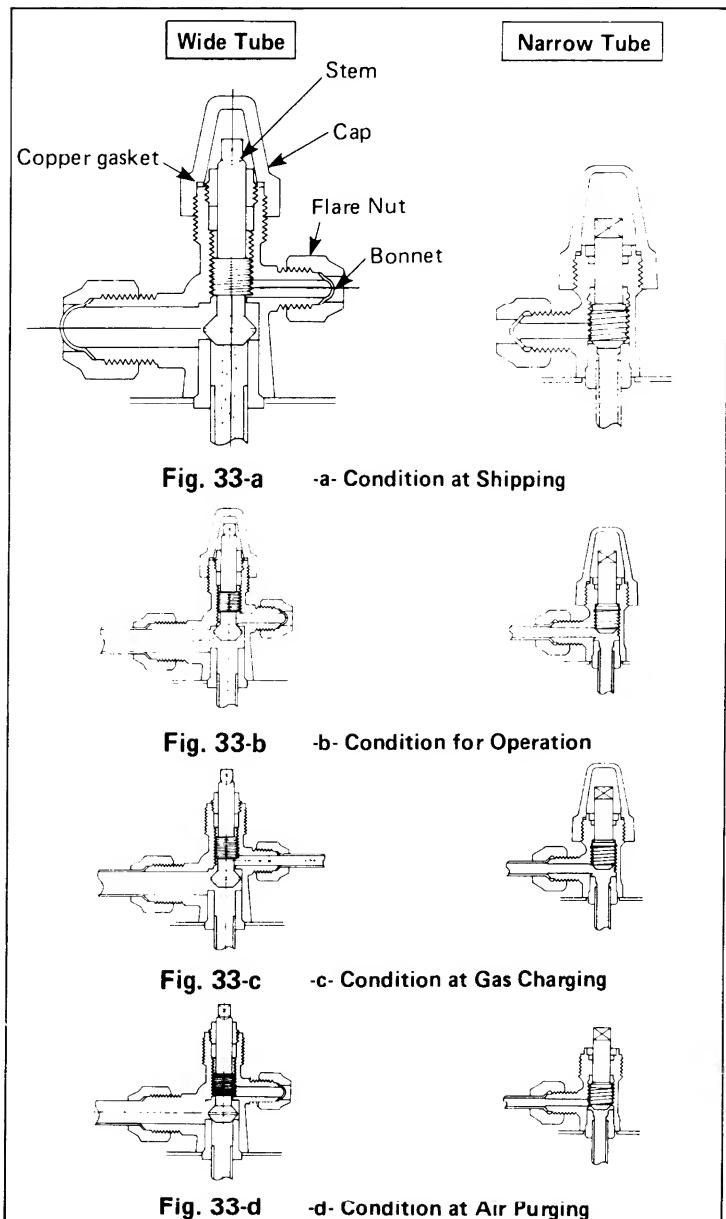


## ■ PUMP DOWN

Pump down means collecting all refrigerant in the system back into the outdoor unit without losing refrigerant gas. Pump down is used when unit is moved or for servicing the refrigerant circuit.

#### **CAUTION :**

- 1) Close valve on wide tube halfway (2 turns).
- 2) Close valve on narrow tube all the way (4 turns).
- 3) Turn unit on (cooling) for approximately 3 minutes then shut off.
- 4) Close valve on wide tube all the way (2 additional turns).
- 5) Disconnect tubes slowly allowing pressure to equalize inside and out.
- 6) When tubing is disconnected provide dust covers for both valves and tubes until unit is reconnected.



## 7. PRECAUTIONS BEFORE STARTING

After insulation, be sure to bind up insulation material and refrigerant tubings with a water-proof tape so as rain should not creep into the insulation material and wiring. Fig. 34

Before attempting to start the air conditioner, check the following:

- a) All loose matter is removed from the cabinet especially steel fillings and chips.
- b) Control wirings are correctly connected and all electrical connections tight.
- c) All temporary jumper wires removed. (Refer to unit wiring diagram.)
- d) Check to see if compressor mounting bracket or board, which secures compressor during transportation, is removed. If not, remove them. Fig. 35
- e) Be sure to confirm that all shut-off valves are open.
- f) Power connected to unit for at least five hours before starting the compressor. The bottom of compressor should be warm to the touch and crankcase heater around the feet of the compressor should be hot to the touch.

## 8. TRIAL RUN

Check that all tubing and wiring have been completed correctly. Check again that wide and narrow tube service valves are fully opened. Turn on power and run the unit.

### NOTE :

If the room temperature is too low, cooling operation may not be possible even if the thermostat knob is set at the lowest position.

In this event, perform test run as follows:

- a) Pull off the thermostat knob. Fig. 36
- b) Set the thermostat lever to the lowest position. (The central position of the lever becomes the TEST RUN position.) Fig. 37
- c) Press OPERATION "ON" button to start the air conditioner.
- d) After completion of test run, press "OFF" button to stop the unit.
- e) Reinstall the thermostat knob. (The stopper position facing down.)

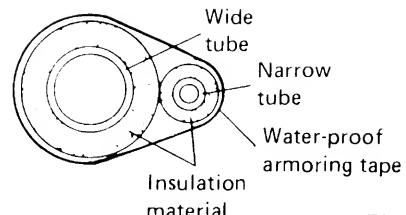


Fig. 34

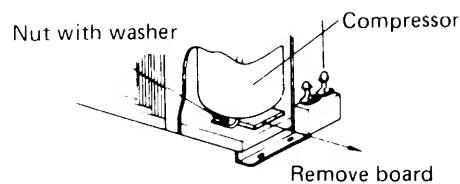


Fig. 35

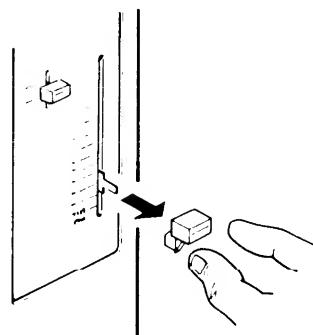


Fig. 36

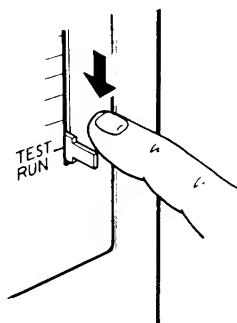


Fig. 37

## 7. TROUBLESHOOTING

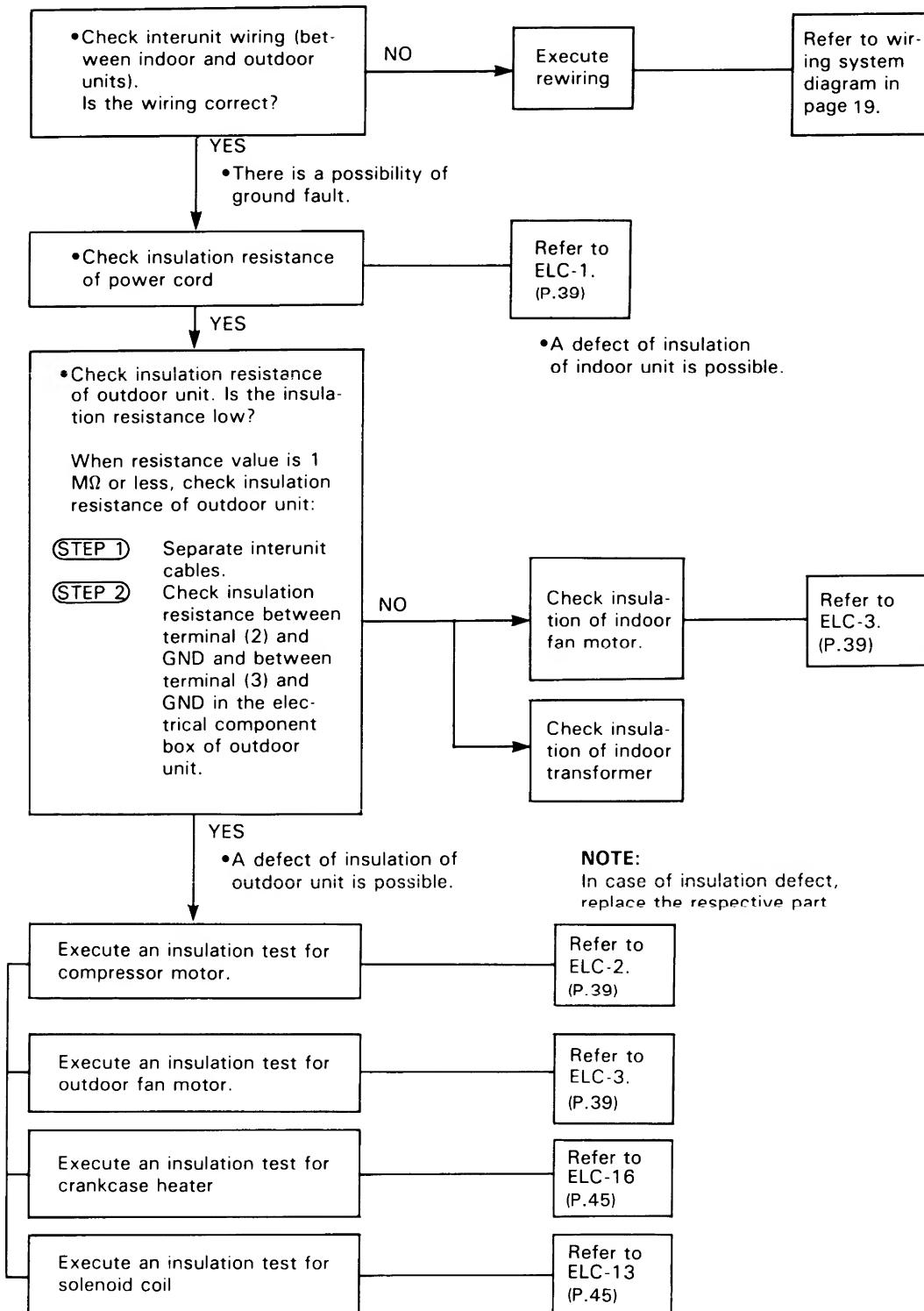
### – Quick Access Index –

	Page
<b>1. Air conditioner does not operate . . . . .</b>	<b>27</b>
1.1. Circuit breaker trips (or fuse blows)	
1.1.1. When circuit breaker is set to ON, it trips soon (resetting is not possible)	
1.1.2. Circuit breaker trips when the operation switch is depressed	
1.2. Neither indoor unit nor outdoor unit runs	
1.3. Auto deflector motor does not run	
<b>2. Some part of air conditioner does not operate . . . . .</b>	<b>30</b>
2.1. Indoor fan does not run	
2.2. Neither outdoor fan nor compressor runs	
2.3. Only outdoor fan does not run	
2.4. Only compressor does not run	
2.5. Compressor frequently repeats ON and OFF	
<b>3. Air conditioner operates, but abnormalities are observed . . . . .</b>	<b>35</b>
3.1. Poor cooling	
3.2. Excessive cooling	

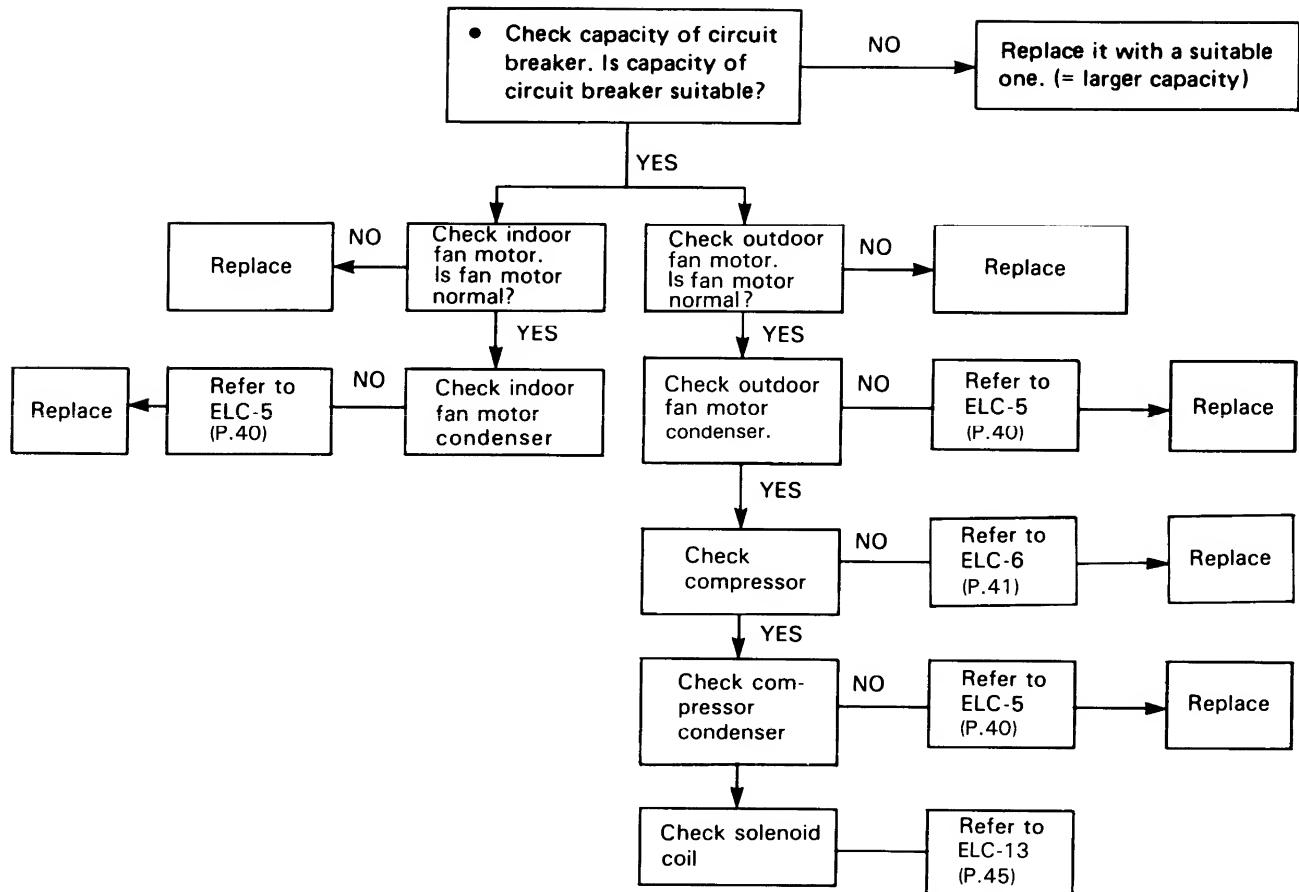
## 1. Air conditioner does not operate

### 1.1 Circuit breaker trips (or fuse blows)

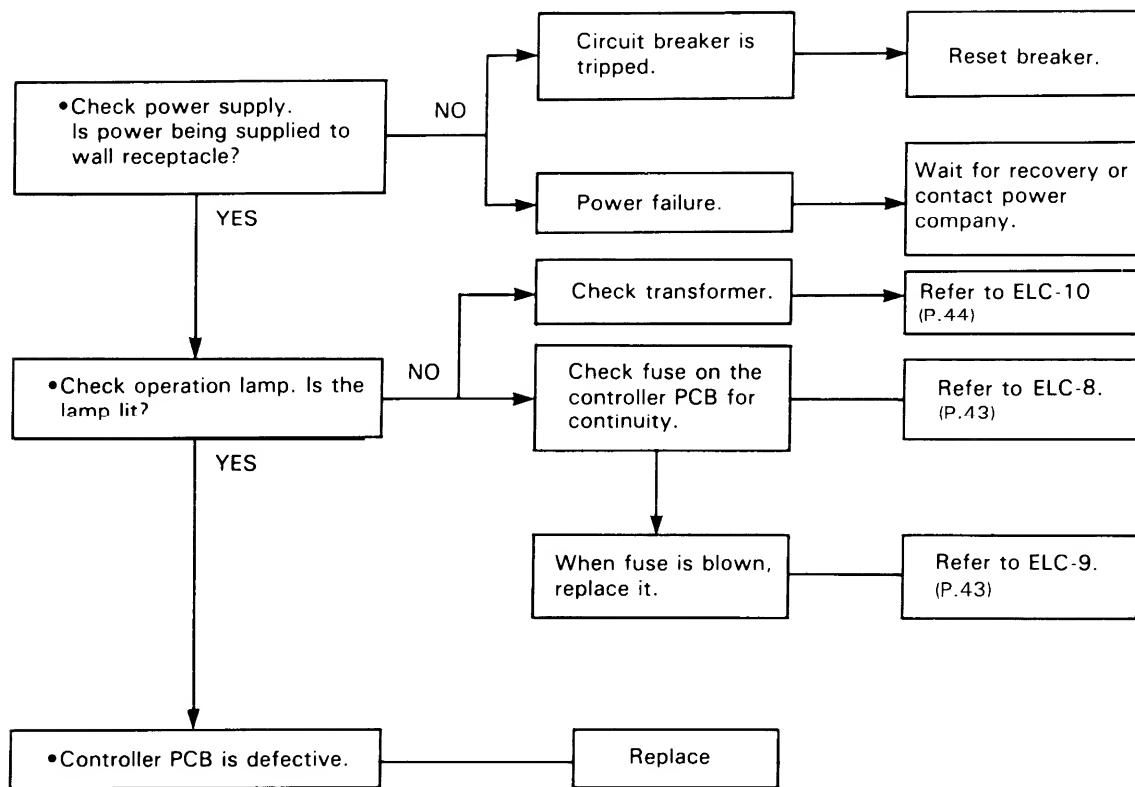
#### 1.1.1 When circuit breaker is set to ON, it trips soon (resetting is not possible)



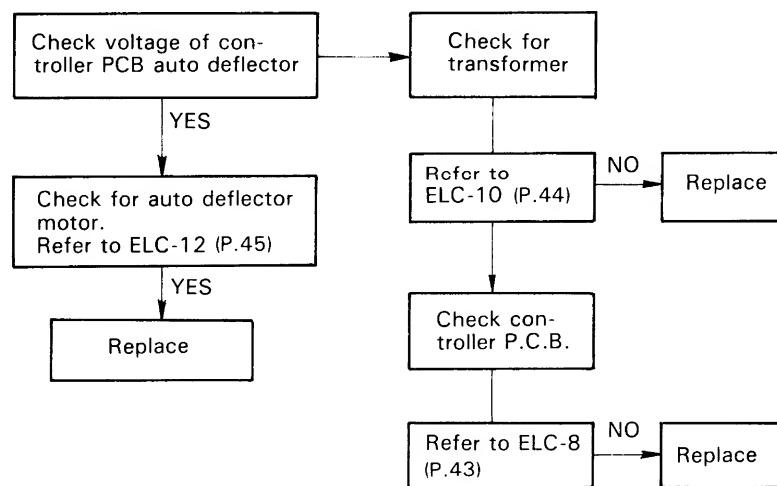
**1.1.2 Circuit breaker trips when the operation switch is depressed.**



## 1.2 Neither indoor unit nor outdoor unit runs

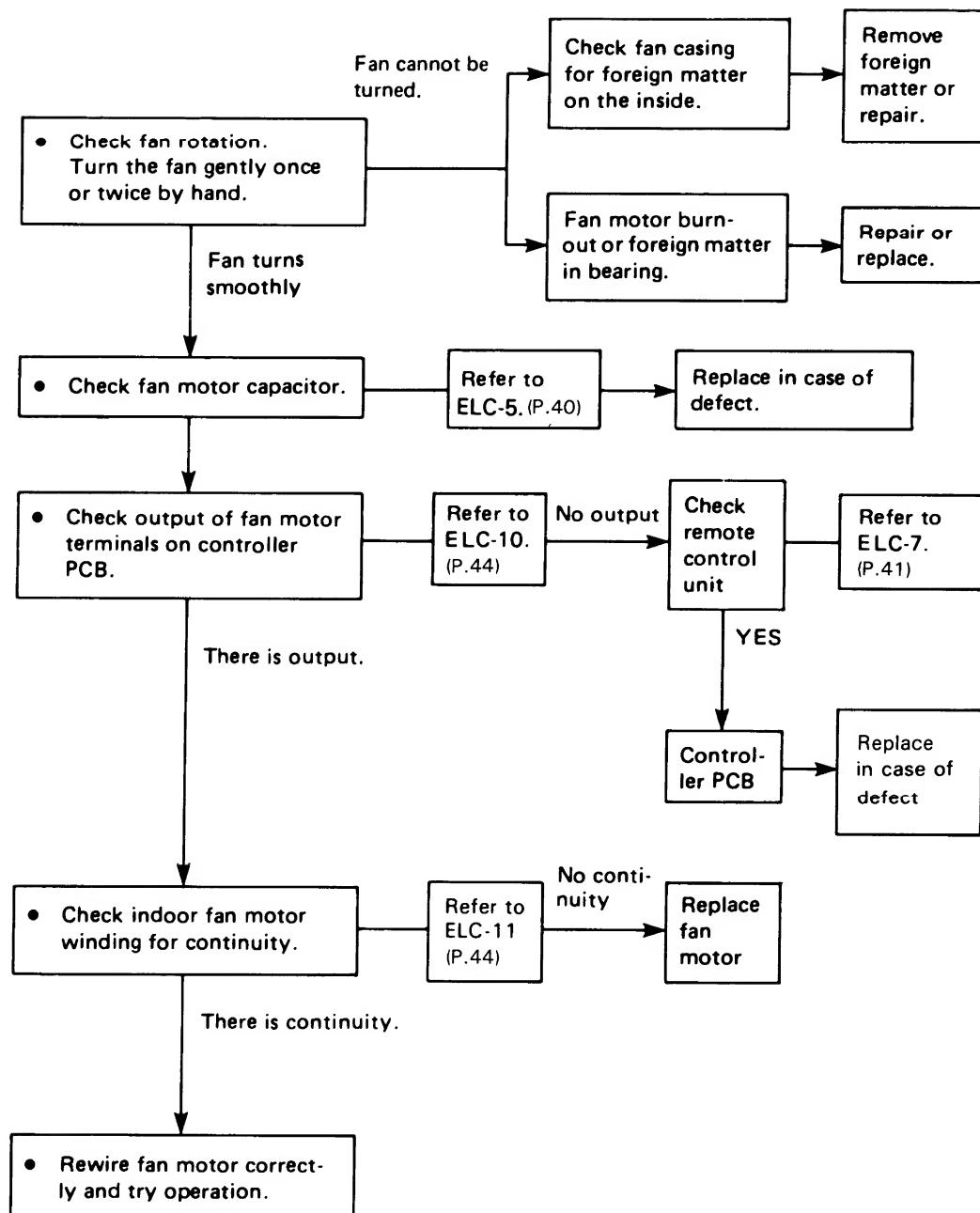


## 1.3 Auto deflector motor does not run.



## 2. Some part of air conditioner does not operate

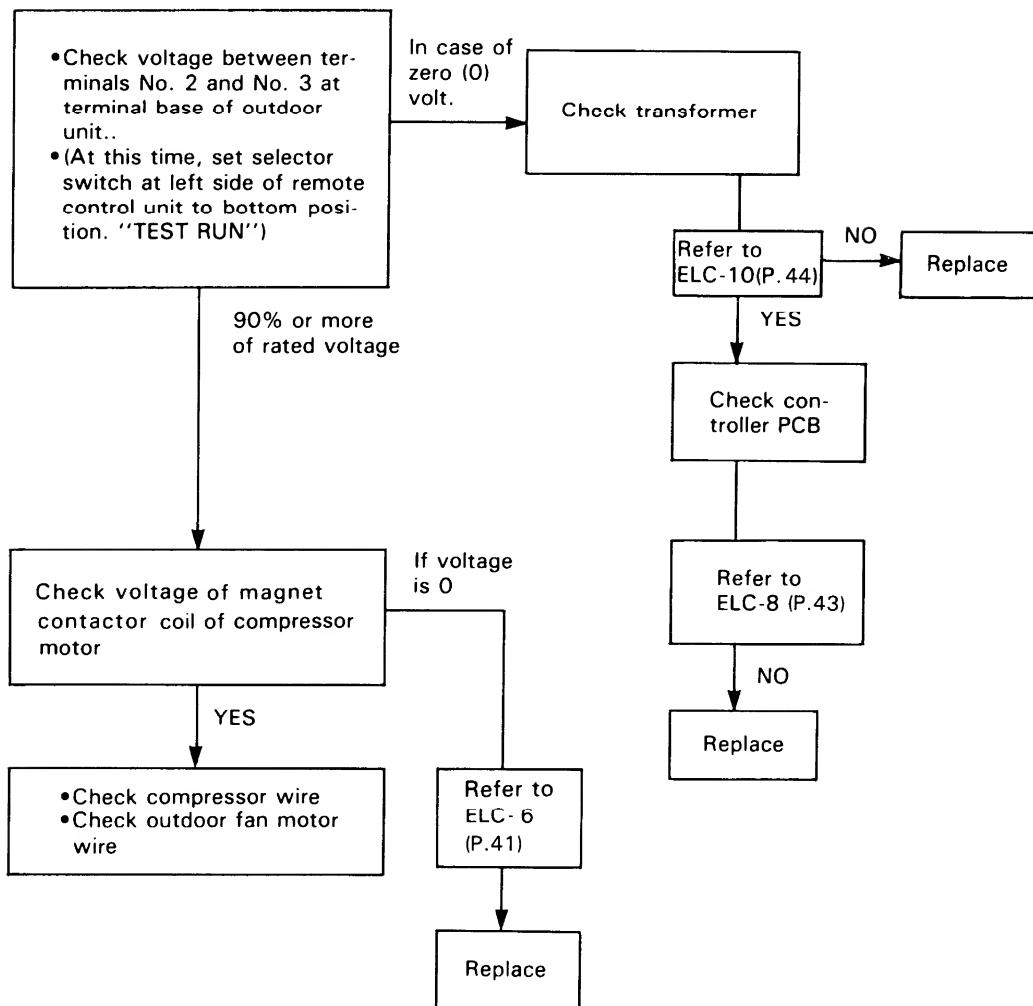
### 2.1 Indoor fan does not run



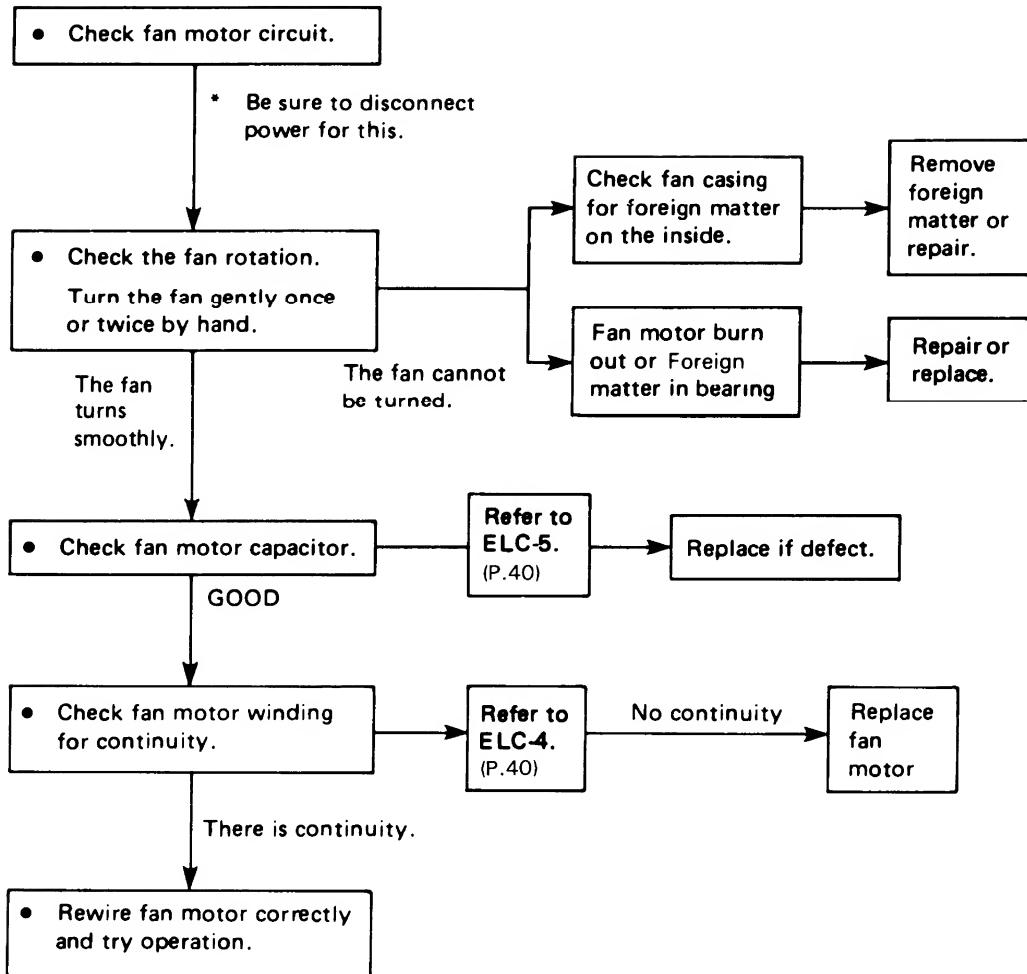
## 2.2 Neither outdoor fan nor compressor runs

**Note:** Check following points at first;

1. Is thermostat setting suitable?
2. Has 3 minute timer operated?  
(No operation for 3 minutes after power ON.)

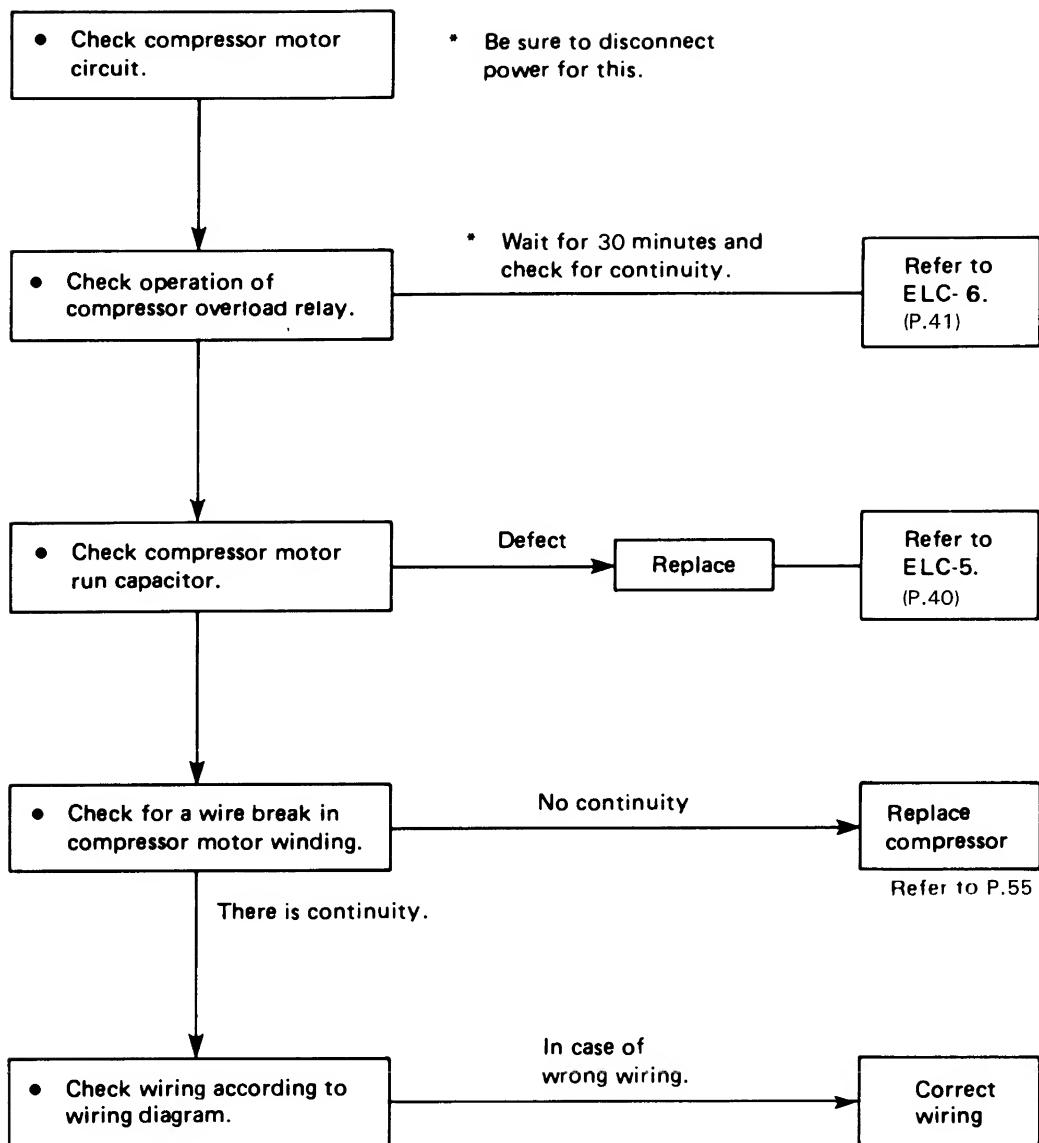


### 2.3 Only outdoor fan does not run



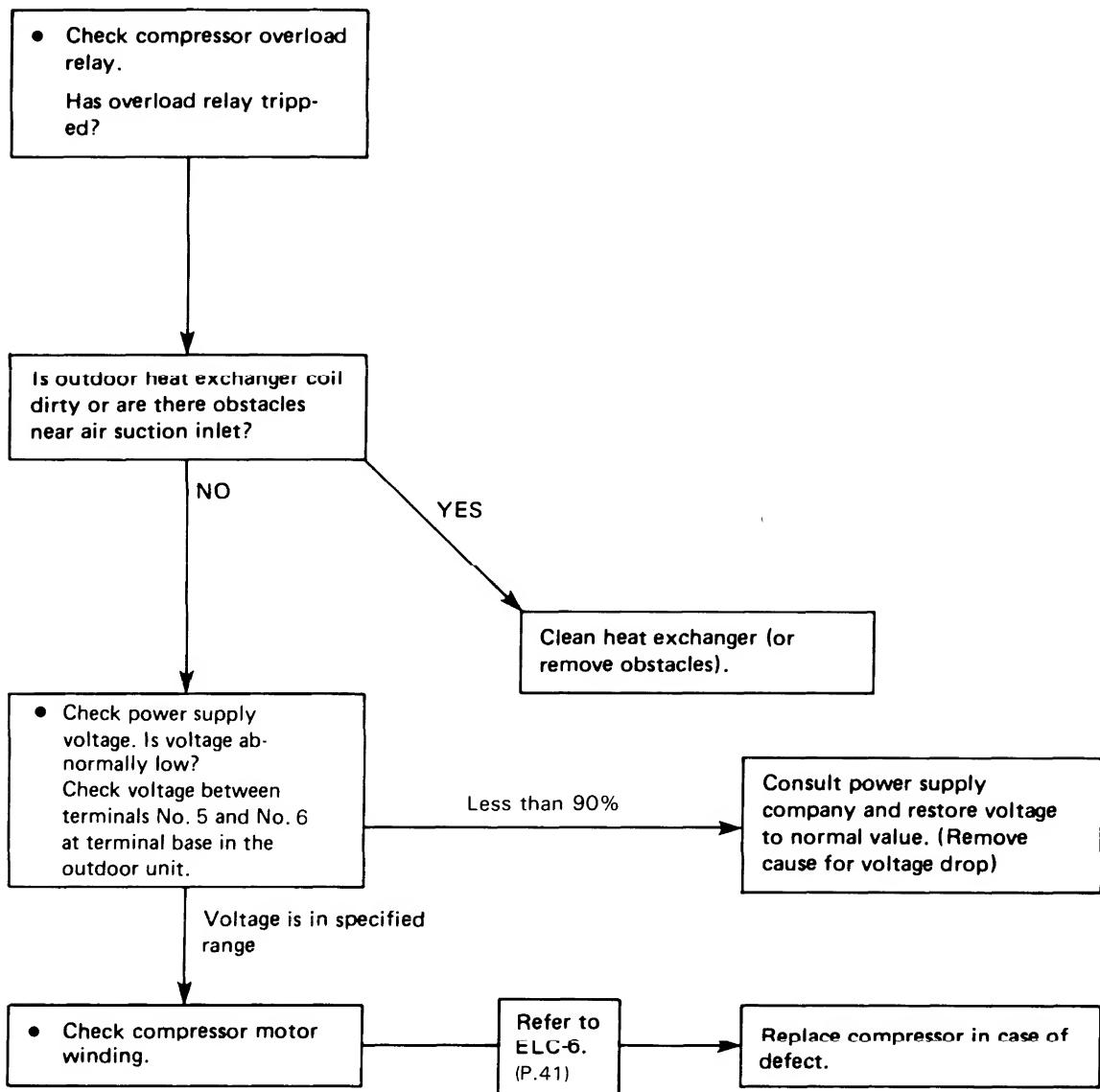
**NOTE:** The fan motor does not run until the winding temperature lowers and automatic resetting works if the internal thermostat operates.

## 2.4 Only compressor does not run



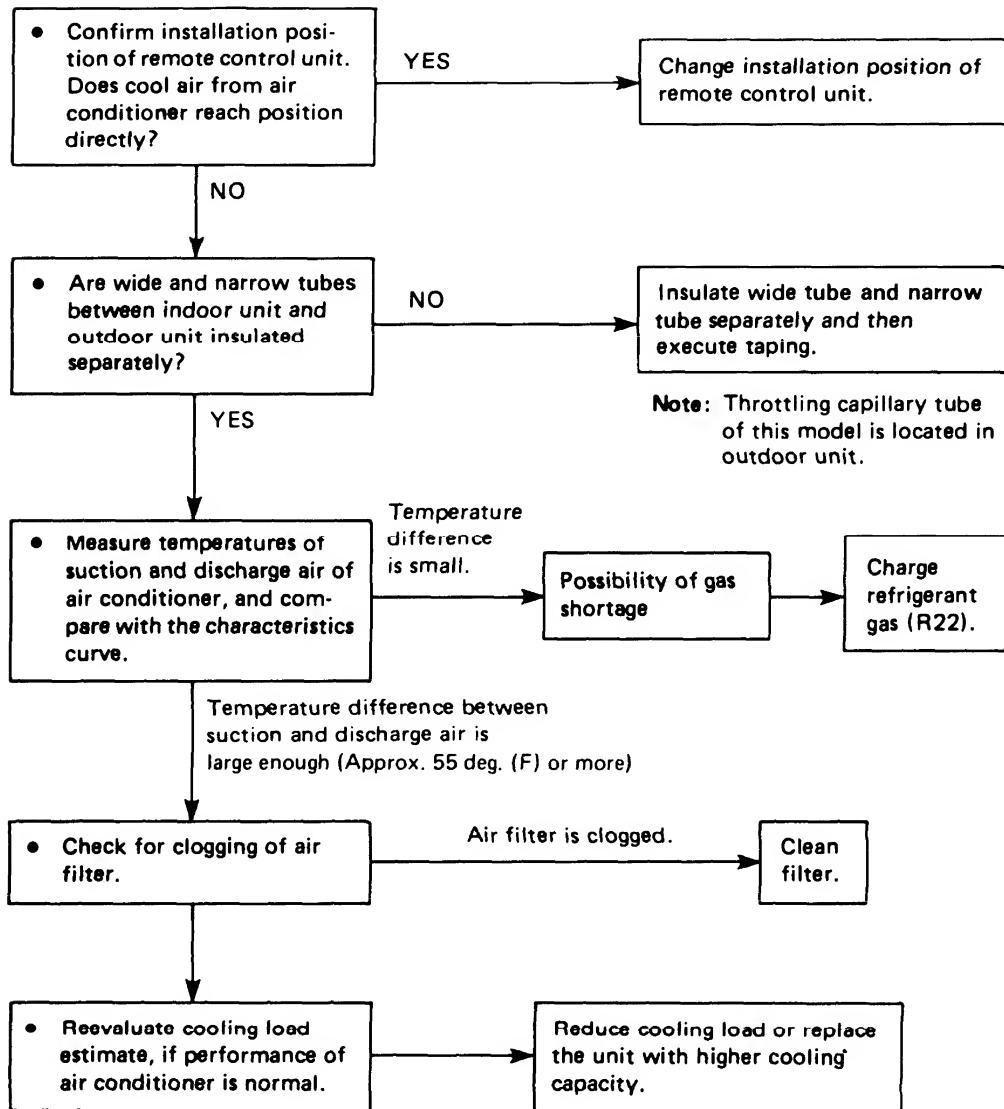
## 2.5 Compressor frequently repeats ON and OFF

(Only compressor repeats ON and OFF, while indoor unit and outdoor fan run without fail.)

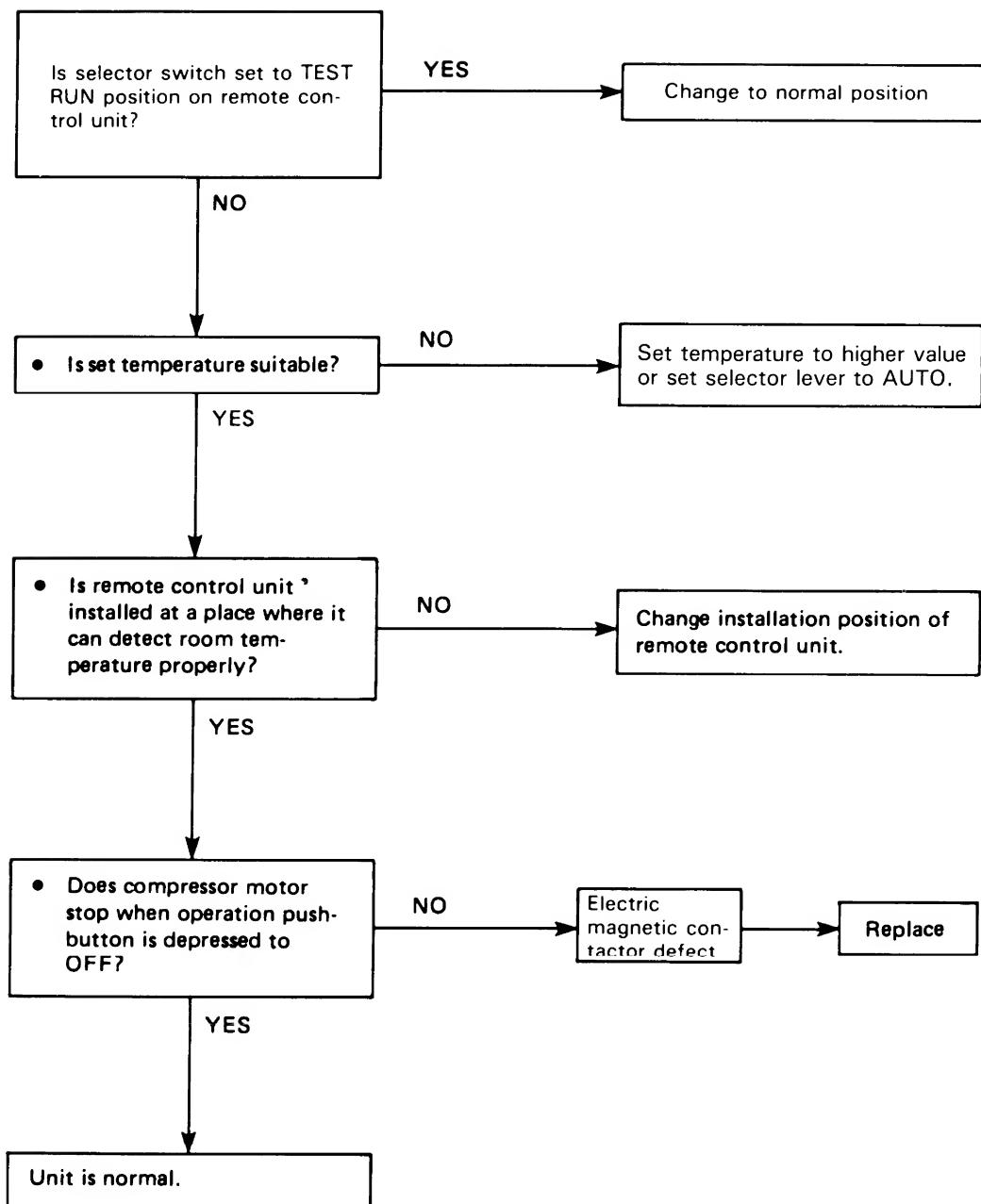


**3. Air conditioner operates, but abnormalities are observed**

**3.1 Poor cooling**

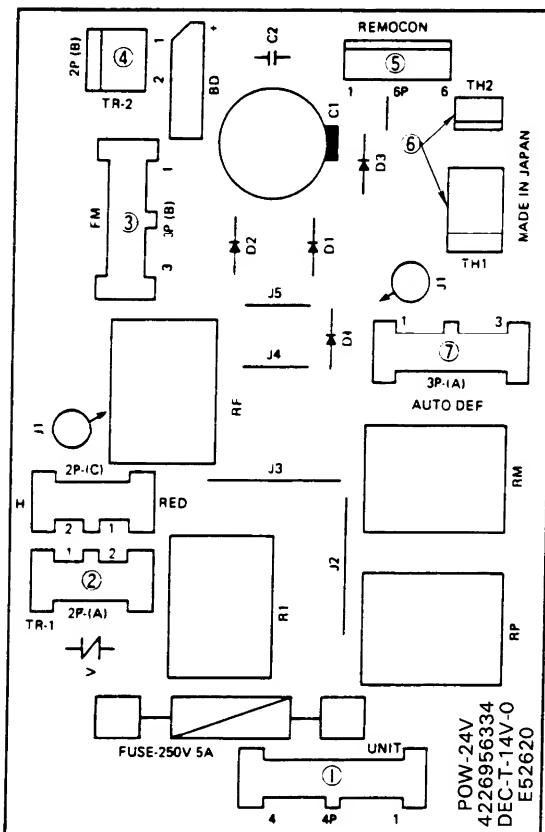


### 3.2 Excessive cooling



## **8. CHECKING AND REPLACING ELECTRICAL COMPONENTS**

—Quick Access Index—	Page
ELA. Connector Identification on Controller PCB . . . . .	38
ELC-1. Measurement of Insulation Resistance of the Power Cord . . . . .	39
ELC-2. Measurement of Insulation Resistance of the Compressor . . . . .	39
ELC-3. Measurement of Insulation Resistance of the Fan Motor . . . . .	39
ELC-4. Checking of the Outdoor Fan Motor . . . . .	40
ELC-5. Checking of the Motor Capacitor . . . . .	40
ELC-6. Checking of the Compressor Motor Winding . . . . .	41
ELC-7. Checking of the Remote Control Unit Proper . . . . .	41
ELC-8. Checking of the Continuity of Fuse on the Controller PCB . . . . .	43
ELC-9. Method to Replace Fuse on the Controller PCB . . . . .	43
ELC-10. Checking of the Power Transformer . . . . .	44
ELC-11. Checking of the Indoor Fan Motor . . . . .	44
ELC-12. Checking of the Auto Deflector Motor . . . . .	45
ELC-13. Checking of the Solenoid Coil . . . . .	45
ELC-14. Checking of the Coil Thermostat . . . . .	45
ELC-15. Checking of the Electric Magnetic Contactor . . . . .	45
ELC-16. Checking of the Crankcase Heater . . . . .	45

**ELA. Connector Identification on Controller PCB**
**POW-24V**

**Fig. E-A**

1. Connector, Power Supply to PCB \*
2. Connector, Transformer (Primary: \* )
3. Connector, Fan Motor \*
4. Connector, Transformer (Secondary: 19 V)
5. Connector, Remote Control Unit 24V
6. Connector, Thermistor Sensor 24V
7. Connector, Auto Deflector \*

\*line voltage

### **ELC-1. Measurement of Insulation Resistance of the Power Cord**

Clamp the ground (GND) line of the Power Cord with a lead clip of the insulation resistance tester and measure the resistance by placing a probe on either of the two power lines.

Then also measure the resistance between the GND line and the other power line. The insulation is in good condition if the resistance exceeds  $1\text{ M}\Omega$ .

Then also measure the resistance between the ground and the other power line. The insulation is in good condition if the resistance exceeds  $1\text{ M}\Omega$  (Fig. E-1).

### **ELC-2. Measurement of Insulation Resistance of the Compressor**

Remove the red lead wire connected to the compressor motor from (4) on the terminal base. Clamp the removed black lead wire with a lead clip of the insulation resistance tester and measure the resistance by placing a probe of the tester to the terminal GND, to which green lead wire is connected.

The insulation is in good condition if the resistance exceeds  $1\text{ M}\Omega$  (Fig. E-2).

### **ELC-3. Measurement of Insulation Resistance of the Fan Motor**

#### **3.1. In case of indoor fan motor**

Remove the fan motor connector from controller PCB (P38, Fig. E-A). Clamp the green lead wire (at the bear section) extended from the terminal GND in the electrical component box and measure insulation resistance by placing a probe of the insulation tester to either pole of this connector.

The insulation is in good condition if the resistance exceeds  $1\text{ M}\Omega$ . Fig. E-3.

#### **Note:**

If the probe does not enter the pole because the hole is too narrow then use a probe with a thinner pin.

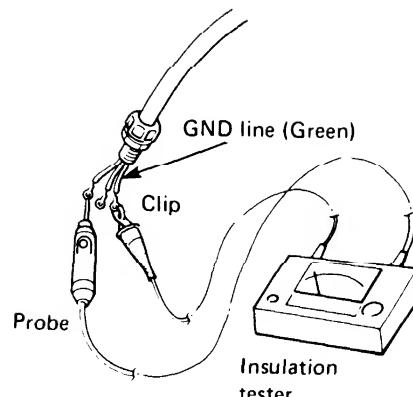
#### **3.2. In case of outdoor fan motor**

Disconnect the white lead wire connected to Terminal (6) of the electric magnetic contactor. Clamp this lead wire with a lead clip of the insulation resistance tester and measure the resistance by placing a probe of the tester to the terminal GND.

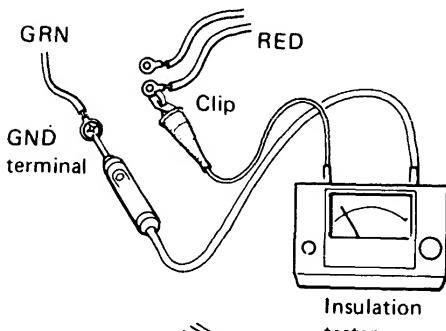
The insulation is in good condition if the resistance exceeds  $1\text{ M}\Omega$ . Fig. E-4.

Disconnect Connector 2P of the auto deflector motor and check the insulation resistance between the white or black lead wire and auto deflector motor case.

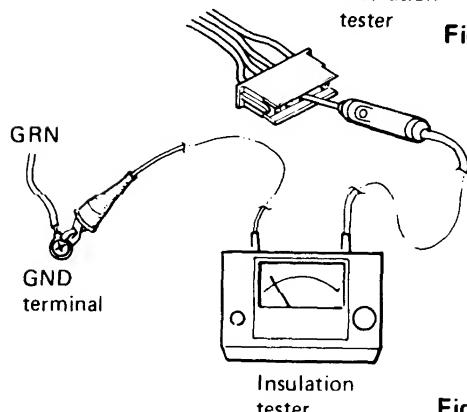
Disjoin and check both ends of the crank case heater.



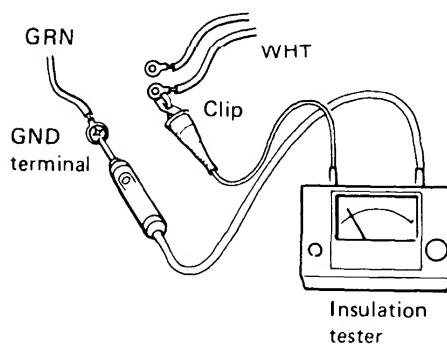
**Fig. E-1**



**Fig. E-2**



**Fig. E-3**



**Fig. E-4**

#### ELC-4. Checking of the Outdoor Fan Motor

Disconnect and check the fan motor lead wires (WHT, BRN, and PNK) as shown in the wiring diagram (Fig. E-5).

Set the resistance measuring range of the multimeter to "X1Ω" and measure the resistance between the fan motor lead wires.

**SAP241C**

Lead wire color	Coil resistance
WHT-BRN	$24\Omega \pm 10\%$
WHT-PNK	$54\Omega \pm 10\%$

(Table-1)

Note: When ambient temp is 70°F

**SAP241C ELECTRIC WIRING DIAGRAM**

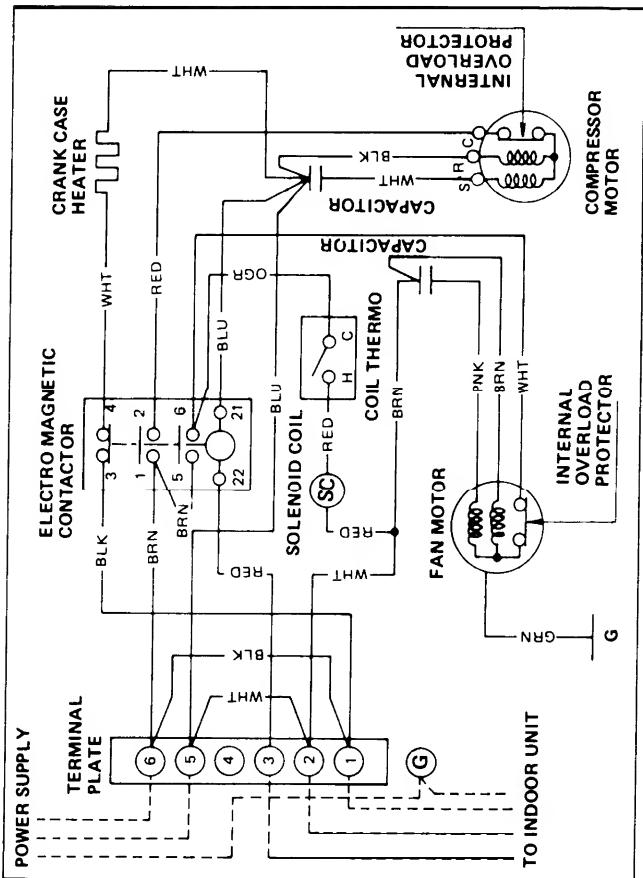


Fig. E-5

#### ELC-5. Checking of the Motor Capacitor

Checking of any of the indoor fan motor capacitor, outdoor fan motor capacitor and compressor motor capacitor can be done by the same method.

Remove both the lead wire terminals connected to the capacitor, place the probe on the capacitor terminals as shown in the Fig. E-6 and observe the deflection of the pointer, setting the resistance measuring range of the multimeter to the maximum value.

For good condition of the capacitor, the pointer bounces to a great extent and then gradually returns to its original position.

The range of deflection and deflection time differ according to the capacity of the capacitor.

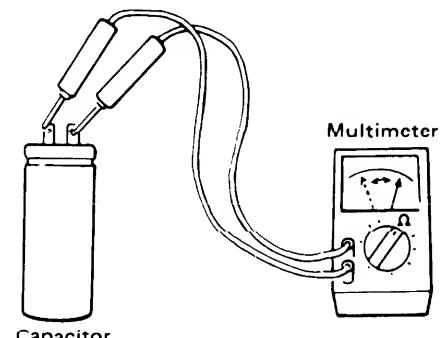


Fig. E-6

### ELC-6. Checking of the Compressor Motor Winding

Remove the terminal cover of the compressor motor, set the resistance measuring range of the multimeter to "X1Ω" and check the continuity between each pair out of the 3 terminals as indicated in Fig. E-7.

It is in good working condition if there is continuity among each pair of terminals.

SAP241C

Lead wire color	Coil resistance
C-R	0.66Ω ± 10%
C-S	1.97Ω ± 10%

(Table-2)

**Note:** When ambient temp is 77°F.

### ELC-7. Checking of the Control Unit Proper

#### A. Caution: Use of the Test Switch (TEST RUN)

The position of the switch which is used to operate the air conditioner for a room temperature below 69°F(21°C) is the position of the switch for this TEST RUN.

If this operation is continued for a long time, there would be a bad effect on the air conditioner because of over-cooling. Therefore, use this switch only for checking, and in any case, **DO NOT KEEP ON COOLING FOR MORE THAN 15 MIN. UNDER TEST RUN MODE.**

When the checking is over, **TURN THE SWITCH BACK TO ITS ORIGINAL POSITION (= RUN) WITHOUT FAIL.**

#### REFERENCE TEST RUN

Check that all tubing and wiring have been completed correctly. Check again that wide and narrow tube service valves are fully opened. Turn on power and run the unit.

#### NOTE :

If the room temperature is too low, cooling operation may not be possible even if the thermostat knob is set at the lowest position.

In this event, perform test run as follows:

- Pull off the thermostat knob. Fig. E-8.
- Set the thermostat lever to the lowest position. (The central position of the lever becomes the TEST RUN position.) Fig. E-9.
- Press OPERATION "ON" button to start the air conditioner.
- After completion of test run, press "OFF" button to stop the unit.
- Reinstall the thermostat knob. (The stopper position facing down.)

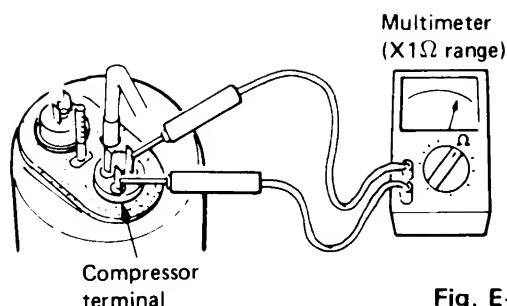


Fig. E-7

### 1. CONTROL UNIT

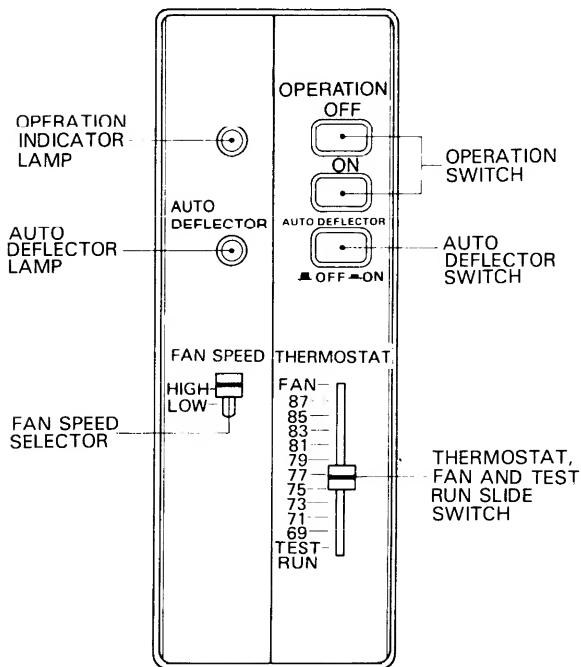


Fig. E-7A

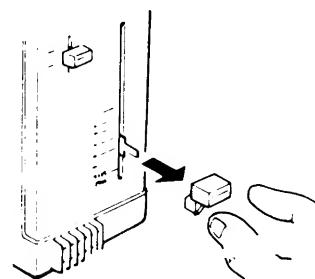


Fig. E-8

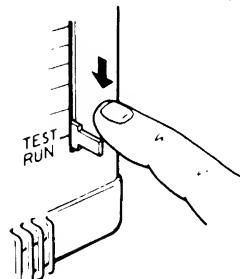
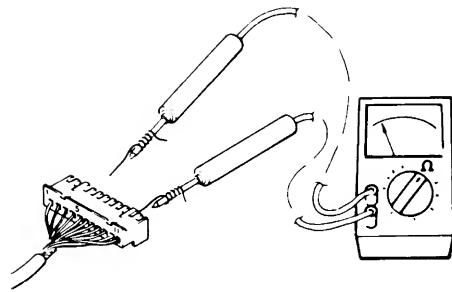


Fig. E-9

### B. Checking of the items of the Remote Control Unit

At first, pull out the connector (7P) of the remote control unit from the controller PCB of the unit (refer to Fig. E-10).



#### (1) Fan Speed Selector

Check the continuity of the connector No. 3 against No. 4 (place the negative (-) probe on No. 4 and positive (+) probe on No. 3).

Checking points	Position of the selector	
	High	Low
3-4	NO	NES

(Table-3)

**NOTE:** YES ..... Continuity  
NO ..... Discontinuity

#### (2) Auto Deflector Motor

Checking-points	ON	OFF
3-6	YES	NO

(Table-4)

**NOTE:** YES ..... Continuity  
NO ..... Discontinuity

#### (3) Checking of the Operation Pushbutton

The operating switch is in good working condition if there is continuity between No. 2 (placing the negative (-) probe and No. 3 (placing positive (+) probe) while the pushbutton is pressed.

#### CAUTION:

**Do not disassemble the Remote Control Unit.**

It is supplied as a complete assembly and is carefully adjusted in the factory by skillful workmanship. Inexperienced disassembly will cause trouble and malfunction in the unit.

### ELC-8. Checking of the Continuity of Fuse on the Controller PCB

Check the continuity by the multimeter as shown in Fig. E-11.

If it is difficult to check in this way, remove the lamp board ass'y connector and then check it.

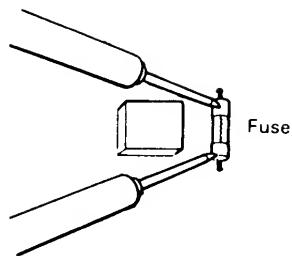


Fig. E-11

### ELC-9. Method to Replace Fuse on the Controller PCB

1. Remove the controller PCB
2. Pull out the fuse at the metal clasp by a pair of pliers while heating the soldered leads on the back side of the controller PCB with a soldering iron (30W or 60W). Fig. E-12.
3. Remove the fuse ends one by one. For replacement, insert a fuse of the same rating and solder it.  
(Allow time to radiate heat during soldering so that the fuse does not melt).

**CAUTION** : Be sure to replace the varistor adjacent to the fuse either when the fuse is blown.

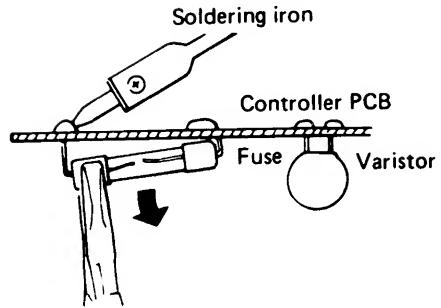


Fig. E-12

**ELC-10. Checking of the Power Transformer**

1. Remove connectors TRANS-1 and TRANS-2 from the controller PCB.
2. Set the resistance measuring range of multimeter to "X1Ω" and measure the resistance of the lead wires between WHT-WHT and BRN-BRN as shown in Fig. E-13.

It will be completely satisfactory if all measured values agree with those indicated in Table-5.

Lead wires	Value of resistance
WHT - WHT	About 143.5Ω
BRN - BRN	About 1.2Ω

(Table-5)

NOTE: Ambient room temp ..... 70°F

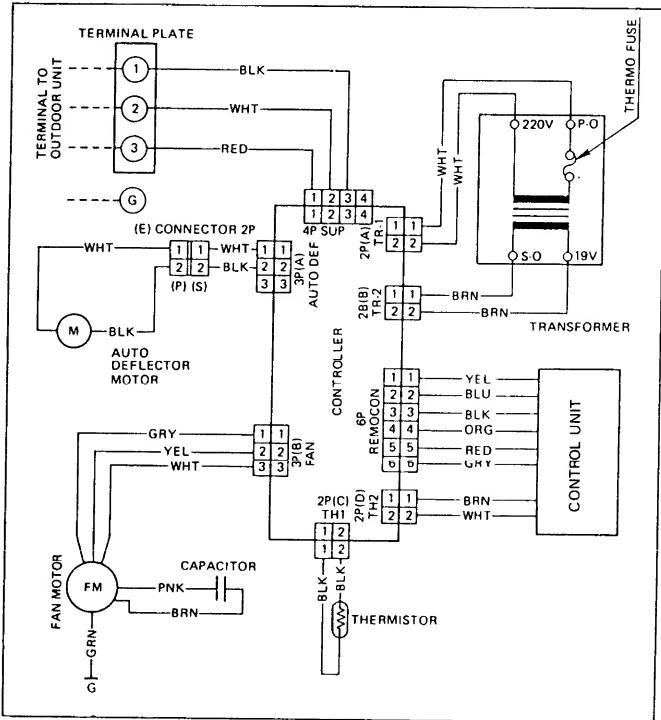
**SAP241V ELECTRIC WIRING DIAGRAM**


Fig. E-13

**ELC-11. Checking of the Indoor Fan Motor**

Remove the fan motor connector FM from controller PCB and measure the resistance between each lead wires of the fan motor connector setting the resistance measuring range to "X1Ω".

The motor is in very good working condition if all the values agree with those indicated in Table-6.

Lead wires	Value of resistance
WHT-BRN	about 67Ω
WHT-YEL	24Ω
YEL-PNK	81Ω

(Table 6)

NOTE: Ambient room temp ..... 68°F

### **ELC-12. Checking of the Auto Deflector Motor**

(1) Disconnect Connector 2P on the auto deflector motor and measure the winding resistance value between Lead Wires (1) and (2) on both ends of the motor. Satisfactory if the resistance value is as shown below. (Table-7)

Coil Resistance ( $\Omega$ ) Ambient temp. 68°F	about 10,629
--	-----------------

(Table-7)

### **ELC-13. Checking of the Solenoid Coil**

1. From the terminal plate (No. 2 terminal), disconnect RED lead wire for the solenoid Coil.)
2. From the Coil Thermo (Terminal "H"), disconnect RED lead wire.
3. Check Solenoid Coil for continuity between the moved RED lead wires with a multimeter. No continuity means broken wire. If so, replace the wire.,

### **ELC-14. Checking of the Coil Thermostat**

Disconnect the lead wire connected to the coil thermostat. Check the coil thermostat itself. Satisfactory if the value is as in Table 8.

ON : 75°F	OFF : 79°F
-----------	------------

(Table-8)

### **ELC-15. Checking of the Electric Magnetic Contactor**

Disconnect BLU lead wire from terminal (21) and RED lead wire from terminal (22) on the contactor and check continuity using a multimeter. Satisfactory if continuity is assured. If continuity cannot be verified, the coil must be broken. Check and replace the coil.

### **ELC-16. Checking of the Crankcase Heater**

Disjoin both ends of the heater and check for continuity. Satisfactory if continuity is assured. If continuity cannot be verified, the heater must have broken wire. Check and replace broken wire.

## 9. DISASSEMBLY AND SERVICE PROCEDURES

### – Quick Access Index –

**INDOOR UNIT**

9-1	Electrical Component Box—Removal . . . . .	47
9-2	Fan and Fan Motor—Removal . . . . .	48
9-3	Control Unit—Removal . . . . .	50
9-4	Evaporator (Indoor Heat Exchanger) and Drain Pan—Removal . . . . .	50

**OUTDOOR UNIT**

9-5	Cabinet—Removal . . . . .	52
9-6	Fan and Fan Motor—Removal . . . . .	52
9-7	Electrical Component Box—Removal . . . . .	53
9-8	Compressor Cover—Removal. . . . .	53
9-9	Compressor—Removal . . . . .	54
9-10	Compressor Replacement . . . . .	55
9-10-1	Tool List Compressor Replacement	
9-10-2	Safety Precautions	
9-10-3	Compressor Replacement Procedures	
	A. Separating the Outdoor Unit	
	B. Removing the Old Compressor	
	C. Installing a New Compressor	
9-11	Leak Test, Evacuation and Charging . . . . .	59
9-11-1	Required Tools and System Set Up	
9-11-2	Leak Test in the System	
9-11-3	Evacuation	
9-11-4	Charging Refrigerant (R22)	

## INDOOR UNIT

### 9-1 Electrical Component Box-Removal

- (1) Open the front panel (A) by pulling the knobs (a) toward you. Then lift the panel up and off as shown in Figure 1.

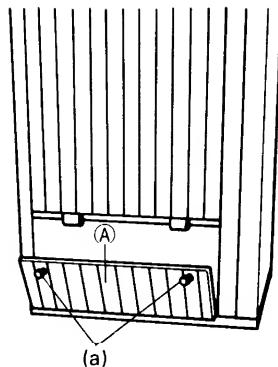


Fig. 1

- (2) Remove the two cover plates (A) and (B) on the electrical component box by unfastening the five screws (a).
- (3) The electrical components can now be checked. Remove the three screws (b) to pull out the electrical component box. (See Figure 2.)

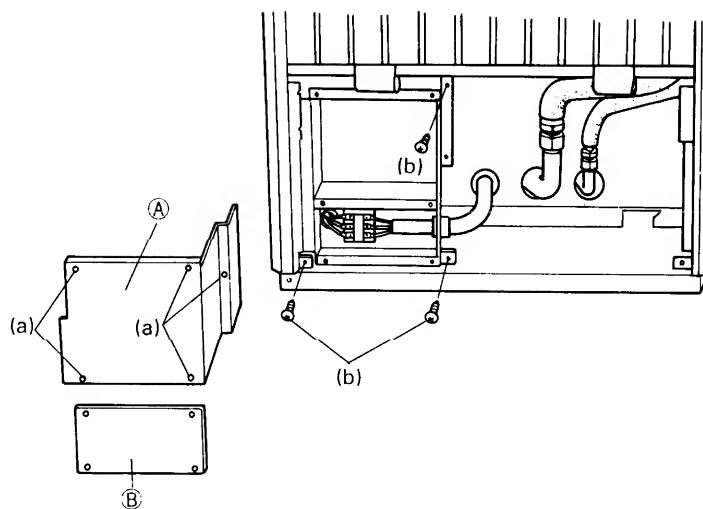


Fig. 2

**9-2 Fan and Fan Motor-Removal**

- (1) Unfasten two screws (a) and slide the corner panels (A) and (B) upward to remove them.
- (2) Remove the front panel (C) by unfastening 12 screws (b) on both sides. (See Figure 3.)

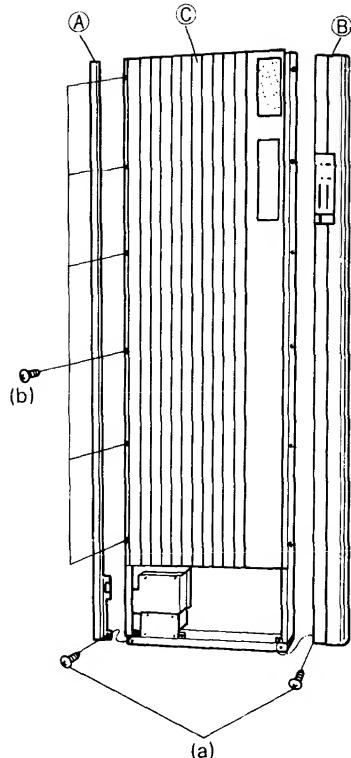


Fig. 3

- (3) Unfasten six screws (a) around the nozzle to pull the fan and fan motor together out of the unit. (See Figure 4.)

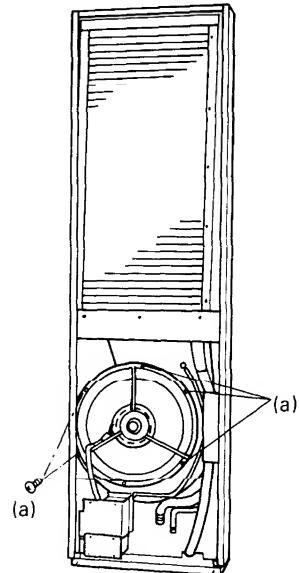


Fig. 4

- (4) Unfasten the three fan fixing bolts (a) as illustrated using a small spanners to remove the fan. (See Figure 5.)

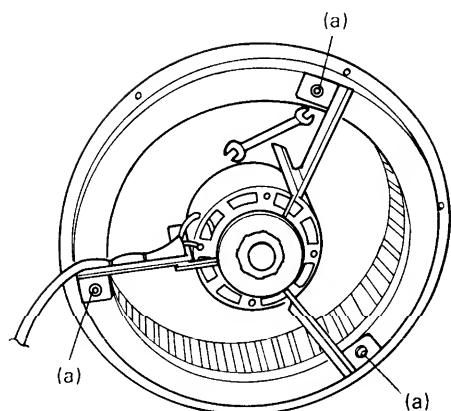


Fig. 5

- (5) Unfasten the screws and nuts to disassemble the fan mounting brackets as illustrated to remove the fan motor. (See Figure 6.)

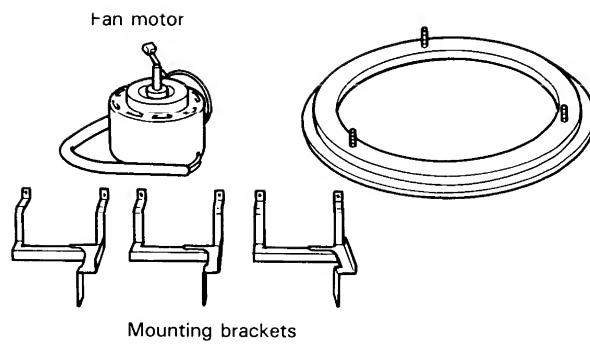


Fig. 6

### 9-3 Control Unit-Removal

- (1) Remove the corner panel (A) fastening the control unit.
- (2) Remove the screws (b) on fastening metal piece to pull out the control unit (B). (See Figure 7.)

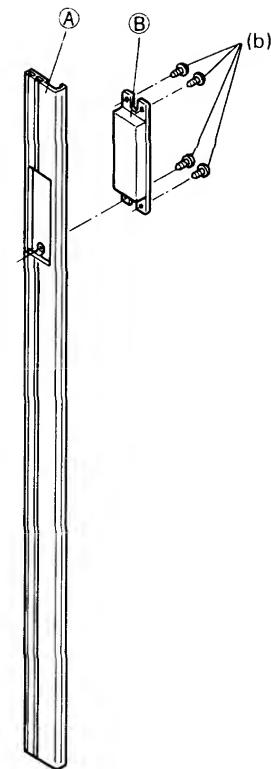


Fig. 7

### 9-4 Evaporator (Indoor Heat Exchanger) and Drain Pan-Removal

- (1) Remove the front panel. See 9-2-(1) and (2) (Page 48)
- (2) Remove the top panel by unfastening ten screws.
- (3) Unfasten the four screws (a) to pull out the evaporator and drain pan. Slightly open the side panels as shown by the arrows at this time. (See Figure 8.)

**CAUTION** : Do not force the refrigerant tubes when removing the evaporator. Otherwise, refrigerant leakage may result at the cracked pipe.

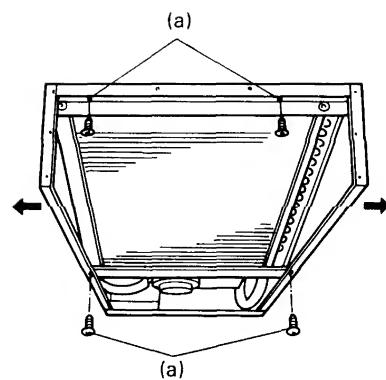


Fig. 8

- (3) Unfasten the three screws (a) on the front side and remove the tube brazing points (b) as illustrated to disassemble the evaporator and drain pan.

(See Figure 9.)

**CAUTION** :Be careful not to damage the heat insulation material when brazing.

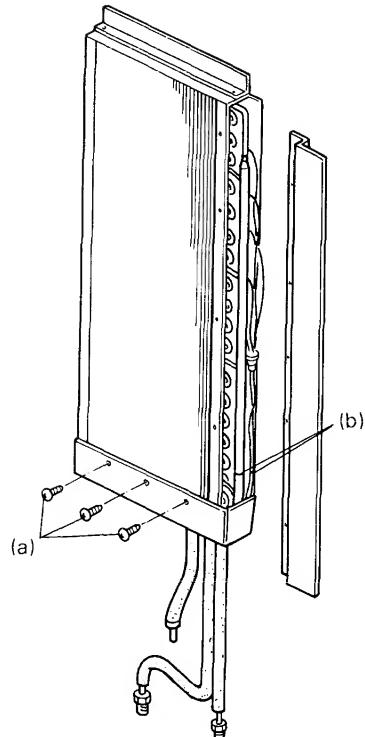


Fig.9

### 9-7 Electrical Component Box-Removal

- 1) Disconnect the following wires from the electrical component box.
  - (1) Compressor wire
  - (2) Crankcase heater wire
  - (3) Solenoid valve wire
- 2) (1) Remove the cover plate (A) and the sensor (B).  
(2) Remove insulation (C). Loosen and remove the holder of sensor (D).
- 3) The electrical component box can now be removed by unscrewing one screw (E).
- 4) Loosen one screw of the mounting plate (F) fixing the solenoid valve to remove the cover (G). (See Figure 12.)

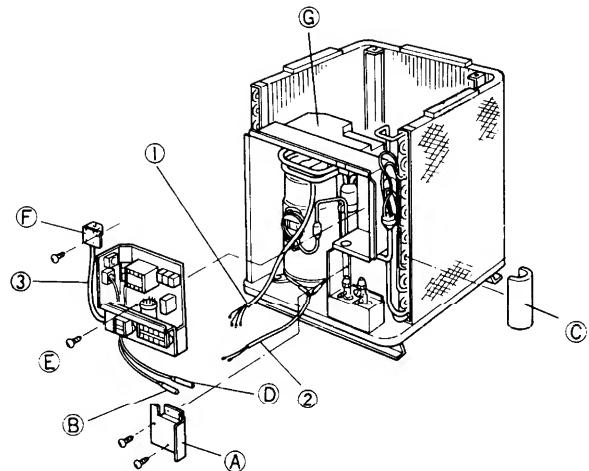


Fig-12

### 9-8 Compressor Cover-Removal

- 1) Unfasten four screws (A) fixing the cover (B). The cover (B) can be removed by lifting it upward. (See Figure 13.)

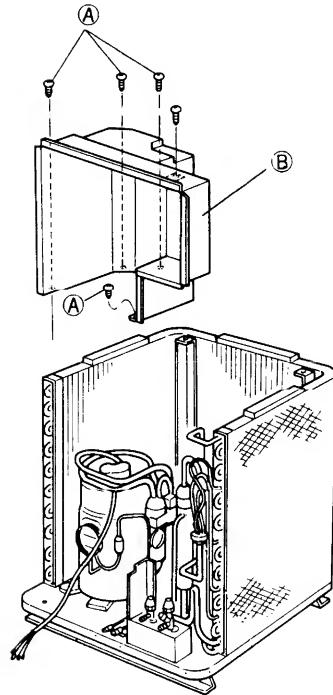


Fig-13

**Outdoor Unit**
**9.5 Cabinet-Removal**

- 1) Remove the exterior panels in the order of the front panel **(A)**, side panel **(B)** and side panel **(C)**
- 2) Remove the cover plates **(D)** and **(E)**
- 3) Remove the mounting plate **(F)** (See Figure 10.)

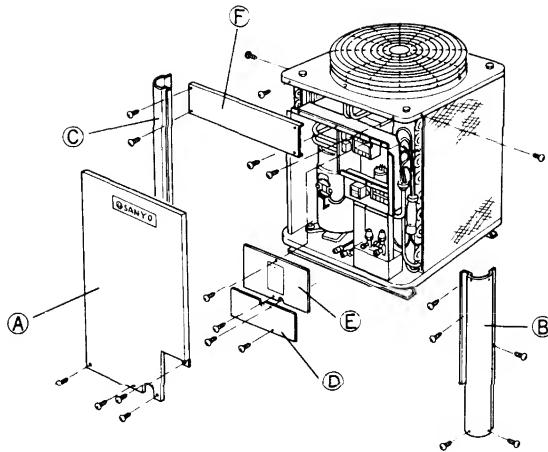


Fig-10

**9.6 Fan and Fan Motor-Removal**

- 1) Remove the fan and fan motor by lifting up after removing the guard **(A)** and loosening set screw (a) of the propeller fan **(B)**
- 2) Disconnect the fan motor wires from the electrical component box and, then remove the top cover **(C)** with fan motor. (See Figure 11.)

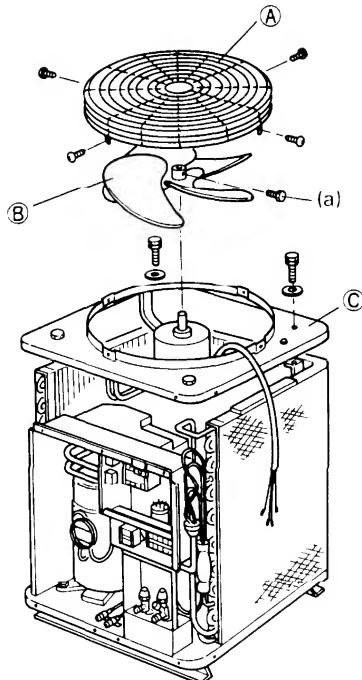


Fig-11

### 9-9 Compressor-Removal

- 1) Take apart four joints (A) (B) (C) and (D) brazed to the compressor by a brazing torch (See Figure 14.)
- 2) Remove the compressor as follows:
  - a) Remove 3 nuts securing compressor to the chassis.
  - b) Lift the compressor to remove it from the chassis.

**CAUTION :**

- 1) Many wires have to be removed. When removing wires, carefully check the electric diagram on the rear side of the cover plate (E) (See Figure 10.) Reconnect the wires correctly after replacing the compressor.
- 2) Three sections of the replacement compressor (A) (B) and (C) are sealed to avoid entry of dust and water. Remove this seals, then connect to the unit tubing when replacing the compressor (See Figure 15.)

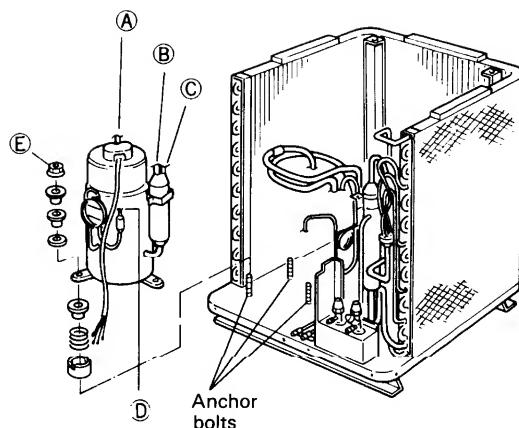


Fig-14

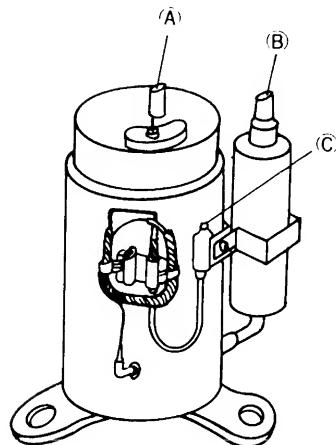


Fig-15

## 9-10 Compressor Replacement

### 9-10-1 Tool List for Compressor Replacement

No.	Item	Q'ty	Remarks
1	Portable fire extinguisher	1	
2	Oxy-acetylene torch set	1	Prest-O-Lite Portable Outfit or equivalent
3	Torch lighter	1	
4	Oxweld goggles	1	
5	Brazing flux	1	
6	Soldering rod	1	
7	Vacuum pump (Capacity: 2 ~ 3 Cu.-ft./min.)	1	Robinair or equivalent
8	Nitrogen gas (in 10 lbs. container)	1	
9	Refrigerant R22 (in 10 lbs. container)	1	
10	Refrigerant charging cylinder (5 lbs. or more)	1	
11	System analyzer valve set	1	Robinair, Imperial or equivalent "Robbi" thermistor vacuum gauge or equivalent
12	Vacuum gauge (Range 0 – 1000 microns)	1	
13	Charging hose W/ 1/4" fittings	5	
14	Charge fitting 1/4"	1	
15	Tube adapter 1/4"	1	
16	Pinch-off tool	1	
17	Diagonal cutting plier	1	
18	Long-nose side cutting plier	1	
19	Slip-joint plier	1	
20	Torque wrench (340 lbs.)	1	
21	Tube cutter	1	Imperial or Rigid
22	Flaring tool	1	Rigid or equivalent
23	Swaging tool	1	
24	Combination file set	1	
25	Regular screwdriver 8"	1	
26	Phillips screwdriver 6"	1	
27	Adjustable wrench 10"	1	
28	Adjustable wrench 12 "	1	
29	Hex. nut driver (6mm)	1	(For compressor bolt)
30	Oil pan	1	
31	Liquid soap with a brush	1	
32	Clean moist cloth	1	

### 9-10-2 Safety Precautions

1. Make sure unit is disconnected from the power source while it is being assembled or disassembled for servicing.
2. Wear protective goggles at any time when brazing or unbrazing.
3. Be sure to confirm system is at atmospheric pressure before using torch.
4. When brazing or unbrazing tubes, tube never locate face or any other parts of the human body in direct line with the tube opening.
5. Before commencing the trial run, be sure the unit is correctly wired and is grounded adequately when it is connected to the power.

### 9-10-3 Compressor Replacement Procedures

#### A. Separating the Outdoor Unit

In case the compressor malfunctions with a split type air conditioner under normal conditions, release the refrigerant gas at the location first and remove the tubing, then separate the outdoor unit. Pay special attention to ventilation if the place of installation is small.

- 1) Make sure that the power is definitely turned OFF and remove the Access Panel "C" of the outdoor unit with power line and inter-unit line connectors. Remove wires from terminals within the electrical component box and wrap the ends of the wires separately with the insulating tape.
- 2) Place an oil pan at the under side of the service valves. Then remove the caps of the wide tube service valve and narrow tube service valve with an adjustable wrench.
- 3) Leave the wide tube service valve fully close by turning the spindle of the valve clockwise with a valve key or ratchet wrench. Close the narrow tube service valve in the same manner.
- 4) Apply two pairs of adjustable wrenches to the union of the wide tube service valve, then disconnect tubing from the outdoor unit.
- 5) Use an adjustable wrench and a torque wrench (130 ~ 170 lbs. in.), and disconnect narrow tube from the outdoor unit.

The refrigerant gas will seep out from the indoor unit as well as the tubing.

- 6) Seal the ends of the tubing so that no moisture or dust to enter.
- 7) Gradually open the narrow tube service valve and release the remaining refrigerant.
- 8) Open the wide tube service valve and release the remaining refrigerant.
- 9) Finally leave the wide tube service valve and narrow tube service valve fully open.
- 10) Clean the oil that has spread around the periphery.
- 11) Keep the separated outdoor unit in an upright position and carry it to the service station.

## B. Removing the Old Compressor

### CAUTION :

Always wear welder's goggles when heating the tubing with a torch and make sure not to get too close to the opening of the tubing. Furthermore, pay special attention to the position of the torch flame so as not to burn the compressor terminals.

- 1) The outdoor unit carried into the service shop may have some refrigerant gas remaining within it. Therefore, make sure that both wide tube service valve and narrow tube service valve are fully open.
- 2) Remove the cabinet according to the disassembly procedure of the outdoor unit. Refer to Page 52. Furthermore remove the terminal cover at the top of the compressor and remove the wiring of the compressor terminal. Fig. 17.
- 3) Set aside an Oxy-Acetylene torch which is needed for removing the tubing of the compressor.
- 4) Confirm that system has reached atmospheric pressure.
- 5) With an Oxy-Acetylne torch apply heat uniformly and unbend the joints of upper section of the Liquid Injection Capillary tube to the compressor, the upper section of the accumulator and the upper section of the compressor discharge tube respectively, and pull them free with pliers. Fig. 16 shows unbending points with arrows.

\* Be sure to save all mounting components with the replacement compressor for future use. Fig. 18

- 6) To remove the compressor, raise it straight and disengage from the base unit.

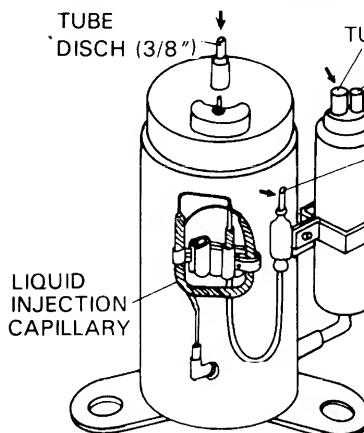


Fig. 16

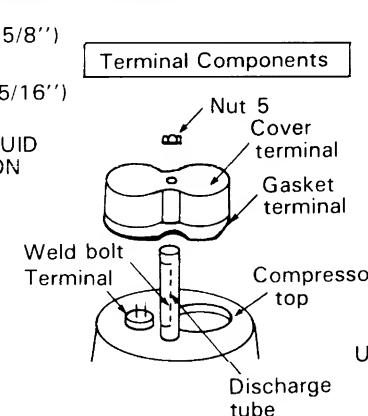


Fig. 17

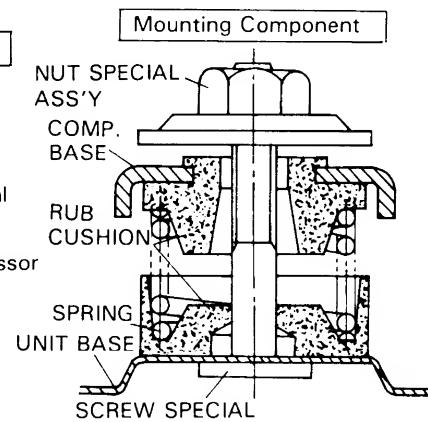


Fig. 18

### IMPORTANT NOTICE

Before installing the new compressor, check for possible system contamination by the following procedure:

- Place about 10 cc of the oil from the old compressor into a transparent container and visually check the degree of oil contamination. If the oil has a slight burnt odor but no color change or residue, and ordinary compressor replacement according to the instructions below may be carried out.
- If the oil has a burnt pungent odor and shows contamination (dark color with tiny particles of metal) the system must be cleaned sufficiently with a suction filter or a drier-strainer and then replace the oil drier with a new one.
- However, if just the compressor is replaced without sufficient system cleaning, contaminated oil may cause the burning of the compressor again.
- If the oil compressor is to be scrapped, by pinching the terminal section with a pair of pliers, there should not be any chance of it being mistakenly used.

**C. Installing a New Compressor**

1. Make sure that the defective old compressor has been removed and the new compressor to be installed is of the same specification by checking the 8 digit code number on stamped marking on the upper section of the compressor helmet case. (e.g. :80648646) For the detail of the compressor identification refer to page. 4.
2. Transfer the mounting parts to the new compressor.
3. Nick the end of the pinched suction tube of the new compressor with a pincher and release the holding charge (Nitrogen: 29 psig).
4. With an Oxy-acetylene torch and pliers, unbraze compressor seals at both discharge port and suction port (upper part of the accumulator).

**CAUTION :**

Be careful of the position of the torch so as not to burn the terminals of the compressor when brazing or unbrazing.

5. Install the new compressor in exactly the same manner as the original compressor.  
(\* See CAUTION bottom of this page.)
6. Shape both the suction and discharge lines to the approx. area of the compressor fittings and engage each tube end to the mating compressor fitting.
7. Hold tubing securely with pliers and braze all connections carefully with the torch.
8. Perform leak test, evacuation, and charging refrigerant according to procedures described in section 9-11. Page 59.

**CAUTION**

\* If the old compressor was heavily contaminated, be sure to replace strainer (or drier) when replacing the new compressor.

## 9-11 Leak Test, Evacuation and Charging

### 9-11-1 Required tools and system set up

No.	Item	Q'ty
1)	Vacuum pump	1
2)	Vacuum gauge	1
3)	System analyzer valve set	1
4)	Charging hose (With 1/4" connector)	6
5)	1/4" Flared tube cross fitting	1
6)	Charging Cylinder	1
7)	1/4" Flared Packless valve (To be used for V3, V4 and V5)	3

\* One of conventional system set up and procedure for leak test, evacuation and charging is described in section 9-11 for the reference.

\*\* Robinair or Imperial Portable Charging Station may be used as a convenient packaged tool for the purpose of servicing the refrigerant system.

### 9-11-2 Leak Test in the System

After replacement of the new compressor, the system must be checked for leaks according to the below mentioned procedure:

\* If cylinder has not yet been filled, move at least one pound of refrigerant (R22) to the charging cylinder. Fig. 19.

1) Prepare the system analyzer valve set and connect charging hoses as in Fig. 20. Be sure to close all valves before connection. (Refer to 24 page, Fig. 33-C)

2) Confirm that both Narrow Tube and Wide Tube service valves on the outdoor unit **V6** and **V7** are fully opened, and other valves are still closed. (Refer to Fig. 21)

3) Open valves **V8**, **V4** and **V2** respectively to allow refrigerant gas entering into the system. Charge about 1/2 pound of gas to the system and close **V2**, **V4** and **V8** in sequence.

4) Apply liquid soap at charge hose connectors, discharge and suction tubes, and brazed liquid injection capillary section of the replaced compressor or other connection parts, and check to see change of bubbles. An electronic halogen gas leak detector, of course, may be used for this purpose.

5) When leaks are located, depressurize system and repair leaks.

6) If there are no leaks, open **V1**, purge the 1/2 pound of refrigerant from the system and proceed for evacuation in section 9-11-3. Refer to page 60.

\* Refer to page 24 in regard to the operation method for the service valve **V7**.

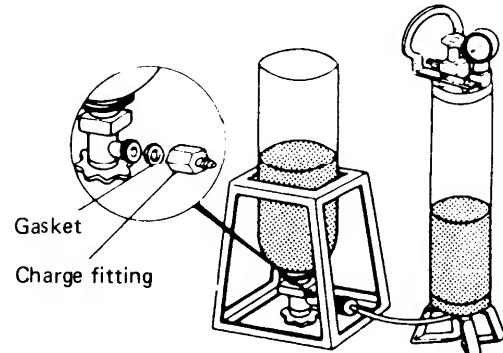


Fig. 19

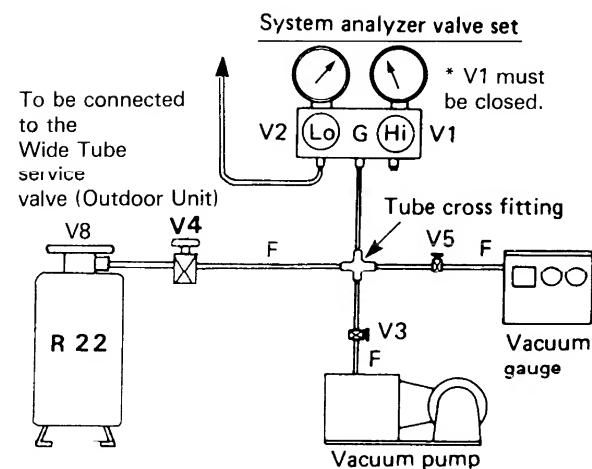


Fig. 20

**9-11-3. Evacuation**

- 1) Connect instrument as in Fig. 21.
- 2) Confirm that all connections are made correctly and check all valves are closed.\* V6 and V7 should be fully opened. (Refer to page 24, Fig. 33-C.)
- 3) Open V2 only.
- 4) Open V3 and V5. Never fail to open the shut off valve on the vacuum pump if there is.
- 5) Run the vacuum pump for evacuation. Required time for complete evacuation differs with capacity of the pump. (Consult shop manual for specifications.)
- \* While system is evacuating, utilize this time to fill the charging cylinder, if it is not ready.
- 6) If vacuum gauge reading has reached 500 microns or less, stop the vacuum pump and close V3.
- 7) Keep this condition at least 5 minutes and observe the vacuum gauge for change. (Fig. 22) If pointer on the gauge moves to larger numbers, check system for leaks again according to the procedure in section 9-11-2. Page 59.
- 8) If the indication of the vacuum gauge will not change, system is now prepared for charging refrigerant. Close V5.
- 9) Proceed to charging refrigerant in section 9-11-4. Page 61.

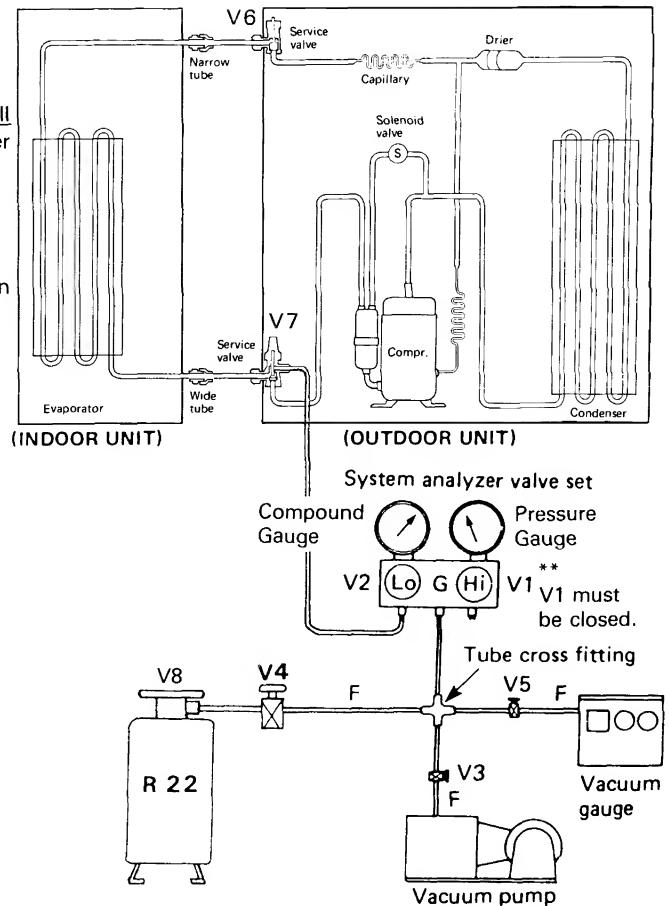


Fig. 21

**NOTE:**

This model uses low pressure on the narrow tube side as well as on the wide tube side. Accordingly, the tubing on both sides must be insulated at the time of installation.

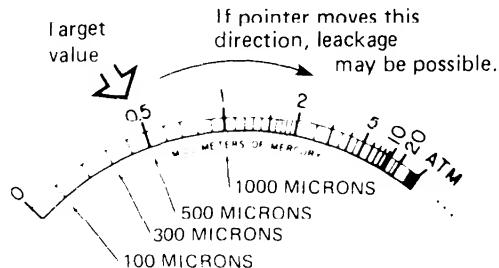


Fig. 22

#### 9-11-4. Charging refrigerant (R22)

##### • Preparation of Refrigerant

- a) Measure the net weight of the charging cylinder before charging refrigerant and memorize it.
- b) Refill required amount of refrigerant from the container to the charging cylinder. Be sure to measure the cylinder contents by weighing it. Fig. 23.

**NOTE**: Do not confuse the refrigerant gas level graduations on the charging cylinder with the weight. Vapor refrigerant on the upper cylinder part must be taken into consideration.

##### • Charging Procedure

- 1) Evacuate system according to the procedure in section 9-11-3.
- 2) Confirm that valves **V1**, **V2**, **V3**, **V4**, **V5**, and **V8** are closed when evacuation is completed.
- 3) Open charging cylinder valve **V8** slightly.
- 4) Loosen hose connection at **V4** a little to let air escape from the hose. Then tighten connection again.
- 5) Measure and memorize charging cylinder weight to charge exact amount of refrigerant.
- 6) Open **V4** fully to supply refrigerant gas to **V2**.
- 7) Close **V7** halfway (2 turns) for charging refrigerant. (Refer to page 24, fig. 33-b.)
- 8) Open **V2** gradually and let refrigerant gas entering into the system.
- 9) When full charge has entered system (do not permit liquid level to drop blow "0" (zero) on the graduation of the charging cylinder), close **V2** tightly.
- 10) Open **V7** fully until it reaches to the back-seat position. (Refer to page 24, Fig. 33-b)
- 11) Close **V4** and **V8**.
- 12) Loosen hose connections and let refrigerant escape from hoses.
- 13) Remove hoses, charging cylinder and system analyzer valve set. Now, system charging has completed.

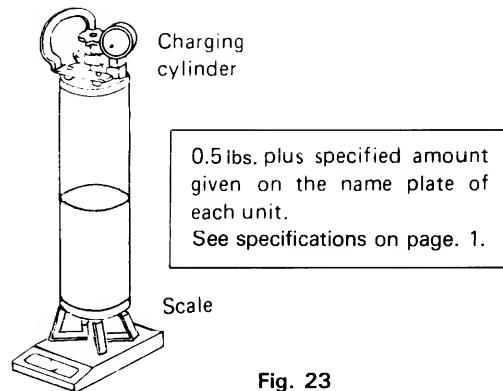
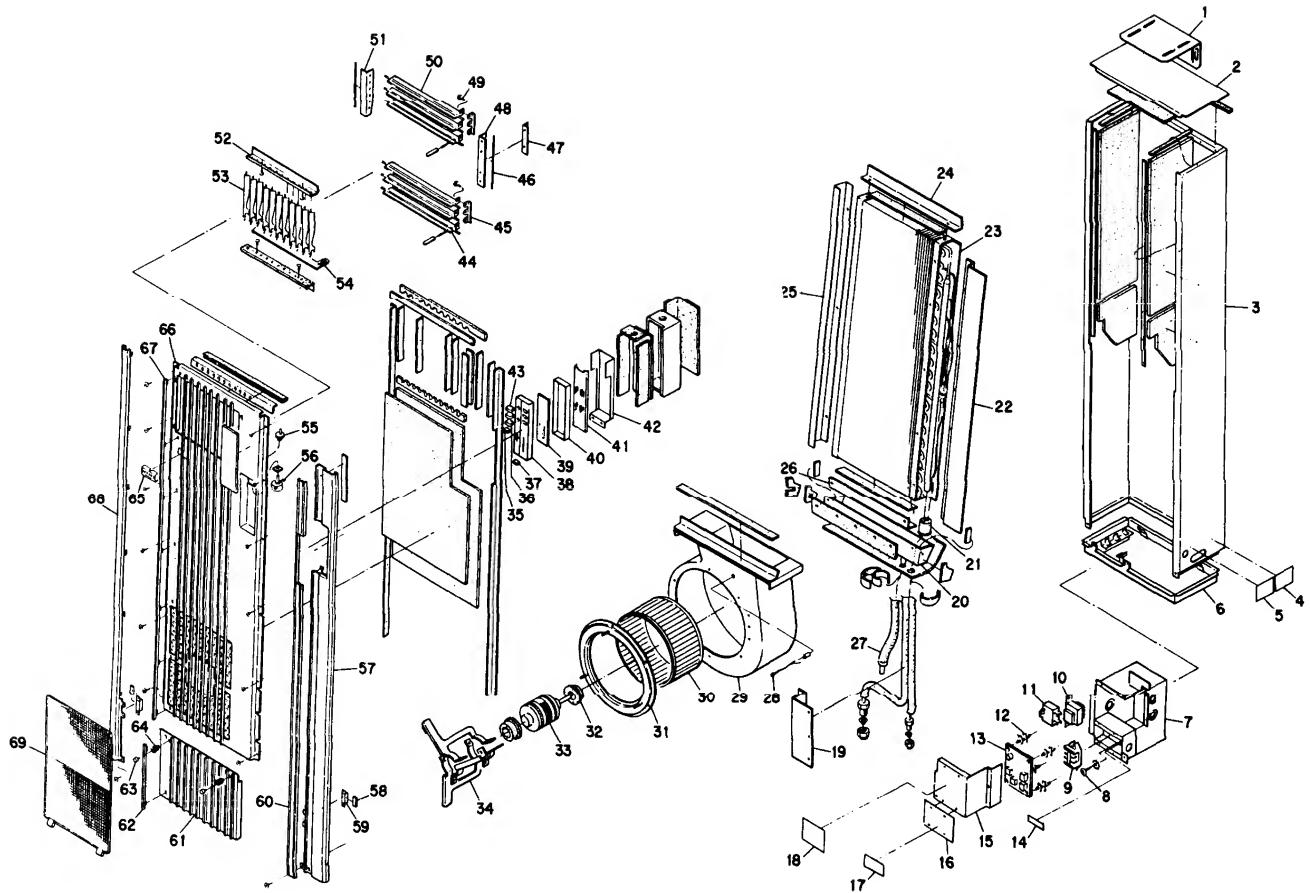


Fig. 23

## 10. PARTS LIST

Indoor Unit: SAP241V



■ Accessory Parts List  
LIST OF PACKAGED PARTS

Description		Shape	Q'ty	Remarks
Fitting	For wall		1	854-2-1129-40101
	For floor		4	854-2-1129-40201
INS. Nipple			3	854-2-2410-32000
Drain hose adaptor			1	854-2-2334-13600
L-shaped tube			1	854-0-4204-80200

SAP241V  
Indoor Unit

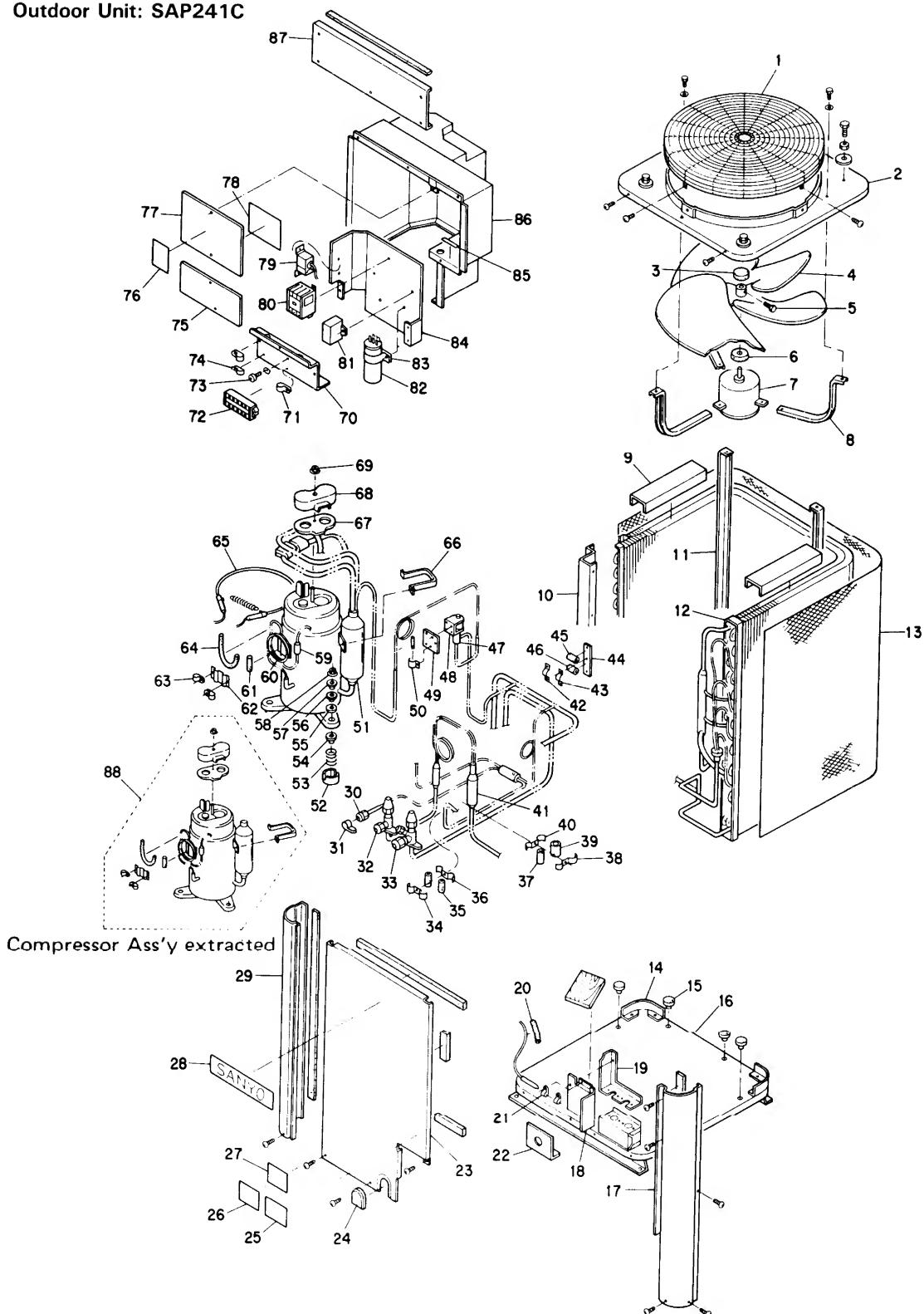
**ATTENTION !**

To ensure correct parts supply, please let us know followings, when you make service parts order:

1. Part No.    2. Description    3. Q'ty    4. Volts - Hz - Ph    5. PRODUCT MODEL NO.

Key No.	Part No.	Description	Q'ty	Key No.	Part No.	Description	Q'ty
1	854-2-1129-40100	Mounting Plate	1	61	854-2-1101-52601	Front Panel	1
2	854-2-1106-239H1	Top Cover Ass'y	1	62	854-0-1301-12000	Ornamental Sash Ass'y	11
3	854-0-1104-129H0	Cabinet Ass'y	1	63	854-2-1311-11800	Knob	2
4	854-6-4729-71600	Label	1	64	854-2-2311-10100	Latch	2
5	854-2-1367-35400	Name Plate	1	65	854-2-1354-17101	Badge	1
6	854-0-2204-36501	Bottom Plate Ass'y	1	66	854-0-1101-302H1	Front Panel Ass'y	1
7	854-0-5301-33801	Electrical Component Box Ass'y	1	67	854-0-1301-11900	Ornamental Sash Ass'y	11
8	852-2-2396-10103	Screw Special	1	68	854-0-1301-10901	Ornamental Sash Ass'y	1
9	4-2379-56168	Terminal Base JTU20-3	1	69	854-0-2308-23800	Air Filter Ass'y	1
10	851-0-5290-692P0	Transformer Ass'y ATR-J122U	1	■	854-6-4119-38400	Operation Manual	1
11	4-2239-56223	Fixed Capacitor 440V 4.5MFD	1	■	854-6-4139-34300	Installation Instructions	1
12	851-2-5366-01400	Spacer	4				
12	851-2-5366-01600	Spacer	1				
13	859-4-7293	Controller POW-24V	1				
14	852-6-4729-17300	Label	1				
15	854-2-5304-26901	Cover Plate	1				
16	854-2-5304-27001	Cover Plate	1				
17	854-2-1358-46700	Label	1				
18	851-2-5250-84100	Wiring Diagram	1				
19	854-2-2518-30300	Mounting Plate	1				
20	854-0-2301-318H1	Drain Pan Ass'y	1				
21	854-2-4311-15600	Cap Rubber	1				
22	854-2-2343-12300	Cover Plate, Drain	1				
23	854-0-4118-35301	Evaporator Ass'y	1				
24	854-2-2232-18800	Mounting, Evaporator	1				
25	854-2-4134-31700	Cover Plate	1				
26	854-2-2232-19000	Mounting, Evaporator	1				
27	854-0-4297-11700	Drain Pipe Ass'y	1				
28	851-0-5259-04500	Thermistor Ass'y OCS5K-UL	1				
29	854-0-2502-196H0	Blower Casing Ass'y	1				
30	854-0-2501-17800	Blower Ass'y	1				
31	854-0-2504-11701	Casing Side Ass'y	1				
32	854-2-2534-12910	Cushion Rubber	2				
33	851-0-5290-692M3	Fan Motor Ass'y KFC8S-61A6P	1				
34	854-0-2511-16201	Support Motor Ass'y	3				
35	854-2-1311-12005	Knob	1				
36	851-2-5375-00602	Knob	1				
37	854-2-1311-12403	Knob	1				
38	854-2-5301-49301	Indicator Plate	1				
39	851-0-5158-08700	Control Switch PCB Ass'y	1				
40	854-2-5301-43711	Bottom Plate	1				
41	854-2-5312-46200	Mounting Plate	1				
42	854-2-5312-52701	Mounting Plate	1				
43	800-2-5328-12603	Knob	2				
44	854-0-1505-20001	Blade Louver Ass'y	2				
45	854-2-1521-11501	Mounting Plate, Blade	2				
46	854-2-1507-15300	Spring	2				
47	854-2-1507-15401	Mounting Plate	1				
48	854-2-1507-14901	Support Louver	1				
49	854-2-1506-13800	Pin Blade	6				
50	854-0-1505-20101	Blade Louver Ass'y	4				
51	854-2-1507-14801	Support Louver	1				
52	854-2-1507-15010	Support Louver	2				
53	854-2-1520-14210	Blade Air Guide	11				
54	854-2-1507-15110	Support Louver	1				
55	854-2-1507-15210	Support Louver	1				
56	851-0-5290-692M0	Synchro Motor Ass'y M001-1	1				
57	854-0-1301-121H1	Ornamental Sash Ass'y	1				
58	854-2-1129-40000	Mounting Plate	2				
59	854-2-1343-11300	Magnet	2				
60	854-2-1301-20520	Ornamental Sash	1				

**NOTE: Metal and plastic parts will be supplied basically with necessary heat insulating pads or packing. Some key numbers are intentionally omitted or left blank for the editor's convenience.**

**Outdoor Unit: SAP241C**


**SAP241C**  
**Outdoor Unit**

**ATTENTION !**

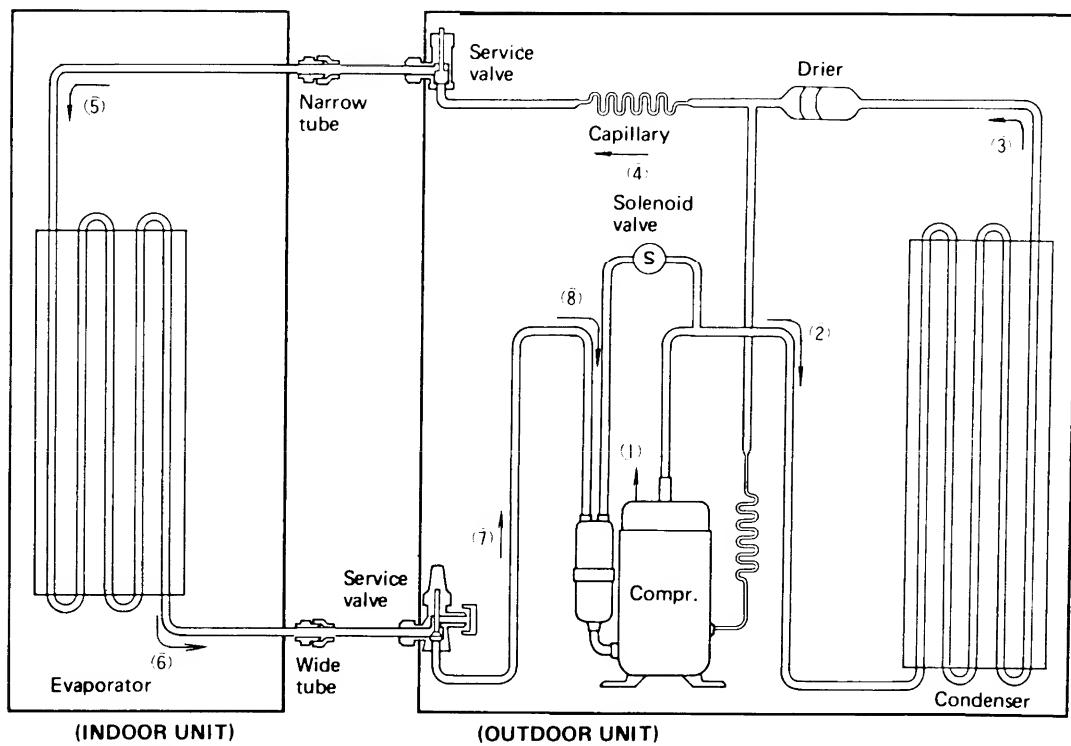
To ensure correct parts supply, please let us know followings, when you make service parts order:

1. Part No.    2. Description    3. Q'ty    4. Volts - Hz - Ph    5. PRODUCT MODEL NO.

Key No.	Part No.	Description	Q'ty	Key No.	Part No.	Description	Q'ty
1	854-0-1113-13801	Guard Ass'y	1	59	852-0-4506-14000	Strainer Ass'y	1
2	854-0-1106-20201	Top Cover Ass'y	1	60	854-2-4219-58100	Capillary Tube	1
3	854-2-2346-11400	Cap	1	61	852-2-2353-19500	Packing	1
4	854-0-2501-18100	Propeller Fan Ass'y	1	62	852-2-2309-34101	Mounting Plate	1
5	854-2-2529-10101	Bolt Special, Propeller Fan	1	63	3-9030-00508	Clamper F-6	2
6	852-2-2514-10700	Cap Rubber	1	64	853-2-4310-10300	Packing	1
7	851-0-5290-636M1	Fan Motor Ass'y KFC8-101A6P	1	65	851-0-5290-636H1	Heater Ass'y CH5700 230V30W	1
8	854-0-2511-14400	Support Motor Ass'y	3	66	851-2-2356-16901	Mounting Plate, Accumulator	1
9	854-2-2360-18900	Mounting Plate	2	67	801-2-5303-13100	Gasket Terminal	1
10	854-2-4134-32100	Mounting Plate	1	68	801-2-6194-12100	Cover Terminal	1
11	854-0-2206-18100	Frame Ass'y	2	69	801-2-8305-10100	Nut 5mm	1
12	854-0-4106-18500	Condenser Ass'y	1	70	854-2-5301-48401	Electrical Component Box	1
13	854-2-1113-12400	Guard	1	71	3-9030-00508	Clamper F-6	1
14	854-2-2360-19100	Mounting Plate	2	72	4-2379-56175	Terminal Base 6P 30A	1
15	854-2-1353-11000	Cushion Rubber	4	73	852-2-2396-10103	Screw Special	1
16	854-0-2204-35801	Bottom Plate Ass'y	1	74	3-9030-00512	Clamper F-10	1
17	854-0-1102-234H0	Side Panel Ass'y, Right	1	75	854-2-5304-26100	Cover Plate	1
18	854-2-1133-20101	Cover Plate	1	76	854-2-1358-46700	Label	1
19	854-2-1133-17501	Cover Plate	1	77	854-2-5304-26000	Cover Plate	1
20	854-2-4310-10100	Mounting Rubber, Capillary	1	78	851-2-5250-76800	Wiring Diagram	1
21	3-9030-00506	Clamper F-4	2	79	4-2339-56195	Thermostat YTB-4U201	1
22	854-2-2360-26801	Mounting Plate	1	80	4-2329-56284	Relay CLK-16E3-21	1
23	854-0-1101-301H0	Front Panel Ass'y	1	81	4-2239-56224	Fixed Capacitor 440VAC 5MFD	1
24	852-2-1320-10500	Eyelet Rubber	1	82	4-2239-56339	Fixed Capacitor 400VAC 35MFD	1
25	854-2-1367-31500	Name Plate	1	83	852-2-5301-20600	Clip, Capacitor	1
26	854-6-4729-68600	Label	1	84	854-0-5301-33001	Electrical Component Box Ass'y	1
27	854-6-4729-71600	Label	1	85	852-6-4729-17300	Label	1
28	854-2-1354-14300	Badge	1	86	854-0-2325-16900	Cover Ass'y	1
29	854-0-1102-233H0	Side Panel Ass'y, Left	1	87	854-2-2208-195H0	Mounting Plate Ass'y	1
30	854-0-4514-10200	Charge Port Ass'y	1	88	852-0-4516-15700	Compressor Ass'y C-R190H6N (806-4-8646)	1
31	3-9030-00512	Clamper F-10	1				
32	854-0-4521-11100	Valve Ass'y 1/4"	1				
33	854-0-4506-16200	Valve Ass'y 5/8"	1				
34	852-2-2356-13301	Mounting Plate, Tube	1				
35	854-2-2336-48200	Packing	2				
36	852-2-2356-13201	Mounting Plate, Tube	1				
37	854-2-4315-13900	Packing	1				
38	854-2-4316-12100	Mounting Plate, Tube	1				
39	854-2-2336-49200	Packing	1				
40	854-2-4316-12200	Mounting Plate, Tube	1				
41	852-0-4505-13600	Dehydrater Ass'y	1				
42	853-2-2340-21901	Mounting Plate, Tube	1				
43	854-2-4134-16501	Mounting Plate, Tube	1				
44	854-2-2360-28700	Mounting Plate	1				
45	854-2-4315-13500	Packing	1				
46	853-2-4319-11200	Packing	1				
47	854-2-4549-10100	Solenoid Valve NEV603DXFU	1				
48	851-0-5290-636C1	Solenoid Ass'y NEVAC208V	1				
49	854-2-2360-38000	Mounting Plate	1				
50	854-2-4316-13101	Mounting Plate, Tube	1				
51	854-0-4517-17800	Accumulator Ass'y	1				
52	851-2-2390-14000	Cushion Rubber	3				
53	851-2-2330-13201	Spring	3				
54	854-2-2356-10500	Rubber Protection	3				
55	854-2-2356-10600	Rubber Protection	3				
56	854-2-2349-12201	Spacer	3				
57	854-2-2356-10400	Rubber Protection	2				
58	854-2-2356-10700	Rubber Protection	1				
58	854-0-2321-10201	Nut Special Ass'y	2				
58	851-0-2395-10702	Nut Special Ass'y	1				

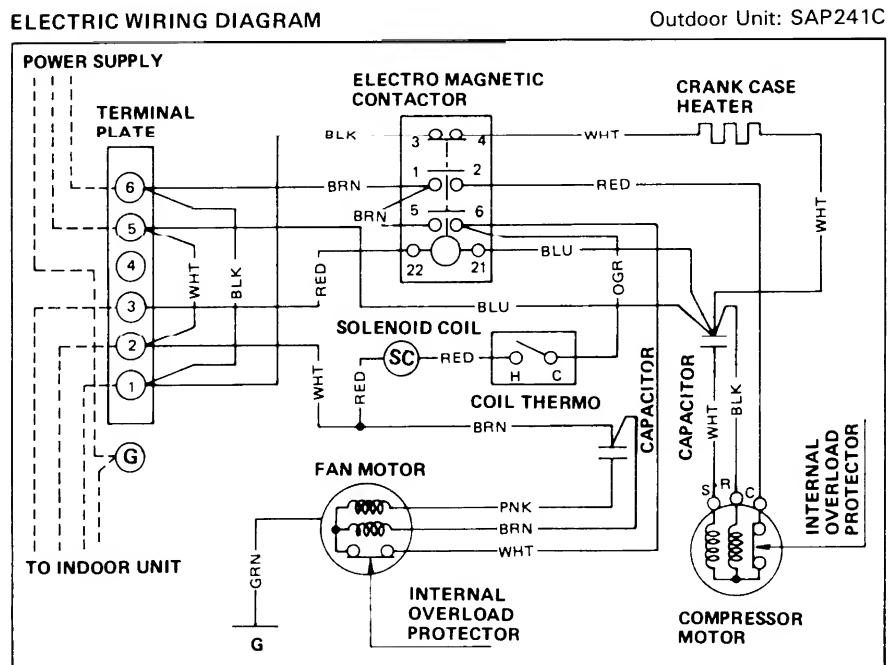
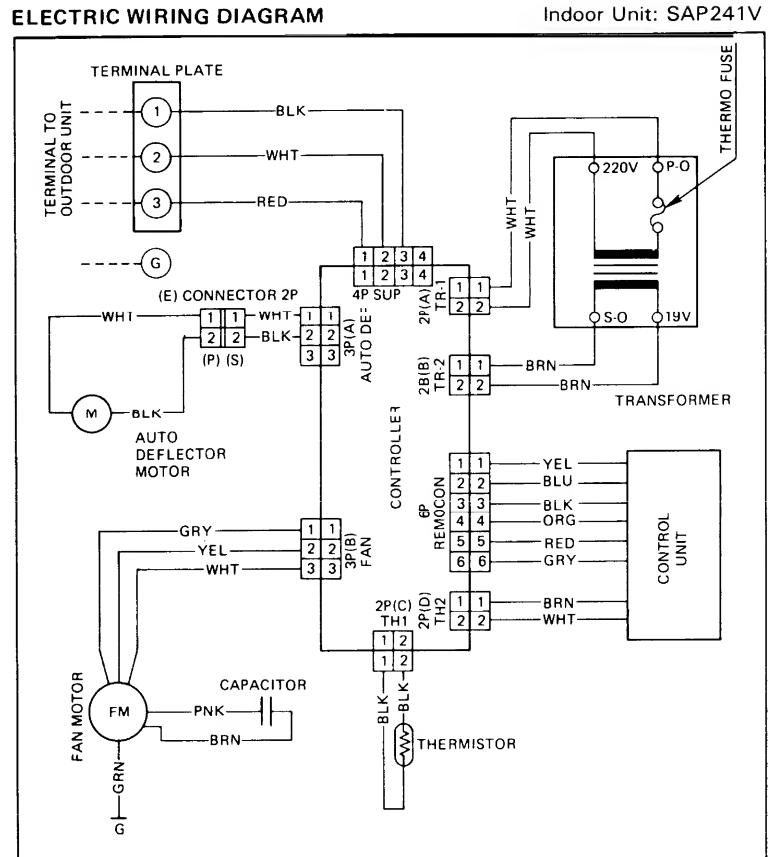
**NOTE: Metal and plastic parts will be supplied basically  
with necessary heat insulating pads or packing.  
Some key numbers are intentionally omitted or  
left blank for the editor's convenience.**

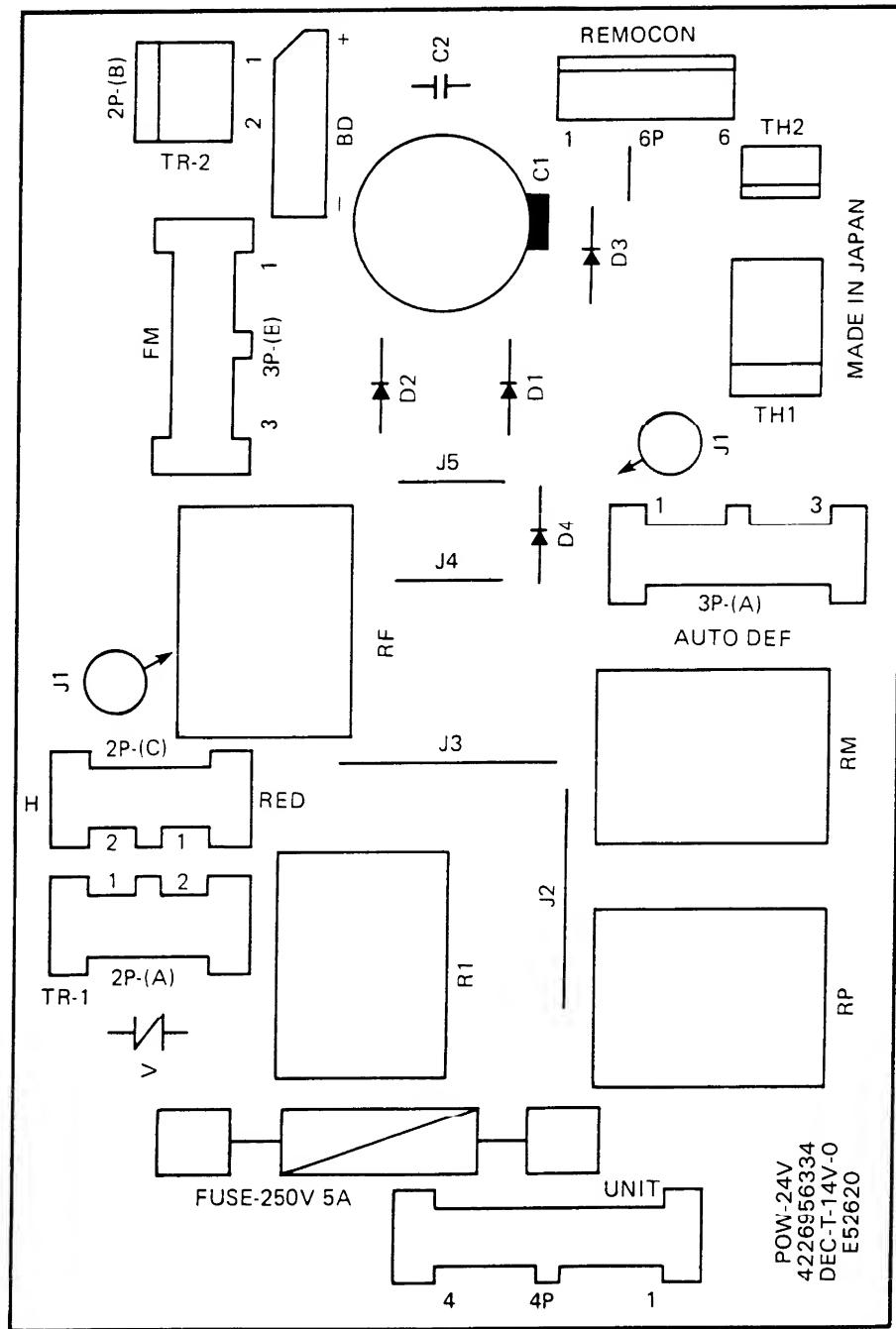
## 11. REFRIGERANT FLOW DIAGRAM


**NOTE:**

→ with sequential number shows flow  
of refrigerant in COOLING CYCLE.

## 12. ELECTRIC WIRING DIAGRAM



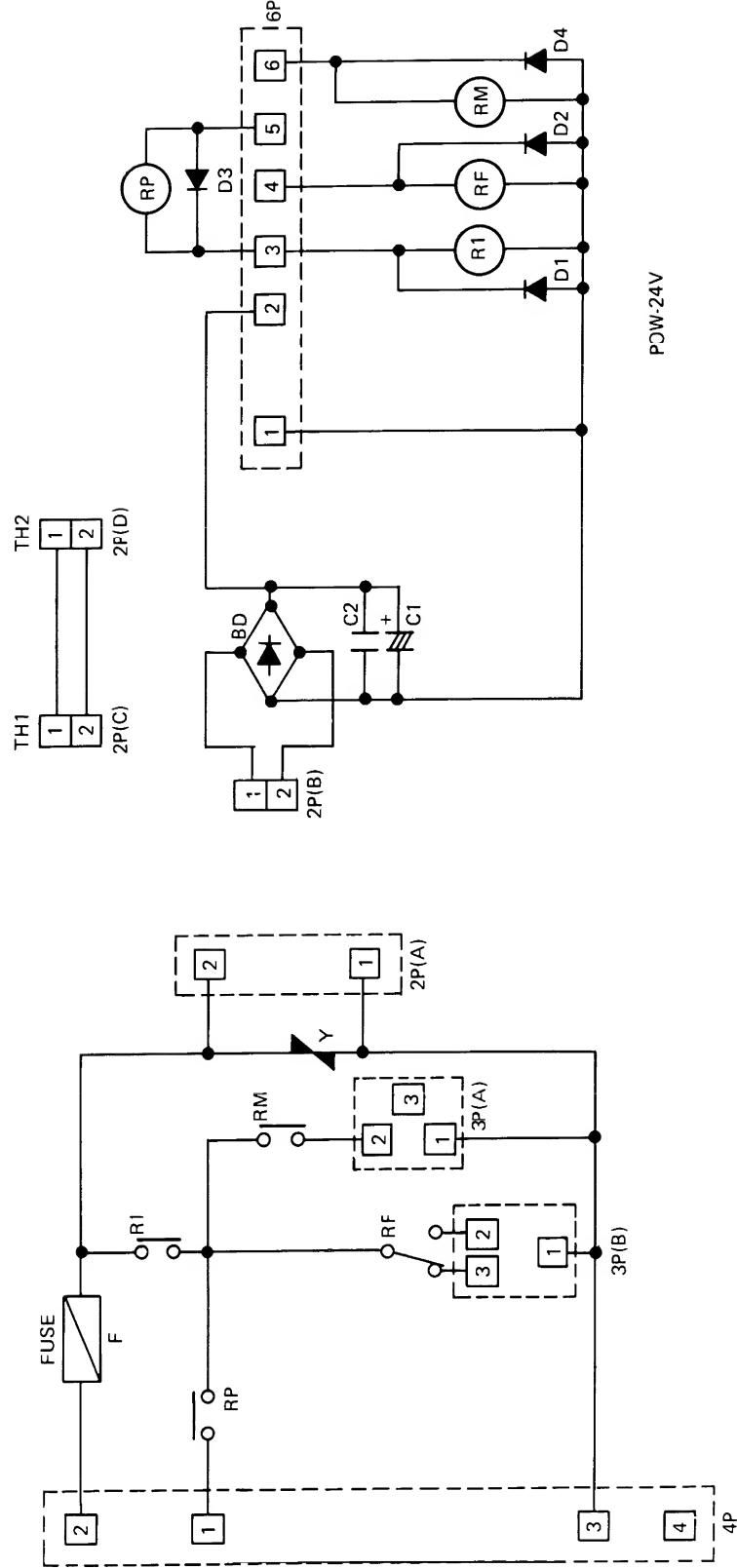
**CONTROLLER PCB POW-24V (PRINTED PATTERN)**


**ELECTRIC WIRING DIAGRAM**  
**CONTROLLER P.C.B. POW-24V**

Key No.	Description	Key No.	Description
BD	Bridge Diode	RF	Relay LZG-24HE
D1	Diode DS-442X	RM	Relay LZG-24HE
D2	Diode DS-442X	RP	Varistor SNR-A420K
D3	Diode DS-442X	V	Connector 6P
D4	Diode DS-442X	6P	Connector 4P
C1	Capacitor 470μF/50V TW	4P	Connector 3P
C2	Capacitor 0.047μF/50V	3P(A)	Connector 3P
R1	Relay LZG-24HE	3P(B)	Relay LZG-24HE

Key No.	Description	Key No.	Description
BD	Bridge Diode DBA-10C	RF	Relay LZG-24HE
D1	Diode DS-442X	RM	Relay LZG-24HE
D2	Diode DS-442X	RP	Varistor SNR-A420K
D3	Diode DS-442X	V	Connector 6P
D4	Diode DS-442X	6P	Connector 4P
C1	Capacitor 470μF/50V TW	4P	Connector 3P
C2	Capacitor 0.047μF/50V	3P(A)	Connector 3P
R1	Relay LZG-24HE	3P(B)	Relay LZG-24HE

Key No.	Description	Key No.	Description
BD	Bridge Diode DBA-10C	RF	Relay LZG-24HE
D1	Diode DS-442X	RM	Relay LZG-24HE
D2	Diode DS-442X	RP	Varistor SNR-A420K
D3	Diode DS-442X	V	Connector 6P
D4	Diode DS-442X	6P	Connector 4P
C1	Capacitor 470μF/50V TW	4P	Connector 3P
C2	Capacitor 0.047μF/50V	3P(A)	Connector 3P
R1	Relay LZG-24HE	3P(B)	Relay LZG-24HE



## 13. APPENDIX

### Conversion Tables

Centigrade  $\longleftrightarrow$  Fahrenheit

Numbers in the center column (between those marked C and F) refer to temperature, Centigrade or Fahrenheit, which it is desired to convert into the other scale. To convert from Fahrenheit to Centigrade find equivalent temperature in left hand column

$^{\circ}\text{C.}$	$^{\circ}\text{F.}$	$^{\circ}\text{C.}$	$^{\circ}\text{F.}$	$^{\circ}\text{C.}$	$^{\circ}\text{F.}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$
-40.0	-40	-40.0	-6.7	20	68.0	15.6	60	140.0	37.8	100	212.0
-38.9	-38	-36.4	-6.1	21	69.8	16.1	61	141.8	38.9	102	215.6
-37.8	-36	-32.8	-5.6	22	71.6	16.7	62	143.6	40.0	104	219.2
-36.7	-34	-29.2	-5.0	23	73.4	17.2	63	145.4	41.1	106	222.8
-35.6	-32	-25.6	-4.4	24	75.2	17.8	64	147.2	42.2	108	226.4
									86.7	188	370.4
									137.8	280	536.0
									140.6	235	545.0
									143.3	290	564.0
									146.1	295	563.0
									148.9	300	572.0
-34.4	-30	-22.0	-3.9	25	77.0	18.3	65	149.0	43.3	110	230.0
-33.3	-28	-18.4	-3.3	26	78.8	18.9	66	150.8	44.4	112	233.6
-32.2	-26	-14.8	-2.8	27	80.6	19.4	67	152.6	45.6	114	237.2
-31.1	-24	-11.2	-2.2	28	82.4	20.0	68	154.4	46.7	116	240.8
-30.0	-22	-7.6	-1.7	29	84.2	20.6	69	156.2	47.8	118	244.4
									92.2	198	388.4
									162.8	325	617.0
-28.9	-20	-4.0	-1.1	30	86.0	21.1	70	158.0	48.9	120	248.0
-27.8	-18	-0.4	-0.6	31	87.8	21.7	71	159.8	50.0	122	251.6
-26.7	-16	3.2	0.0	32	89.6	22.2	72	161.6	51.1	124	255.2
-25.6	-14	6.8	+ 0.6	33	91.4	22.8	73	163.4	52.2	125	258.8
-24.4	-12	10.4	1.1	34	93.2	23.3	74	165.2	53.3	128	262.4
									97.8	208	406.4
									176.7	350	662.0
-23.3	-10	14.0	1.7	35	95.0	23.9	75	167.0	54.4	130	266.0
-22.2	-8	17.6	2.2	36	96.8	24.4	76	168.8	55.6	132	269.6
-21.1	-6	21.2	2.8	37	98.6	25.0	77	170.6	56.7	134	273.2
-20.0	-4	24.6	3.3	38	100.4	25.6	78	172.4	57.8	136	276.8
-18.9	-2	28.4	3.9	39	102.2	26.1	79	174.2	58.9	138	280.4
									103.3	218	424.4
									190.6	375	707.0
-17.8	0	32.0	4.4	40	104.0	26.7	80	176.0	60.0	140	284.0
-17.2	1	33.8	5.0	41	105.8	27.2	81	177.8	61.1	142	287.6
-16.7	2	35.6	5.6	42	107.6	27.8	82	179.6	62.2	144	291.2
-16.1	3	37.4	6.1	43	109.4	28.3	83	181.4	63.3	146	294.8
-15.6	4	39.2	6.7	44	111.2	28.9	84	183.2	64.4	148	298.4
									108.9	228	442.4
									204.4	400	752.0
-15.0	5	41.0	7.2	45	113.0	29.4	85	185.0	65.6	150	302.0
-14.4	6	42.8	7.8	46	114.8	30.0	86	186.8	66.7	152	305.6
-13.9	7	44.6	8.3	47	116.6	30.6	87	188.6	67.8	154	309.2
-13.3	8	46.4	8.9	48	118.4	31.1	88	190.4	68.9	156	312.8
-12.8	9	48.2	9.4	49	120.2	31.7	89	192.2	70.0	158	316.4
									114.4	238	460.4
									232.2	450	842.0
-12.2	10	50.0	10.0	50	122.0	32.2	90	194.0	71.1	160	320.0
-11.7	11	51.8	10.6	51	123.8	32.8	91	195.8	72.2	162	323.6
-11.1	12	53.6	11.1	52	125.6	33.3	92	197.6	73.3	164	327.2
-10.6	13	55.4	11.7	53	127.4	33.9	93	199.4	74.4	166	330.8
-10.0	14	57.2	12.2	54	129.2	34.4	94	201.2	75.6	168	334.4
									121.1	250	482.0
									260.0	500	932.0
-9.4	15	59.0	12.8	55	131.0	35.0	95	203.0	76.7	170	338.0
-8.9	16	60.8	13.3	56	132.8	35.6	96	204.8	77.8	172	341.6
-8.3	17	62.6	13.9	57	134.6	36.1	97	206.6	78.9	174	345.2
-7.8	18	64.4	14.4	58	136.4	36.7	98	208.4	80.0	176	348.8
-7.2	19	66.2	15.0	59	138.2	37.2	99	210.2	81.1	178	352.4
									135.0	275	527.0
									287.8	550	1022.0

**Kilocalorie → British Thermal Units (1kcal = 3.9683 B. T. U.)**

Kilocalories	0	1	2	3	4	5	6	7	8	9
	B.T.U.									
0	.....	3.968	7.937	11.905	15.873	19.841	23.810	27.778	31.746	35.714
10	39.683	43.651	47.619	51.587	55.556	59.524	63.497	67.460	71.429	75.391
20	79.365	83.333	87.302	91.270	95.238	99.206	103.175	107.143	111.111	115.079
30	119.048	123.016	126.984	130.952	134.921	138.889	142.857	146.825	150.794	154.762
40	158.730	162.698	166.667	170.635	174.603	178.571	182.540	186.508	190.476	194.444
50	198.413	202.381	206.349	210.317	214.286	218.254	222.222	226.190	230.159	234.127
60	238.095	242.063	246.032	250.000	253.968	257.936	261.905	265.873	269.841	273.809
70	277.778	281.746	285.714	289.682	293.651	297.619	301.587	305.555	309.524	313.492
80	317.460	321.428	325.397	329.365	333.333	337.301	341.270	345.238	349.206	353.174
90	357.143	361.111	365.079	369.047	373.016	376.984	380.952	384.920	388.889	392.857
100	386.250	400.793	404.762	408.730	412.698	416.666	420.635	424.603	428.571	432.539

**Kilograms → Pounds (1kg = 2.205 Lbs.)**

Kilograms	0	1	2	3	4	5	6	7	8	9
	Lbs.									
0	.....	2.205	4.409	6.614	8.818	11.023	13.228	15.432	17.637	19.842
10	22.046	24.251	26.455	28.660	30.865	33.069	35.274	37.479	39.683	41.888
20	44.092	46.297	48.502	50.706	52.911	55.116	57.320	59.535	61.729	63.934
30	66.139	68.343	70.548	72.752	74.957	77.162	79.366	81.571	83.766	85.980
40	88.185	90.390	92.594	94.799	97.003	99.208	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.84	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.23	209.44	211.64	213.85	216.05	218.26
100	220.46	222.67	224.87	227.08	229.28	231.49	233.69	235.89	238.10	240.30

**Liters → U. S. Gallons (1Lit. = 0.264 Gallons)**

Liters	0	1	2	3	4	5	6	7	8	9
	Gallons									
0	.....	0.264	0.528	0.739	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.277	4.491	4.755	5.019
20	5.283	5.548	5.812	6.076	6.340	6.604	6.868	7.133	7.397	7.611
30	7.925	8.189	8.453	8.718	8.982	9.246	9.510	9.774	10.038	10.303
40	10.567	10.831	11.095	11.359	11.623	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.794	15.058	15.322	15.586
60	15.850	16.114	16.379	16.643	16.907	17.171	17.435	17.699	17.964	18.288
70	18.492	18.756	19.020	19.284	19.549	19.813	20.077	20.341	20.605	20.869
80	21.134	21.398	21.662	21.926	22.190	22.454	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.360	25.625	25.889	26.153
100	26.417	26.681	26.945	27.210	27.474	27.738	28.002	28.266	28.530	28.795

**Kilograms per Square Centimeter → Pounds per Square Inch (1kg/cm² = 14.22 Lbs/in²)**

Kilograms per Sq. Cm.	0	1	2	3	4	5	6	7	8	9
	Lbs. Per Sq. In.									
0	.....	14.22	28.45	42.67	56.89	71.12	85.34	99.56	113.78	128.01
10	142.23	156.45	170.68	184.90	199.12	213.35	227.57	241.79	256.02	270.24
20	284.46	298.69	312.91	327.13	341.36	355.58	369.80	384.03	398.25	412.47
30	426.70	440.92	455.14	469.36	483.59	497.81	512.03	526.26	540.48	554.70
40	568.93	583.15	597.37	611.60	625.82	640.04	654.27	668.49	682.71	696.94
50	711.16	725.38	739.61	753.83	768.05	782.28	796.50	810.72	824.94	839.17
60	853.39	867.61	881.84	896.06	910.28	924.51	938.73	952.95	967.18	981.40
70	995.62	1009.8	1024.1	1038.3	1052.5	1066.7	1081.0	1095.2	1109.4	1123.6
80	1137.8	1152.1	1166.3	1180.5	1194.7	1209.0	1223.2	1237.4	1251.6	1265.9
90	1280.1	1294.3	1308.5	1322.7	1337.0	1351.2	1365.4	1379.6	1393.9	1408.1
100	1422.3	1436.5	1450.8	1465.0	1479.2	1493.4	1507.7	1521.9	1536.1	1550.3

**Square Centimeters → Square Inches (1cm<sup>2</sup> = 0.155 In.<sup>2</sup>)**

Square Cm.	0	1	2	3	4	5	6	7	8	9
	Sq. In.									
0	.....	0.155	0.310	0.465	0.620	0.775	0.930	1.085	1.240	1.395
10	1.550	1.705	1.860	2.015	2.170	2.325	2.480	2.635	2.790	2.945
20	3.100	3.255	3.410	3.565	3.720	3.875	4.030	4.185	4.340	4.495
30	4.650	4.805	4.960	5.115	5.270	5.425	5.580	5.735	5.890	6.045
40	6.200	6.355	6.510	6.665	6.820	6.975	7.130	7.285	7.440	7.595
50	7.750	7.905	8.060	8.215	8.370	8.525	8.680	8.835	8.990	9.145
60	9.300	9.455	9.610	9.765	9.920	10.075	10.230	10.385	10.540	10.695
70	10.850	11.005	11.160	11.315	11.470	11.625	11.780	11.935	12.090	12.245
80	12.400	12.555	12.710	12.865	13.020	13.175	13.330	13.485	13.640	13.795
90	13.950	14.105	14.260	14.415	14.570	14.725	14.880	15.035	15.190	15.345
100	15.500	15.655	15.810	15.965	16.120	16.275	16.430	16.585	16.740	16.895

**Square Meters → Square Feet (1m<sup>2</sup> = 10.76 Ft.<sup>2</sup>)**

Square Meters	0	1	2	3	4	5	6	7	8	9
	Sq. Ft.									
0	.....	10.76	21.53	32.29	43.06	53.82	64.58	75.35	86.11	96.88
10	107.64	118.40	129.17	139.93	150.69	161.46	172.22	182.99	193.75	204.51
20	215.28	226.04	236.81	247.57	258.33	269.10	279.86	290.62	301.39	312.15
30	322.92	333.68	344.44	355.21	365.97	376.74	387.50	398.26	409.03	419.79
40	430.55	441.32	452.08	462.85	473.61	484.37	495.14	505.90	516.67	527.43
50	538.19	548.96	559.72	570.48	581.25	592.01	602.78	613.54	624.30	635.07
60	645.83	656.60	667.36	678.12	688.89	699.65	710.42	721.18	731.94	742.71
70	753.47	764.23	775.00	785.76	796.53	807.29	818.05	828.82	839.58	850.35
80	861.11	871.87	882.64	893.40	904.16	914.93	925.69	936.46	947.22	957.98
90	968.75	979.51	990.28	1001.04	1011.80	1022.57	1033.33	1044.10	1054.86	1065.62
100	1076.39	1087.15	1097.92	1108.68	1119.44	1130.21	1140.97	1151.74	1162.50	1173.26

**Cubic Centimeters → Cubic Inches (1cm<sup>3</sup> = 0.061 In.<sup>3</sup>)**

Cubic Cm.	0	1	2	3	4	5	6	7	8	9
	Cubic Inches									
0	.....	0.0610	0.1221	0.1831	0.2441	0.3051	0.3661	0.4272	0.4882	0.5492
10	0.6102	0.6712	0.7323	0.7933	0.8543	0.9153	0.9763	1.0374	1.0984	1.1594
20	1.2205	1.2815	1.3426	1.4063	1.4646	1.5256	1.5866	1.6477	1.7087	1.7697
30	1.8308	1.8918	1.9529	2.0139	2.0749	2.1359	2.1969	2.2580	2.3190	2.3800
40	2.4410	2.5020	2.5631	2.6241	2.6851	2.7461	2.8071	2.8682	2.9292	2.9902
50	3.0513	3.1123	3.1734	3.2344	3.2954	3.3564	3.4174	3.4785	3.5395	3.6005
60	3.6615	3.7225	3.7836	3.8446	3.9056	3.9666	4.0276	4.0887	4.1497	4.2107
70	4.2718	4.3328	4.3939	4.4549	4.5159	4.5769	4.6379	4.6990	4.7600	4.8210
80	4.8820	4.9430	5.0041	5.0651	5.1261	5.1871	5.2481	5.3092	5.3702	5.4312
90	5.4923	5.5533	5.6144	5.6754	5.7364	5.7974	5.8584	5.9195	5.9805	6.0415
100	6.1025	6.1635	6.2246	6.2856	6.3466	6.4076	6.4686	6.5297	6.5907	6.6517

**Cubic Metres → Cubic Feet (1m<sup>3</sup> = 35.3 Ft.<sup>3</sup>)**

Cubic Meters	0	1	2	3	4	5	6	7	8	9
	Cubic Feet									
0	.....	35.3	70.6	105.9	141.3	176.6	211.9	247.2	282.5	317.8
10	353.1	388.5	423.8	459.1	494.4	529.7	565.0	600.3	635.7	671.0
20	706.3	741.6	776.9	812.2	847.5	882.9	918.2	953.5	988.8	1024.1
30	1059.4	1094.7	1130.1	1165.4	1200.7	1236.0	1271.3	1306.6	1341.9	1377.3
40	1412.6	1447.9	1483.2	1518.5	1553.8	1589.2	1624.5	1659.8	1695.1	1730.4
50	1765.7	1801.0	1836.4	1871.7	1907.0	1942.3	1977.6	2012.9	2048.2	2083.6
60	2118.9	2154.2	2189.5	2224.8	2260.1	2295.4	2330.8	2366.1	2401.4	2436.7
70	2472.0	2507.3	2542.6	2578.0	2613.3	2648.6	2683.9	2719.2	2754.5	2789.8
80	2825.2	2860.5	2895.8	2931.1	2966.4	3001.7	3037.0	3072.4	3107.7	3143.0
90	3178.3	3213.6	3248.9	3284.2	3319.6	3354.9	3390.2	3425.5	3460.8	3496.1
100	3531.4	3566.7	3602.0	3637.3	3672.7	3708.0	3743.3	3778.6	3813.9	3849.2

**Millimeters → Inches**

Millimeters	Inches	Millimeters	Inches	Millimeters	Inches
0.01	0.0004	0.35	0.0138	0.68	0.0268
0.02	0.0008	0.36	0.0142	0.69	0.0272
0.03	0.0012	0.37	0.0146	0.70	0.0276
0.04	0.0016	0.38	0.0150	0.71	0.0280
0.05	0.0020	0.39	0.0154	0.72	0.0283
0.06	0.0024	0.40	0.0157	0.73	0.0287
0.07	0.0028	0.41	0.0161	0.74	0.0291
0.08	0.0031	0.42	0.0165	0.75	0.0295
0.09	0.0035	0.43	0.0169	0.76	0.0299
0.10	0.0039	0.44	0.0173	0.77	0.0303
0.11	0.0043	0.45	0.0177	0.78	0.0307
0.12	0.0047	0.46	0.0181	0.79	0.0311
0.13	0.0051	0.47	0.0185	0.80	0.0315
0.14	0.0055	0.48	0.0189	0.81	0.0319
0.15	0.0059	0.49	0.0193	0.82	0.0323
0.16	0.0063	0.50	0.0197	0.83	0.0327
0.17	0.0067	0.51	0.0201	0.84	0.0331
0.18	0.0071	0.52	0.0205	0.85	0.0335
0.19	0.0075	0.53	0.0209	0.86	0.0339
0.20	0.0079	0.54	0.0213	0.87	0.0343
0.21	0.0083	0.55	0.0217	0.88	0.0346
0.22	0.0087	0.56	0.0220	0.89	0.0350
0.23	0.0091	0.57	0.0224	0.90	0.0354
0.24	0.0094	0.58	0.0228	0.91	0.0358
0.25	0.0098	0.59	0.0232	0.92	0.0362
0.26	0.0102	0.60	0.0236	0.93	0.0366
0.27	0.0106	0.61	0.0240	0.94	0.0370
0.28	0.0110	0.62	0.0244	0.95	0.0374
0.29	0.0114	0.63	0.0248	0.96	0.0378
0.30	0.0118	0.64	0.0252	0.97	0.0382
0.31	0.0122	0.65	0.0256	0.98	0.0386
0.32	0.0126	0.66	0.0260	0.99	0.0390
0.33	0.0130	0.67	0.0264	1.00	0.0394
0.34	0.0134	.....	.....	.....	.....

**Inches → Millimeters**

Inches	Millimeters	Inches	Millimeters	Inches	Millimeters
0.001	0.025	0.290	7.37	0.660	16.76
0.002	0.051	0.300	7.62	0.670	17.02
0.003	0.076	0.310	7.87	0.680	17.27
0.004	0.102	0.320	8.13	0.690	17.53
0.005	0.127	0.330	8.38	0.700	17.78
0.006	0.152	0.340	8.64	0.710	18.03
0.007	0.178	0.350	8.89	0.720	18.29
0.008	0.203	0.360	9.14	0.730	18.54
0.009	0.229	0.370	9.40	0.740	18.80
0.010	0.254	0.380	9.65	0.750	19.05
0.020	0.508	0.390	9.91	0.760	19.30
0.030	0.762	0.400	10.16	0.770	19.56
0.040	1.016	0.410	10.41	0.780	19.81
0.050	1.270	0.420	10.67	0.790	20.07
0.060	1.524	0.430	10.92	0.800	20.32
0.070	1.778	0.440	11.18	0.810	20.57
0.080	2.032	0.450	11.43	0.820	20.83
0.090	2.286	0.460	11.68	0.830	21.08
0.100	2.540	0.470	11.94	0.840	21.34
0.110	2.794	0.480	12.19	0.850	21.59
0.120	3.048	0.490	12.45	0.860	21.84
0.130	3.302	0.500	12.70	0.870	22.10
0.140	3.556	0.510	12.95	0.880	22.35
0.150	3.81	0.520	13.21	0.890	22.61
0.160	4.06	0.530	13.46	0.900	22.86
0.170	4.32	0.540	13.72	0.910	23.11
0.180	4.57	0.550	13.97	0.920	23.37
0.190	4.83	0.560	14.22	0.930	23.62
0.200	5.08	0.570	14.48	0.940	23.88
0.210	5.33	0.580	14.73	0.950	24.13
0.220	5.59	0.590	14.99	0.960	24.38
0.230	5.84	0.600	15.24	0.970	24.64
0.240	6.10	0.610	15.49	0.980	24.89
0.250	6.35	0.620	15.75	0.990	25.15
0.260	6.60	0.630	16.00	1.000	25.40
0.270	6.86	0.640	16.26	.....	.....
0.280	7.11	0.650	16.51	.....	.....

**Fractional Inches → Decimals and Millimeters**

Inch	Decimal Inch	Millimeter									
1/64	0.015525	0.396785	17/64	0.205823	6.746375	33/64	0.515625	13.096875	49/64	0.765625	19.446875
1/32	0.03125	0.79375	9/32	0.28125	7.14375	17/32	0.53125	13.49375	25/32	0.78125	19.84375
3/64	0.046875	1.190625	19/64	0.296875	7.540625	35/64	0.546875	13.890625	51/64	0.796875	20.240625
1/16	0.0625	1.5875	5/16	0.3125	7.9375	9/16	0.5625	14.2875	13/16	0.8125	20.6375
5/64	0.078125	1.984375	21/64	0.328125	8.334375	37/64	0.578125	14.684375	53/64	0.828125	21.034375
3/32	0.09375	2.38125	11/32	0.34375	8.73125	19/32	0.59375	15.08125	27/32	0.84375	21.43125
7/64	0.109375	2.778125	23/64	0.359375	9.128125	39/64	0.609375	15.478125	55/64	0.859375	21.828125
1/8	0.125	3.175	3/8	0.375	9.525	5/8	0.625	15.875	7/8	0.875	22.225
9/64	0.140625	3.571875	25/64	0.390625	9.921875	41/64	0.640625	16.271875	57/64	0.890625	22.621875
5/32	0.15625	3.96875	13/32	0.40625	10.31875	21/32	0.65625	16.66875	29/32	0.90625	23.01875
11/64	0.171875	4.365625	27/64	0.421875	10.715625	43/64	0.671875	17.065625	59/64	0.921875	23.415625
3/16	0.1875	4.7625	7/16	0.4375	11.1125	11/16	0.6875	17.4625	15/16	0.9375	23.8125
13/64	0.203125	5.159375	29/64	0.453125	11.509375	45/64	0.703125	17.859375	61/64	0.953125	24.209375
7/32	0.21875	5.55624	15/32	0.46875	11.90625	23/32	0.71875	18.25625	31/32	0.96875	24.60625
15/64	0.234375	5.953125	31/64	0.484375	12.303125	47/64	0.734375	18.653125	63/64	0.984375	25.003125
1/4	0.25	6.35001	1/2	0.50	12.7	3/4	0.75	19.05	1	1.00000	25.4



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