

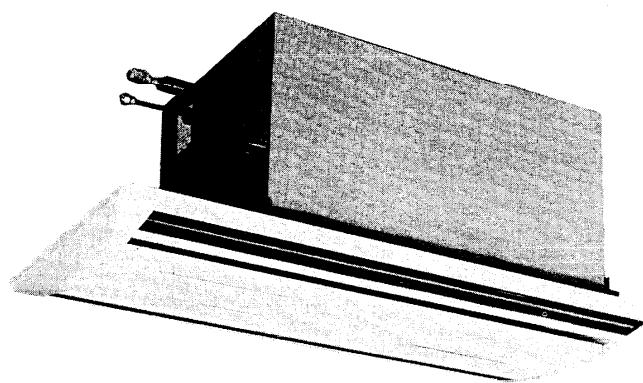
SERVICE MANUAL

SPLIT-TYPE
AIR CONDITIONER



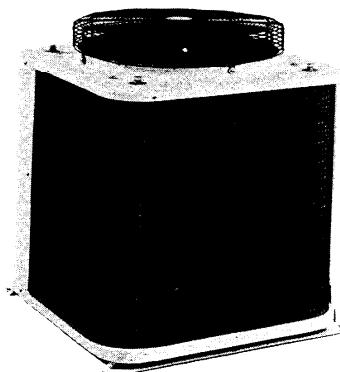
SAP241RC

(U.S.A.,



Indoor Unit

SAP241R



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: SAP241RC**
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1. SPECIFICATIONS

1.1 Unit Specifications

Model No.	SAP241RC	
Unit Model No.	Indoor unit Outdoor unit	SAP241R SAP241C
PERFORMANCE & ELECTRICAL RATINGS		
Capacity — Cooling	BTU/hr.	23,800/23,400
— Heating	BTU/hr.	—
Moisture Removal (High)	Pints/hr.	8.4
Air Circulation (High)	Cu.ft./min.	565/530
SEER (EER)	BTU/Whr.	8.1/8.3 (7.85/7.9)
COP		—
Frequency	Hz	60
Rated Voltage	V	230/208
*Running Amps	A	13.6/14.4
Power Input	W	3,030/2,960
Back-up Heater	kW	—
Fuse (or Circuit Breaker) Capacity	A	30
FEATURES		
Controls	Microcomputer IC	— Yes
Fan Speeds		2
Timer		—
Ventilator		—
Air Deflection	Horizontal 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 Tube o.d.	In. (mm)	3/4 (26.67)
Refrigerant Tubing Kit		Optional
DIMENSIONS & WEIGHT		
Dimensions	Height In. (mm)	19-1/4 (490)
	Width In. (mm)	51-3/16 (1,300)
	Depth In. (mm)	24-7/16 (620)
Net Weight	Ibs. (kg)	99.2 (45)
Shipping Size	Cu.ft. (cu.m)	19.8 (0.56)
Shipping Weight	Ibs. (kg)	132 (66)
Indoor Unit		Outdoor Unit

* Without electric heater

DATA SUBJECT TO CHANGE WITHOUT NOTICE

1.2 Major Component Specifications

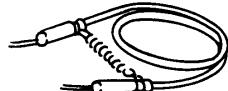
Unit Model No.		SAP241C	
Compressor		Hermetic Rotary Type	
Compressor Model No.		C-R190H6N	
Source		230/208 V, 60 Hz, Single Phase	
Pole		2	
Nominal Output (W)		1900	
Displacement (cc/rev.)		41.6	
Amps.-Full Load (A)		12.7/14.0	
-Locked Rotor (A)		84 (240 V)	
Type of Oil		Special oil for Rotary Compressor	
Compressor Oil Amount (cc)		1,350	
Coil Resistance (Ω) (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.	SAP241R	SAP241C	
Fan Motor			
Capacitor Run Induction Motor			
Fan Motor Model No.		KFG4S-81B6P	KFC8-101A6P
Source		230/208 V, 60 Hz, Single Phase	
Pole		4	8
Nominal Output (W)		80	20
Amps.-Full Load (A)		0.83/0.77	0.5/0.5
-Locked Rotor (A)		—	
Protective Device		Internal Protector (17AM031 A5-4)	Internal Protector (17AM035 A5-4)
Run Capacitor,	MFD	3	5
	VAC	440	
Coil Resistance (Ω) (Ambient Temp. 68°F)		WHT-BRN: 55.2 WHT-YEL: 53.2 YEL-PNK: 74.6	WHT-BRN: 24.1 WHT-PNK: 53.8

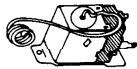
Unit Model No.	SAP241R	Figure
Room Temp. Sensor*	OCS5K-UL	Incorporated in the remote control unit
Resistance (kΩ)	69°F: 6–6.5 86°F: 3.9–4.2 77°F: 4.9–5.2	

Note: * = thermistor

Unit Model No.	SAP241R	Figure
Power Transformer (for Controller PCB)	ATR-J122U	
Resistance (Ω)	Primary: WHT-NHT 143.5 Secondary: BRN-BRN 1.2	

Unit Model No.	SAP241C	Figure
Magnet Relay	CLK-16E3-21	

Unit Model No.	SAP241C	Figure
Crankcase Heater	CH5700	
Rating	230 V, 30 W	

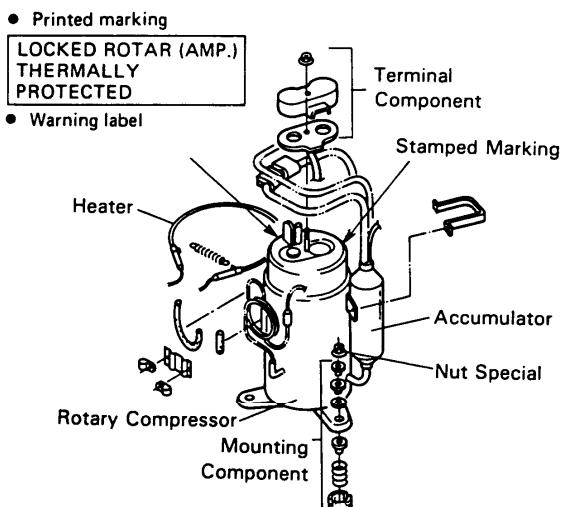
Unit Model No.	SAP241C	Figure
Outdoor Coil Thermostat	YTB-4U201	
Operating Temperature	ON: 75°F, OFF: 78°F	

Unit Model No.	SAP241C	Figure
Solenoid Valve	NEV603DXFU (valve), NEVAC208 (coil)	
Rating	230 V/208 V 5.5 W/5 W	

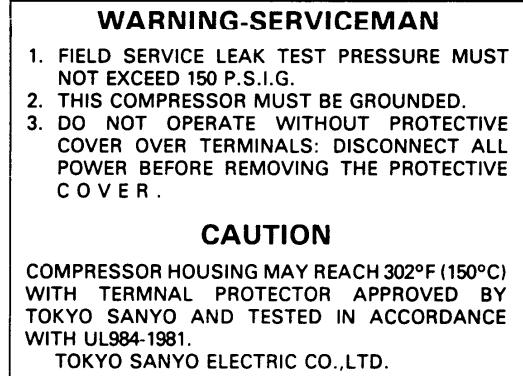
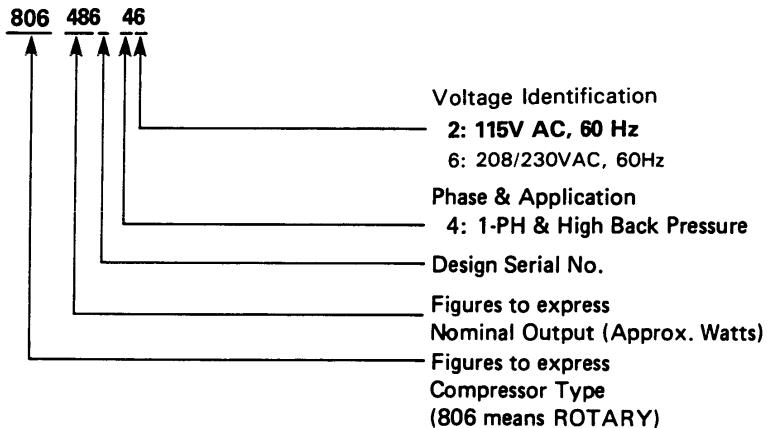
1.3. Compressor Identification

1. Marking (Stamped)

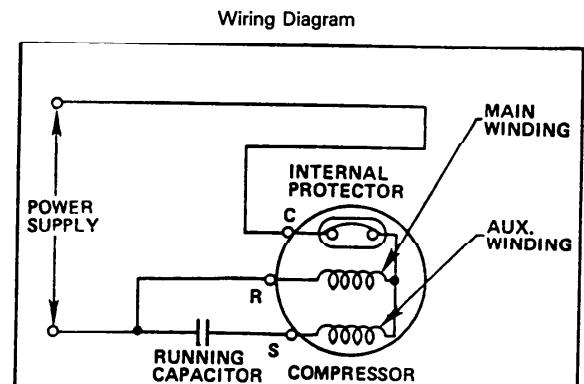
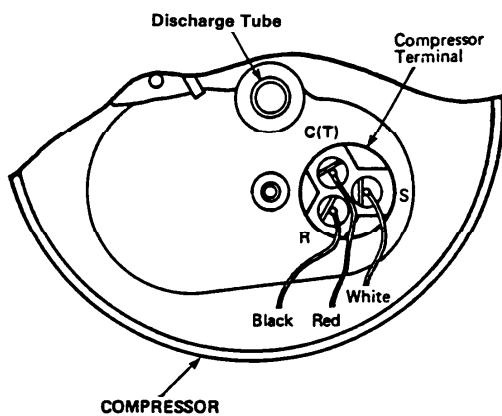
Compressor code No. → 806 486 46 Manufacturer: T = Tokyo
 Model No. → C - R190H6N **TSE** S = Sanyo
 E = Electric.
 Production Date → 30 01 5 ← (= 30 Jan., 1985)
 Ratings (V) → V230/208
 Frequency (Hz) and Phase → HZ60 PH1



2. Compressor Code No.

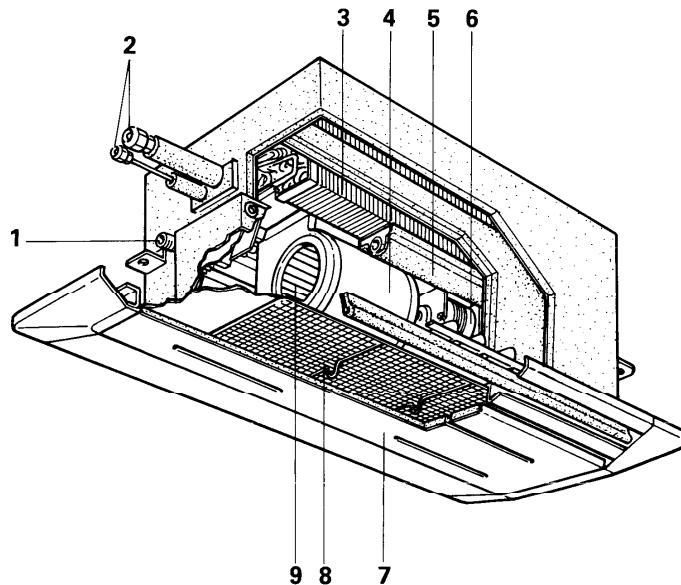


3. Compressor Wire Orientation



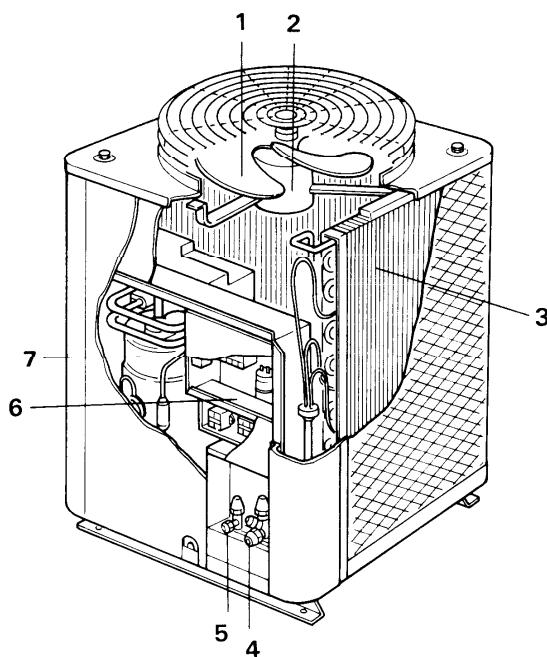
2. CONSTRUCTION OF THE UNIT

INDOOR UNIT SAP241R



1. Drain hose
2. Refrigerant tubing
3. Evaporator (= Indoor heat exchanger)
4. Blower casing
5. Drain pan
6. Fan motor
7. Air discharge panel
8. Air filter
9. Blower

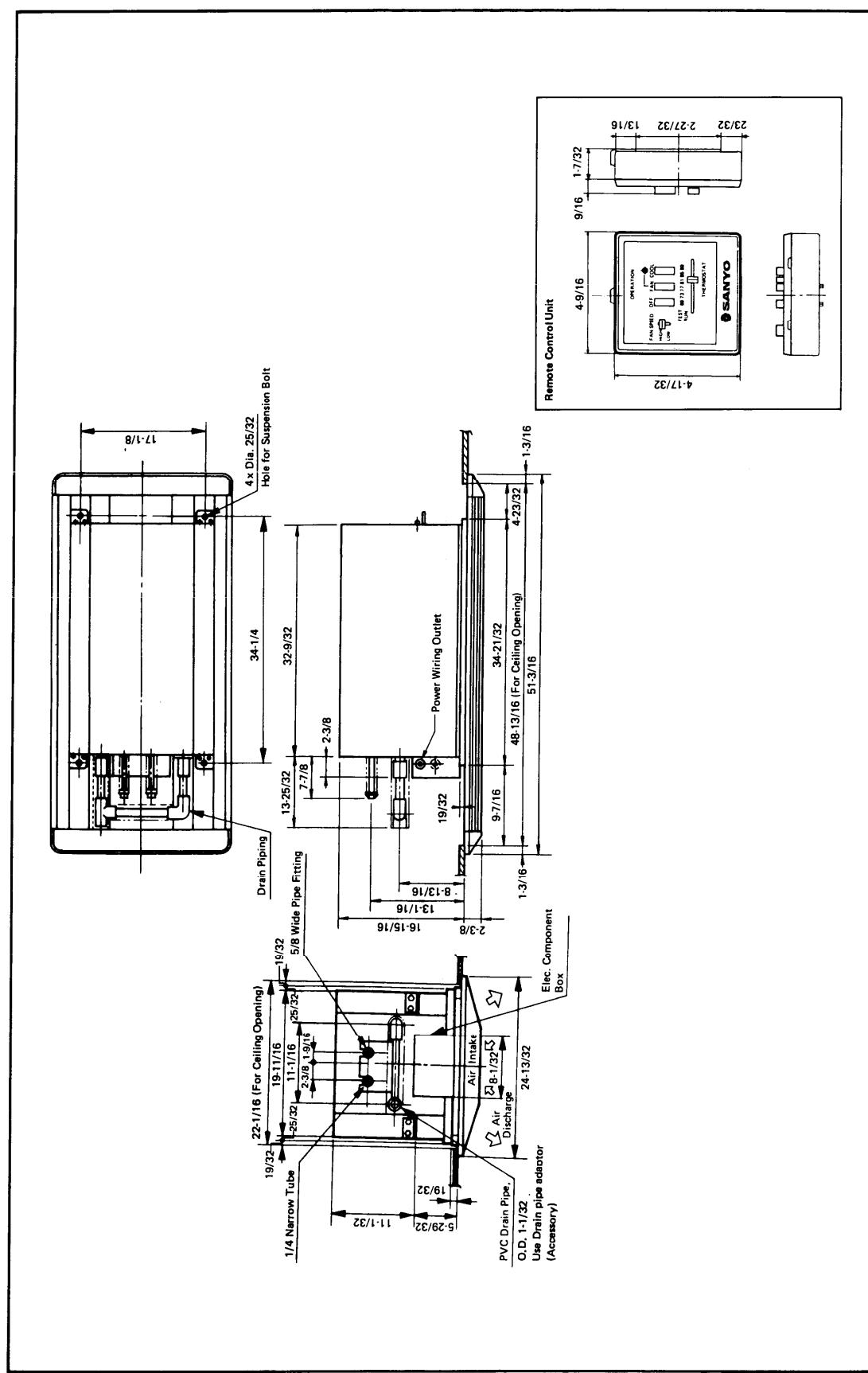
OUTDOOR UNIT SAP241C



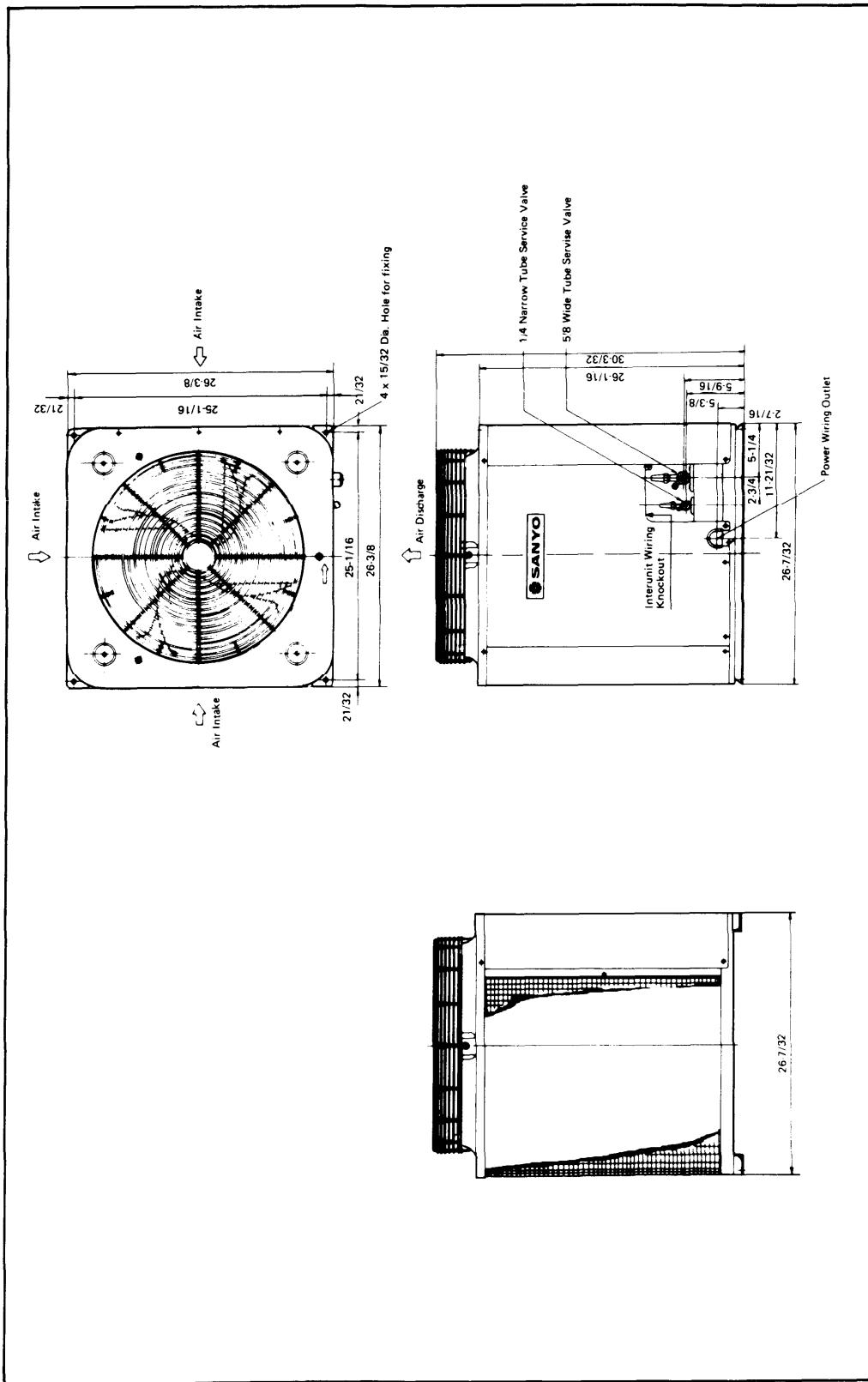
1. Propeller fan
2. Fan motor
3. Condenser (= Outdoor heat exchanger)
4. Service valve (Wide tube)
5. Service valve (Narrow tube)
6. Electrical component box
7. Compressor

3. DIMENSIONAL DATA

Indoor Unit SAP241R



Outdoor Unit SAP 241C

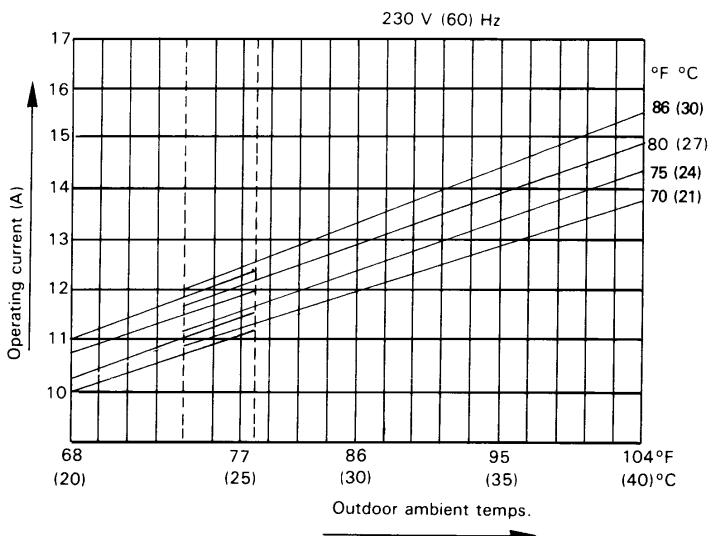


4. PERFORMANCE CHARTS

Cooling characteristics Model: SAP241RC

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

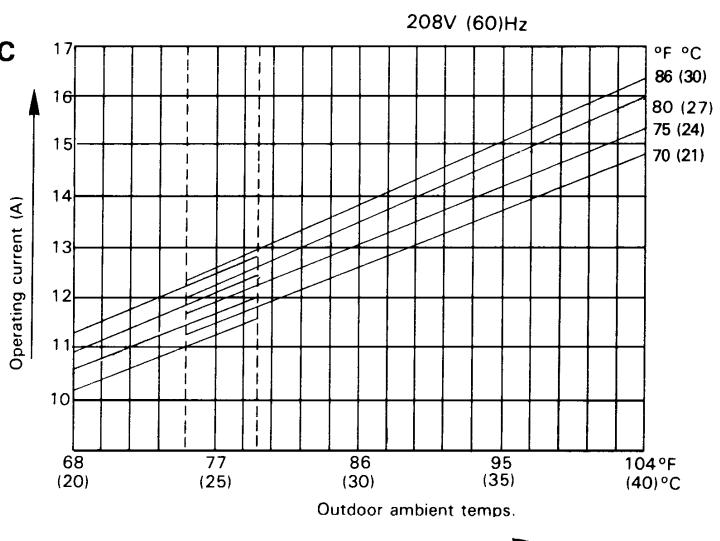
NOTE: The solenoid valve opens to by-pass refrigerant flow when the outdoor ambient temperature stays within the dotted-line range.



Cooling characteristics Model: SAP241RC

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

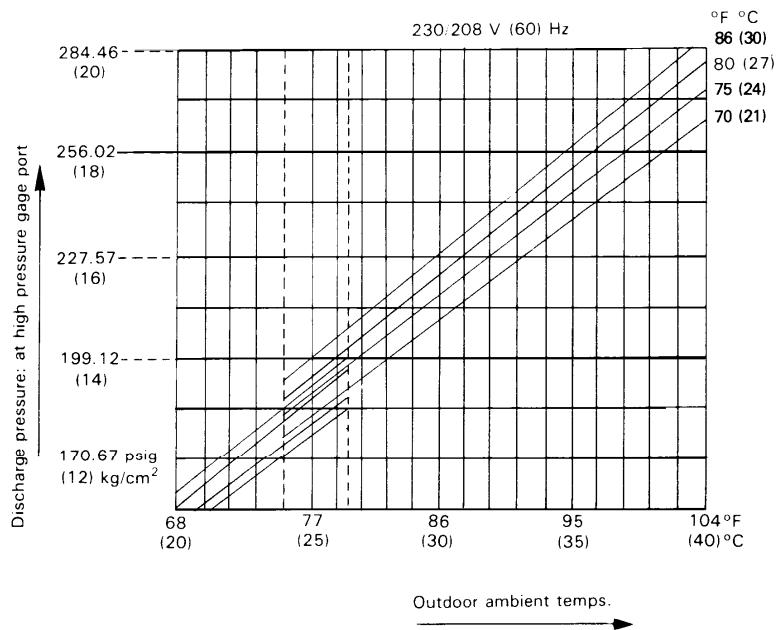
NOTE: The solenoid valve opens to by-pass refrigerant flow when the outdoor ambient temperature stays within the dotted-line range.



Cooling characteristics Model: SAP241RC

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

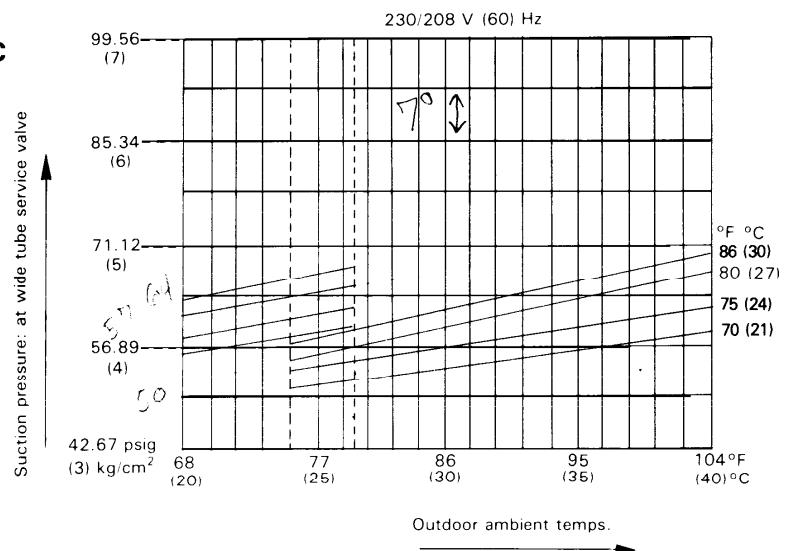
NOTE: The solenoid valve opens to by-pass refrigerant flow when the outdoor ambient temperature stays within the dotted-line range.



Cooling characteristics Model: SAP241RC

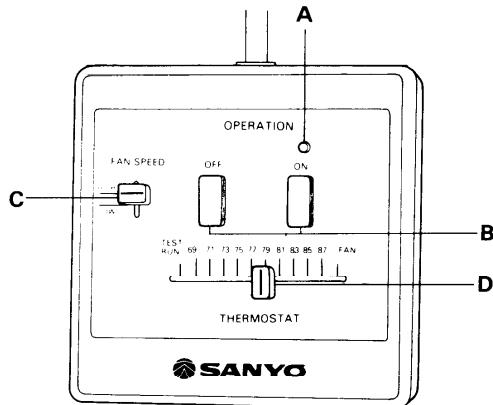
Low pressure characteristics versus outdoor ambient temperature and indoor temperature (Indoor relative humidity: 50%, indoor air velocity: High.)

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. REMOTE CONTROL UNIT



A. INDICATOR LAMP (Green)

This lamp lights up during fan only and cooling operation.

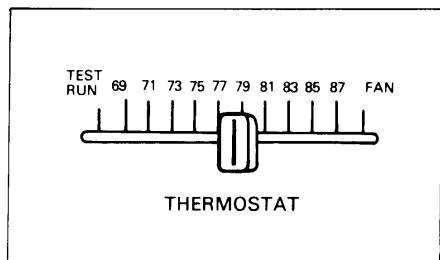
B. OPERATION SWITCH

OFF	Stops air conditioner.
ON	Starts air conditioner; bringing cooling, room air circulation and filtering dusts.

C. FAN SPEED SWITCH

HIGH	To operate the fan at high speed, set lever to HIGH position.
LOW	To operate the fan at low speed, set lever to LOW position.

D. THERMOSTAT, FAN AND TEST RUN SLIDE SWITCH



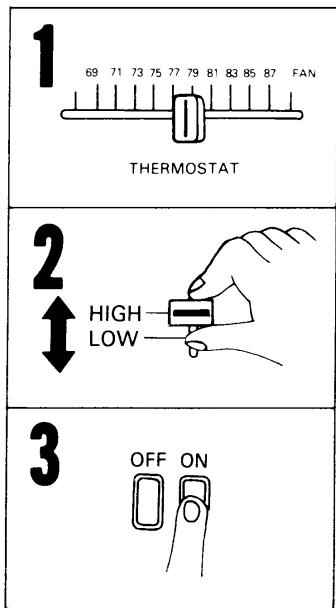
THERMOSTAT

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.

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

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

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 cooling load.



2. HOW TO OPERATE

Turn on the power supply disconnect at least five hours before starting the air conditioner.

1. Set THERMOSTAT lever to the desired position.
2. Set FAN SPEED selector lever to the desired position.
3. Press the ON button to start the air conditioner.

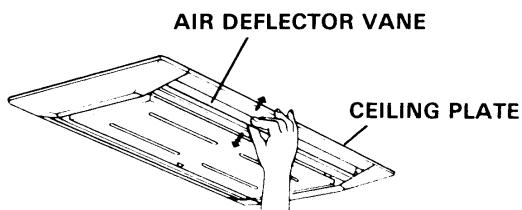
HOW TO STOP

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.

3. AIR FLOW DIRECTION ADJUSTMENT

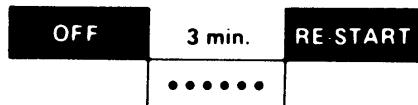


Air deflector vanes can be manually adjusted for the desired air distribution.

4. CAUTION

• SAFETY INTERVAL RESTARTING

After pressing the OFF button, the air conditioner stops and it will not start for three (3) minutes. To start the unit again after three minutes, press the ON button.



6. INSTALLATION INSTRUCTIONS

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1. GENERAL

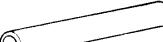
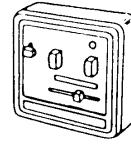
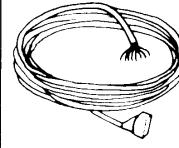
Here is a brief outline of where and how to install the unit. Please read over entire set of instructions for indoor and outdoor units and make sure all accessory parts listed are with the unit before beginning.

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

1-2. Accessories Supplied with Unit for Installation

Description	Shape	Q'ty	Remarks	Description	Shape	Q'ty	Remarks
PVC elbow		1	For drain piping	Flanged hex nut		4	For suspending unit
PVC T-fitting		1		Special washer			
PVC pipe		4		Remote control unit			
PVC socket		2				1	Install accessible position on the wall
Pan-head screw	 M5	4	For ceiling panel	Lead wire for remote control unit		1	Length of lead wire: 10m
Countersunk-head wood screw		2	For remote control unit				
Drain Hose adaptor		1					

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 22)
- 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.
 - installing remote control unit behind curtains or furniture that obstruct air circulation.

- 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
 - allow room for mounting control unit about 4' off the floor, in an area that is not in direct sunlight or in the flow of cool air from the unit.
 - install unit within 33' up or down of outdoor unit and within a total of 50' from outdoor unit. Fig. 2

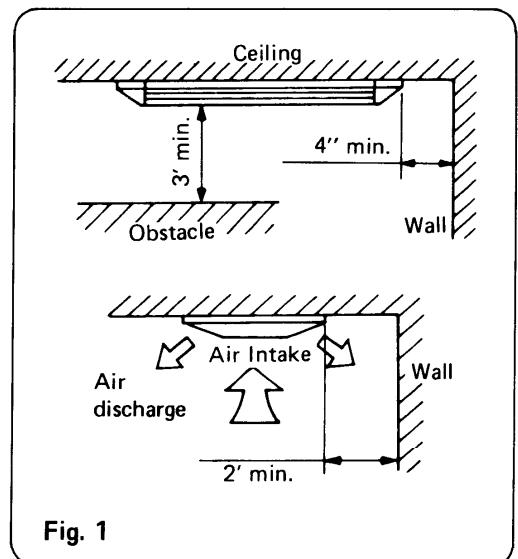


Fig. 1

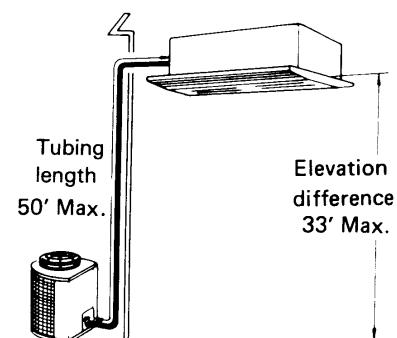


Fig. 2

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.

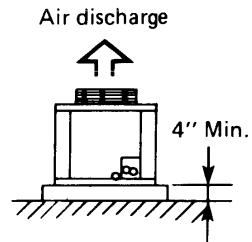


Fig. 5

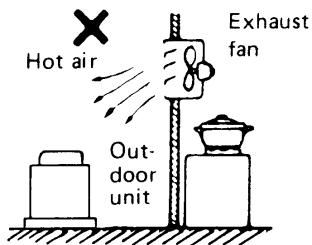


Fig. 3

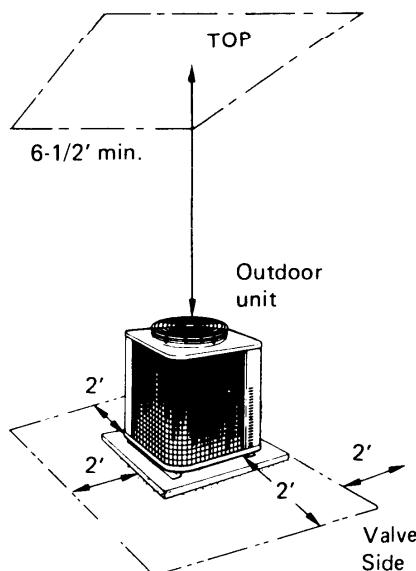


Fig. 4

3. HOW TO INSTALL INDOOR UNIT

3-1. Mount the Unit

a) Make an opening on the ceiling and determine the positions of the suspension bolt holes according to Fig. 6

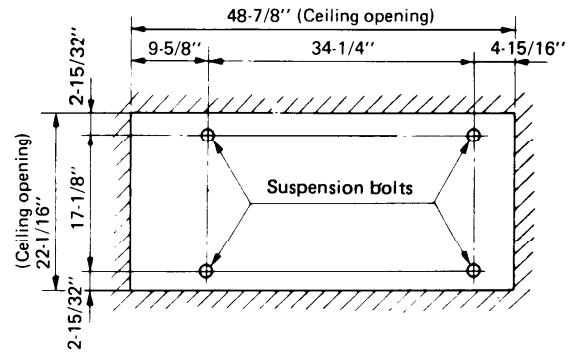


Fig. 6

b) In the holes for the bolts, insert securely bolt anchors (or bolt holding plugs). Then securely screw the bolts into the anchors, as shown in the illustration at right. Fig. 7A

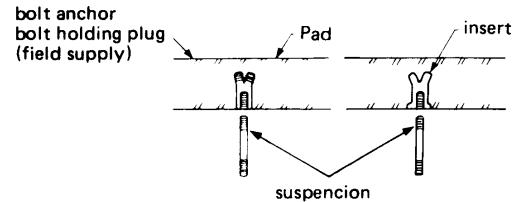


Fig. 7A

NOTE : If the ceiling pad is not strong enough to suspend the air conditioner or if it is difficult to use bolt anchors, secure the suspension bolts with the construction member. Refer to Fig.7B.

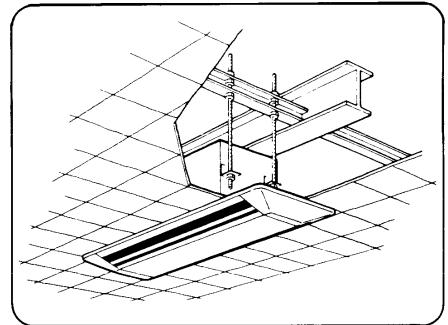


Fig. 7B

- c) If tubing and wire are to go directly out back of unit, make holes 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

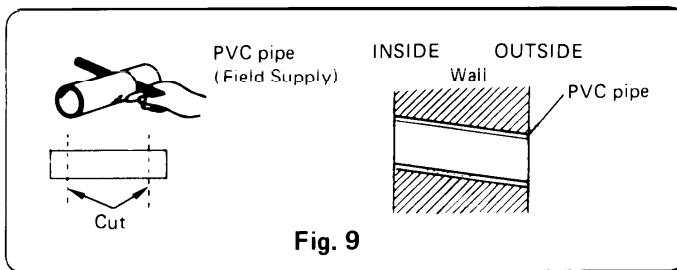


Fig. 9

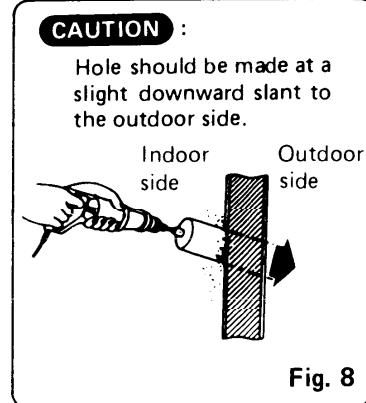


Fig. 8

- e) Screw flanged nuts (accessories) into the four suspension bolts, then lift the unit into position so that the suspension bolts pass through the holes in the suspension lugs on the unit. Fig. 10
- f) Put the special washers onto the suspension bolts upward which penetrate the suspension lugs and then fasten them with M10 nuts temporarily.
- g) Adjust the suspension height so that the distance between the bottom face of the flange of the indoor unit and the bottom face of the ceiling material is approx. 3/4". Fig. 11
Also, suspend the unit horizontally to prevent leakage of drainage or other trouble.

Ensure that the clearance between the flange of the unit body and the ceiling opening is as shown in Fig. 12.

Adjust the position of the unit within the range of the diameter ($\phi 20$) of the suspension hole. After adjustment, fasten M10 nuts securely.

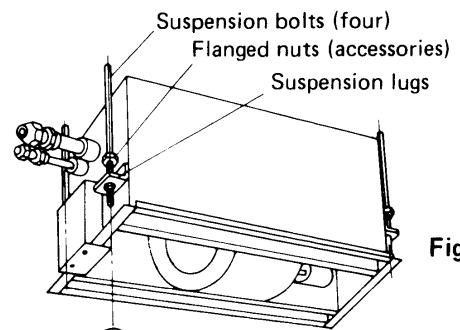


Fig. 10

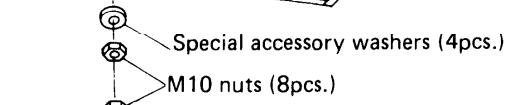


Fig. 11

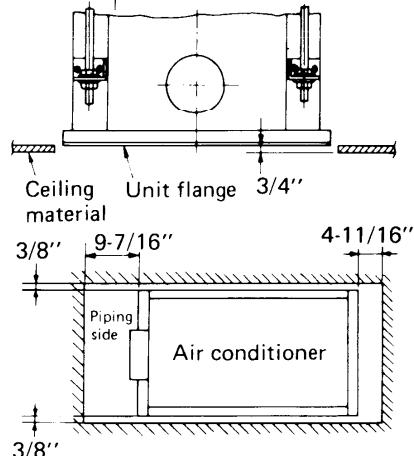


Fig. 12

3-2. Wiring Instructions 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.

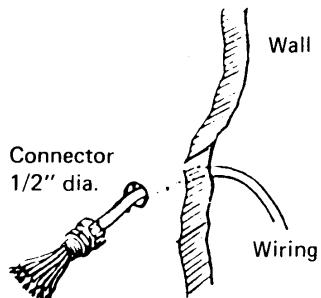


Fig. 13

- b) Unscrew the cover plate of the electrical component box. Fig. 14

- c) Temporarily set the wiring connector in the hole at the electrical component box.

- d) Secure the conduit connector to the electrical component box with a lock nut. Fig. 15

- e) Give some play to the interunit wiring from the outdoor unit to the corresponding terminals on the terminal base.

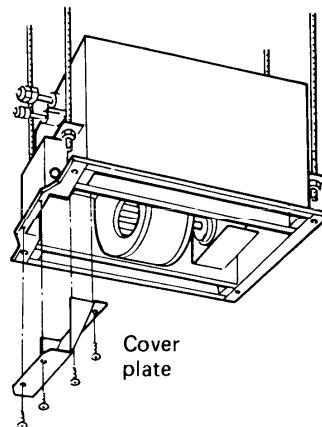


Fig. 14

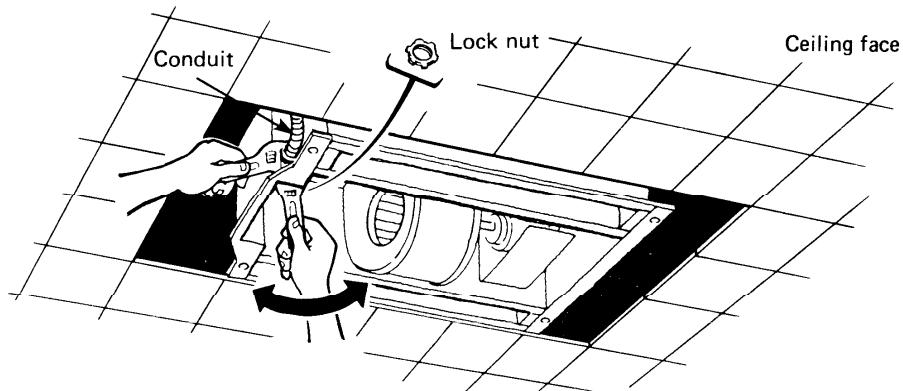


Fig. 15

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 codes and also any specific wiring instructions or limitation.

3-3. Drain Piping

Drain pipe connecting parts

The connection outlets for the drain pipes are on the same side of the unit body as the refrigerant piping and electrical box.

Connecting up drain piping

- There are two piping connection outlets as shown in the figure at right.
- Connect up the PVC pipe connectors and straight pipe provided (indicated by solid lines) to the connection outlets on the unit body. Fig. 16
- For the piping past the above accessory pieces (PVC piping connectors and straight pipe), use PVC pipes and connect them up using adhesive.
- Be sure to slope the drain piping downward, ensuring that no traps are formed in it.
- Be sure to apply thermal insulation to drain piping in the room.
- Upon completion of drain piping work, remove the blind cover shown in the above figure, then pour water into the drain pan and check to see whether or not it flows satisfactorily.

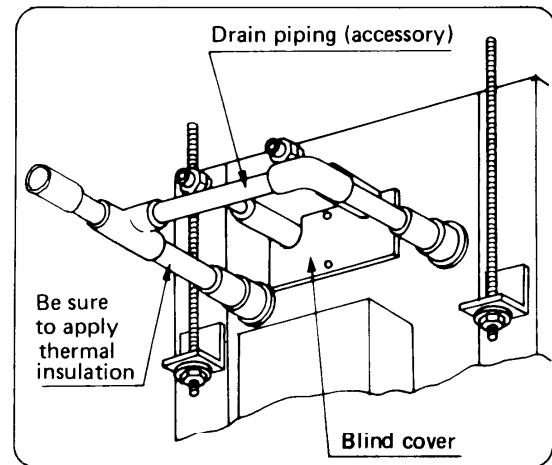


Fig. 16

3-4. Install Remote Control Unit: Fig.17

- a) Install the remote control mounting plate in a place which can be reached by the remote control cable.
- b) Connect up the remote control wiring according to the instructions on the label pasted on the back of the dressing cover of the remote control unit, by matching up the colors of the remote control wiring with the numbers on the PCB in the remote control unit body.
- c) After wiring work as in the below figure, fix the remote control unit body to the plastic box using the M4 small screws (four) provided. (*The M4 small screws are contained in the packing of the remote control unit.)
- d) Align the prongs of the dressing cover with the mating holes on the remote control unit body, and fasten them firmly.
- e) After mounting pushbuttons on corresponding switches, hang the remote control unit onto the mounting plate and slide it until it is seated. Thus installation completes.

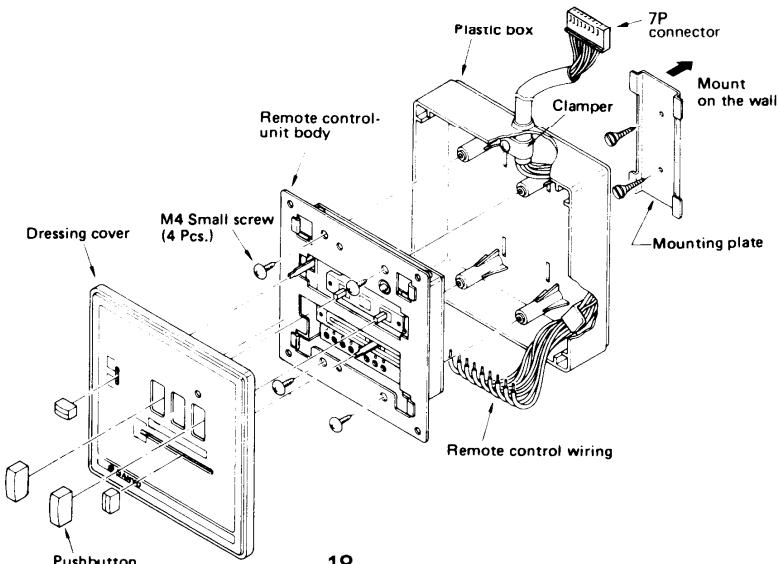


Fig. 17

NOTE : In case of use recessed outlet box, install remote control unit body, dressing cover and pushbutton directly to outlet box as same as Fig. 17. Do not use plastic box and mounting plate. Fig. 18

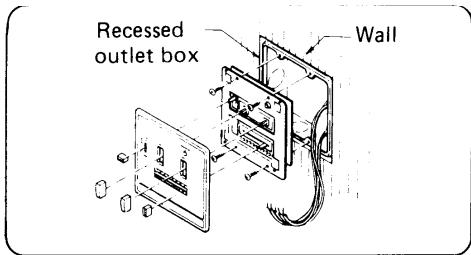


Fig. 18

3-5. Install Ceiling Panel: Fig. 19

- Screw the M5 x 35 small screws provided (in the ceiling panel packing) into four points on the flange face of the unit body which has been bolted to the back of ceiling. Screw in the small screws to an extent such that the distance between the bottom of the screw head and the bottom face of the flange is at least 3/4". (See figure below.)
- Next, lift the ceiling panel into position so that the small screws (four pcs) which were screwed onto the unit body pass through the keyhole-shaped openings in the panel, then shift the panel sideways until it is caught by the screws.
- Keeping the ceiling panel in this position, check to see if the joining patterns of the ceiling panes are in line with those of ceiling material. If they are not in line, remove the ceiling panel and finely adjust the suspension position of the unit body.
- Once the joining patterns are properly aligned with each other, screw-in the four small screws.

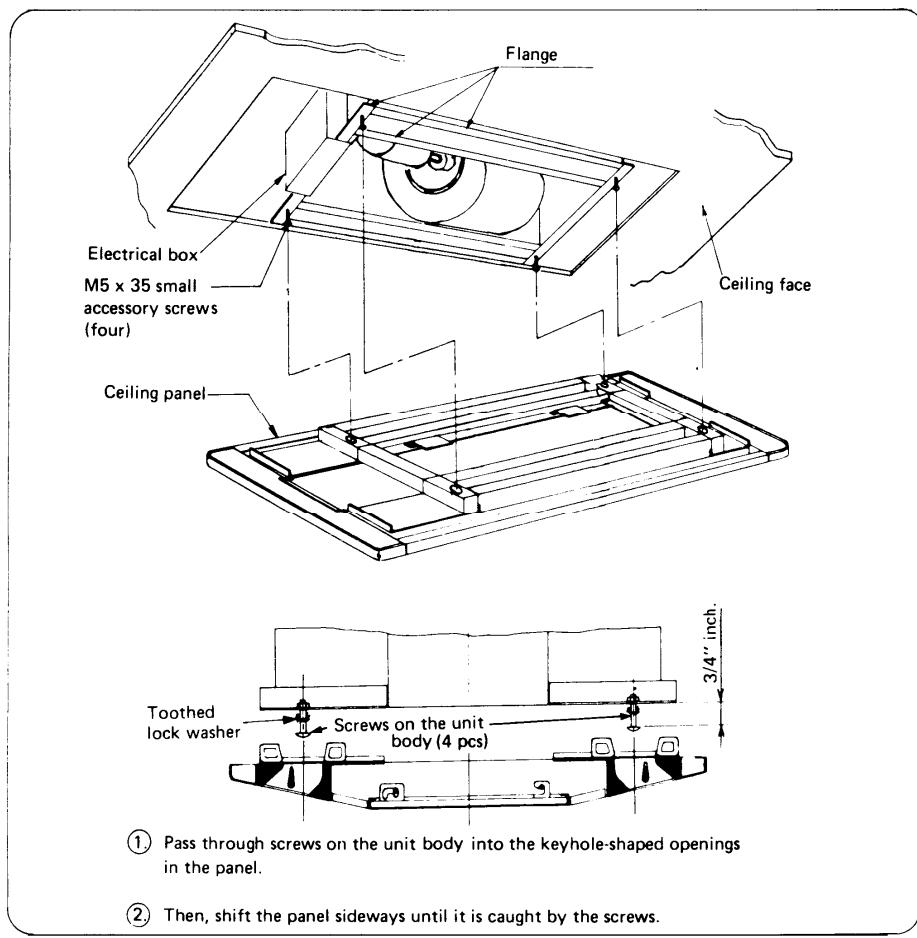


Fig. 19

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. 20
- Connect interunit power line and power supply line per drawing on inside of the panel "C". Fig. 21
- 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"

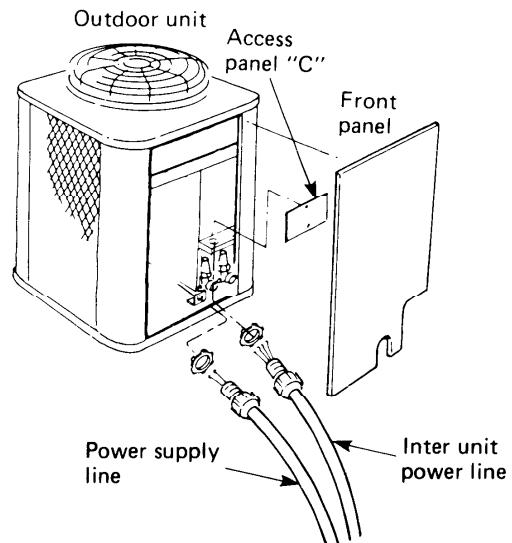


Fig. 20

WIRING SYSTEM DIAGRAM

SAP241RC

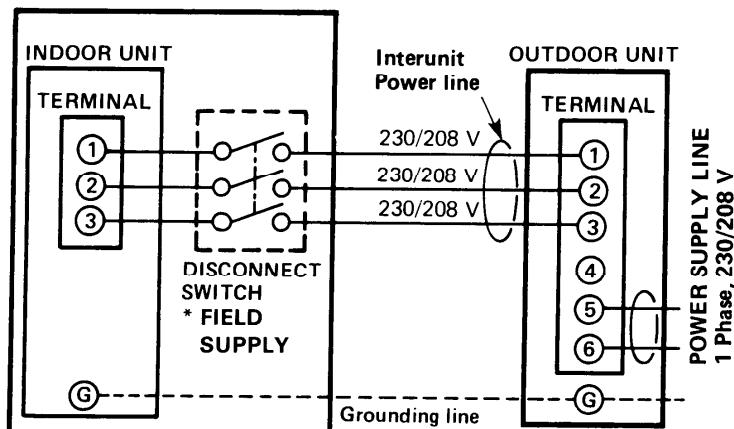


Fig. 21

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. 22

NOTE : When reaming, hold the copper tube end downward and be sure that no copper scraps fall into the tube. Fig. 23

- 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. 24 (*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.

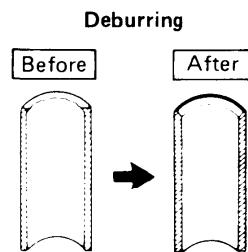


Fig. 22

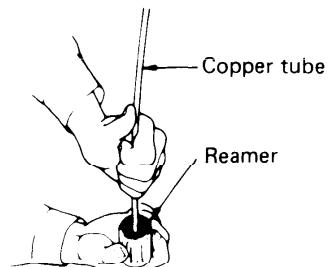


Fig. 23

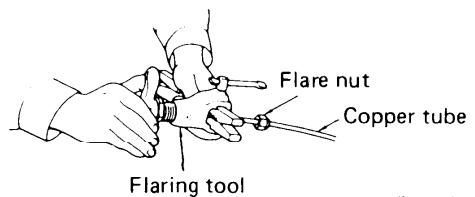


Fig. 24

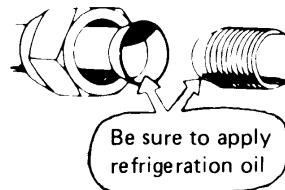


Fig. 25

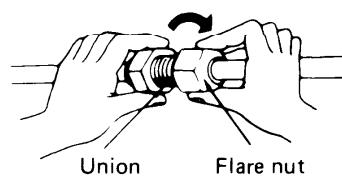


Fig. 26

5-3. Caution before Connecting Tubes Tightly

- a) Be sure to apply blind cap or water proof tape to prevent dust or water from getting into the copper tube , until it is used.
- b) Be sure to apply refrigeration oil to the matching surfaces of flare and union before connecting them together. This is effective for reducing gas leaks. Fig. 25
- c) For proper connection, hold the tube with union and the flared tube straight with each other, screw in the flare nut lightly at first to obtain smooth match. Fig. 26

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. 27
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. 28

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.

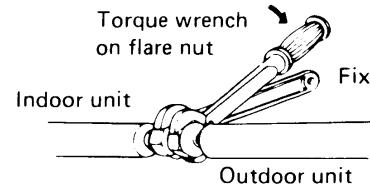


Fig. 27

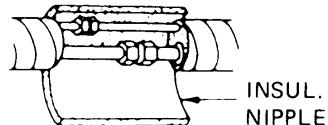


Fig. 28

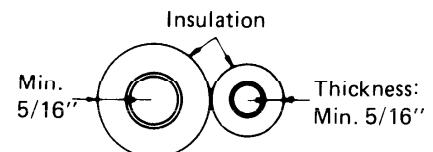


Fig. 29

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. 29

- **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. 30
- 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.

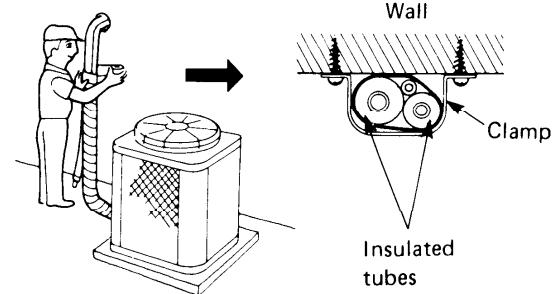


Fig. 30

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. 31

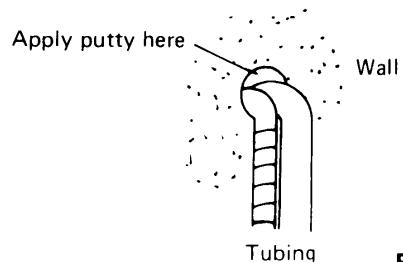


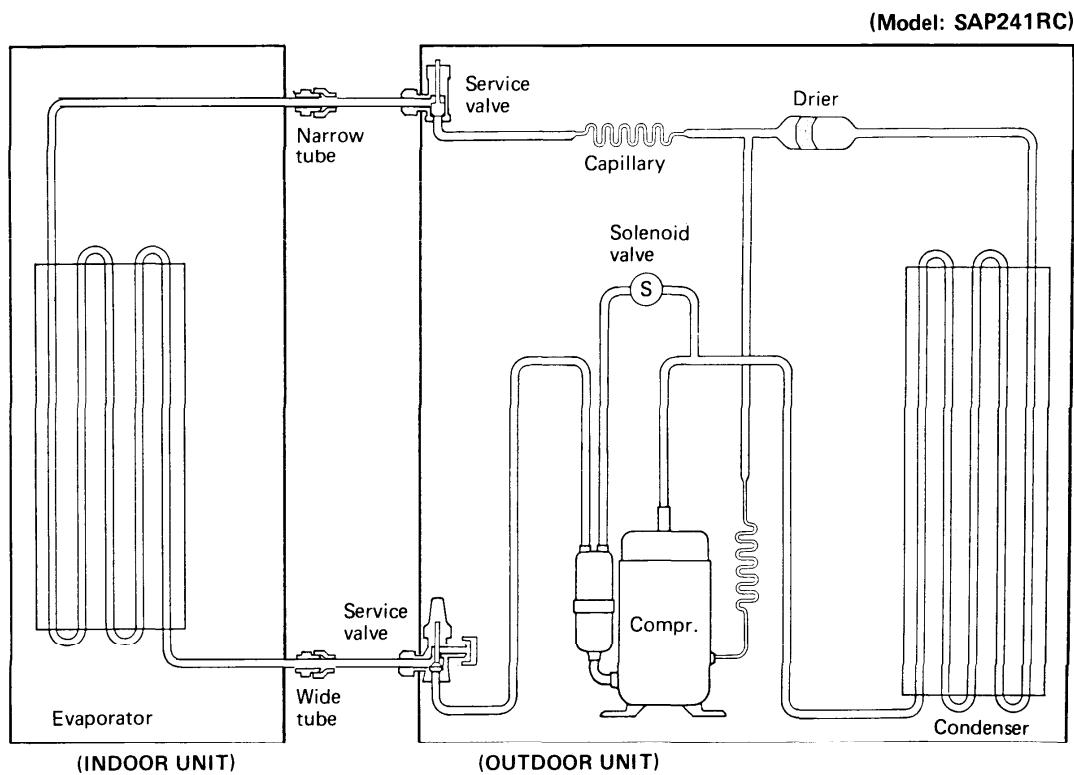
Fig. 31

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



*The solenoid valve is provided to keep the unit running in cool atmosphere. It opens to bypass refrigerant flow when the outdoor ambient temperature drops below 75°F, and closes at 78°F.

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. 32
- 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. 33
- 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. 34
- 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.

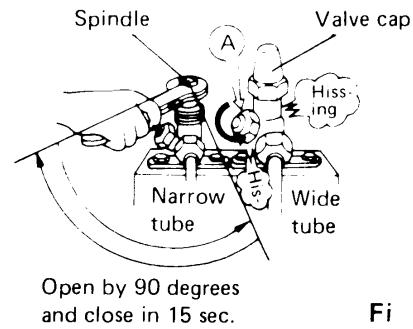


Fig. 32

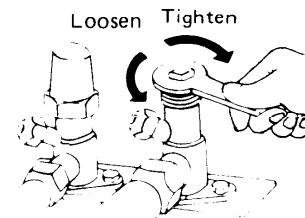


Fig. 33

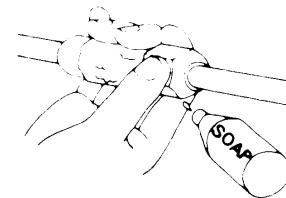


Fig. 34

■ 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. 35-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. 35-b)

- **Valve Position -c-**

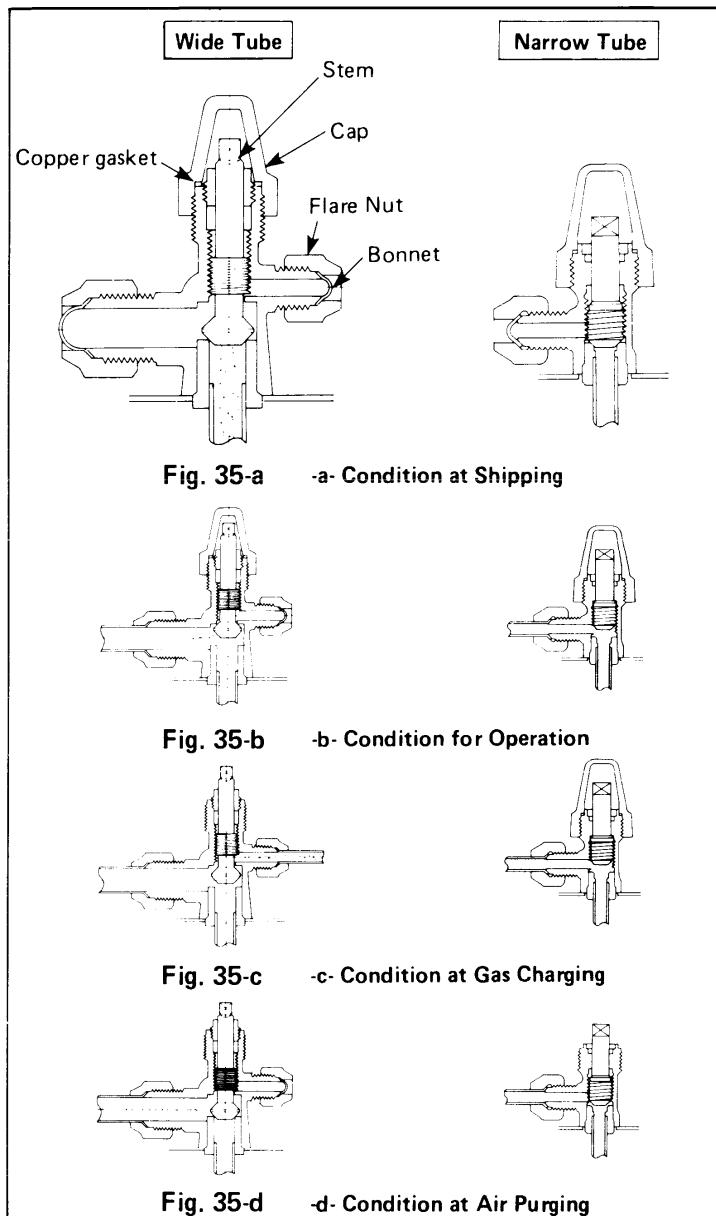
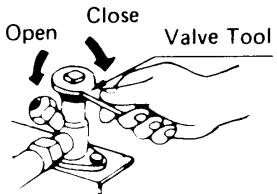
With the narrow tube valve kept at BACK SEAT, only the wide tube valve stem is turned halfway-down position. This position is used for pressure measurement and gas charging. (Fig. 35-c)

- **Valve Position -d-**

Like position -a-, but with the flare nut of wide tube open. This position is used for air purging. (Fig. 35-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.

- 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. 36

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. 37
- 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.

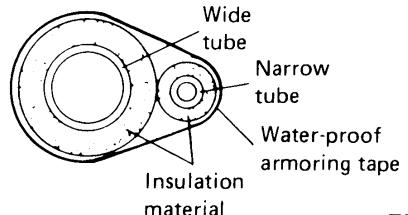


Fig. 36

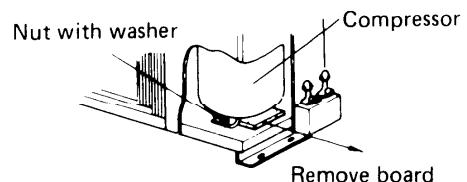


Fig. 37

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. 38
- b) Set the thermostat lever to the TEST RUN position. Fig. 39
- 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.)

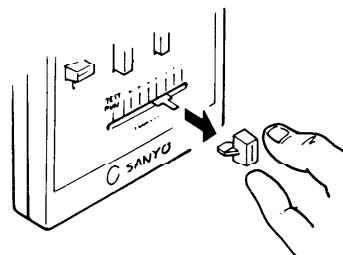


Fig. 38

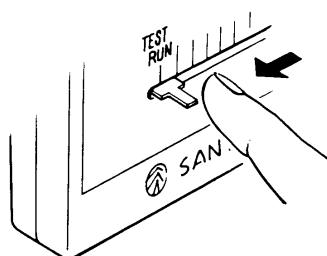


Fig. 39

7. TROUBLESHOOTING

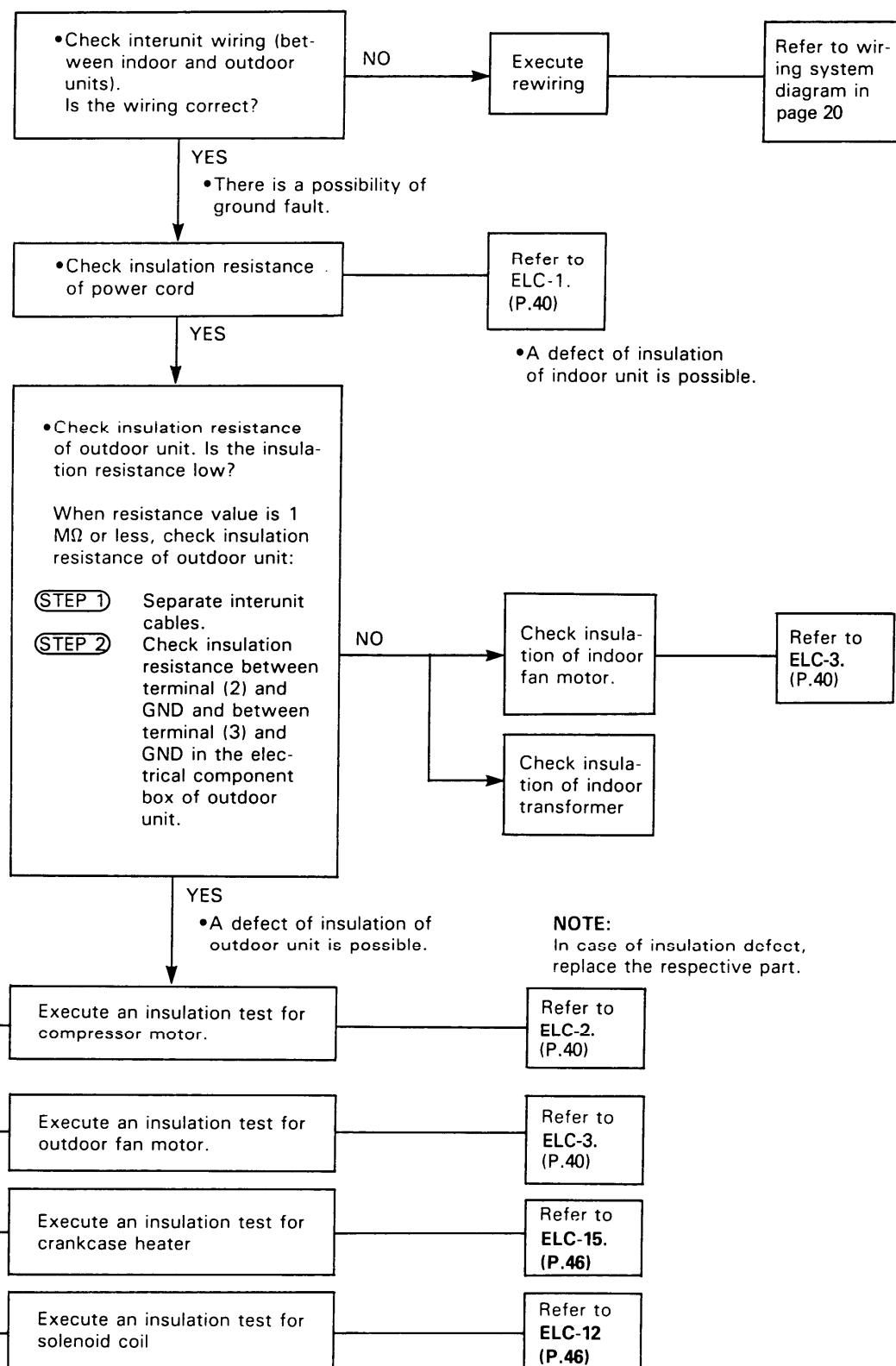
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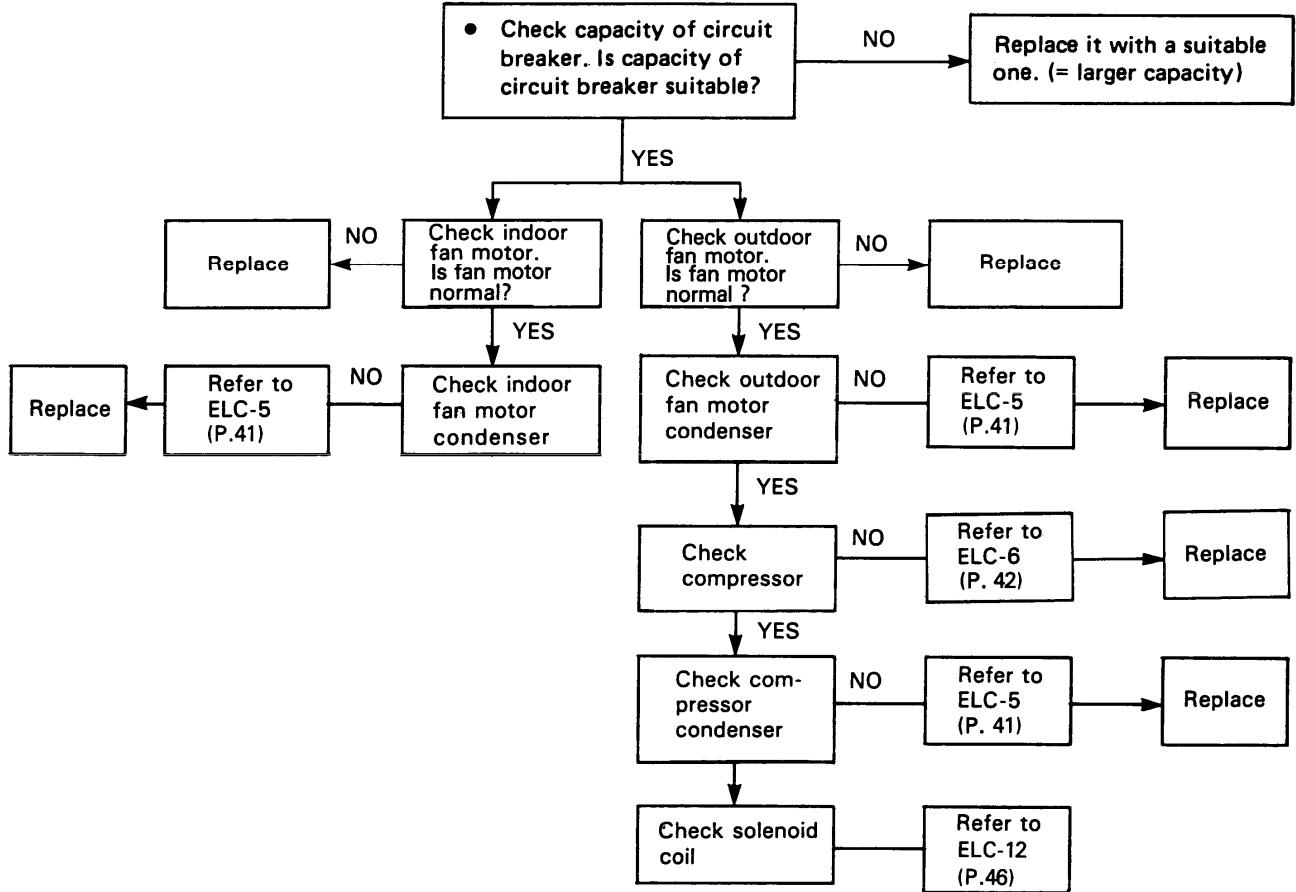
1. Air conditioner does not operate

1.1 Circuit breaker trips (or fuse blows)

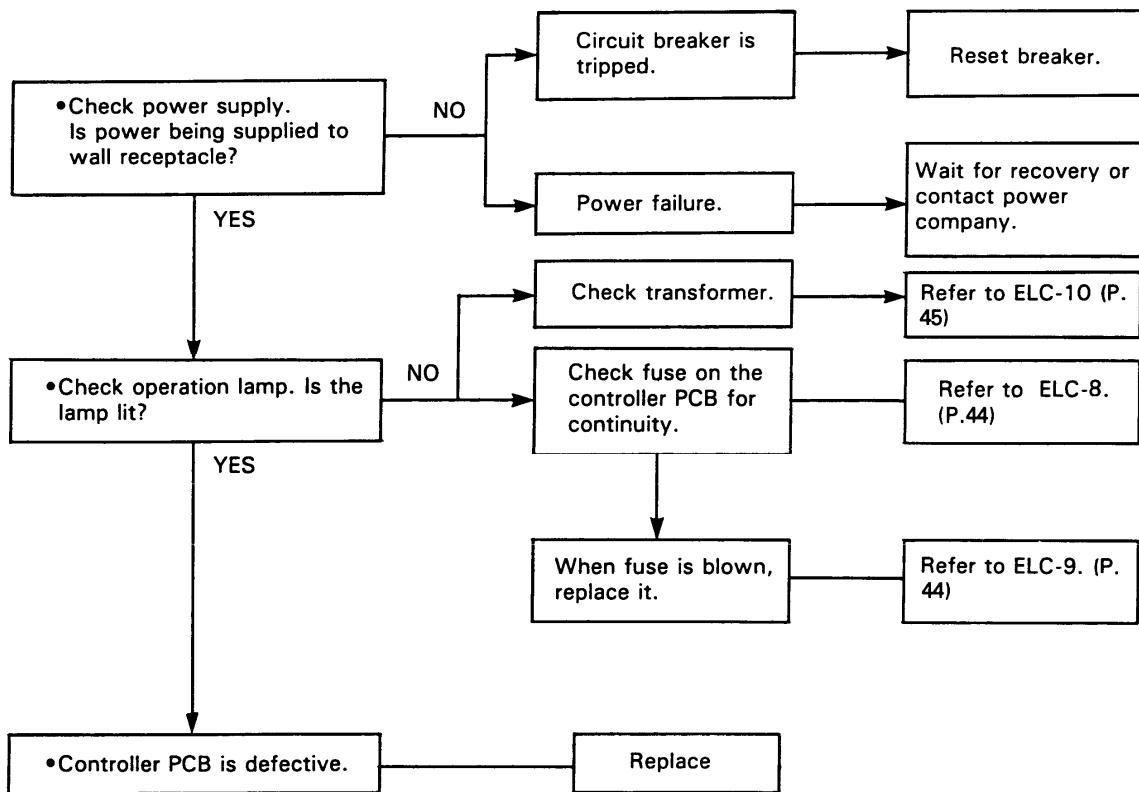
1.1.1 When circuit breaker is set to ON, it trips soon
(resetting is not possible)



1.1.2 Circuit breaker trips when the operation switch is depressed.

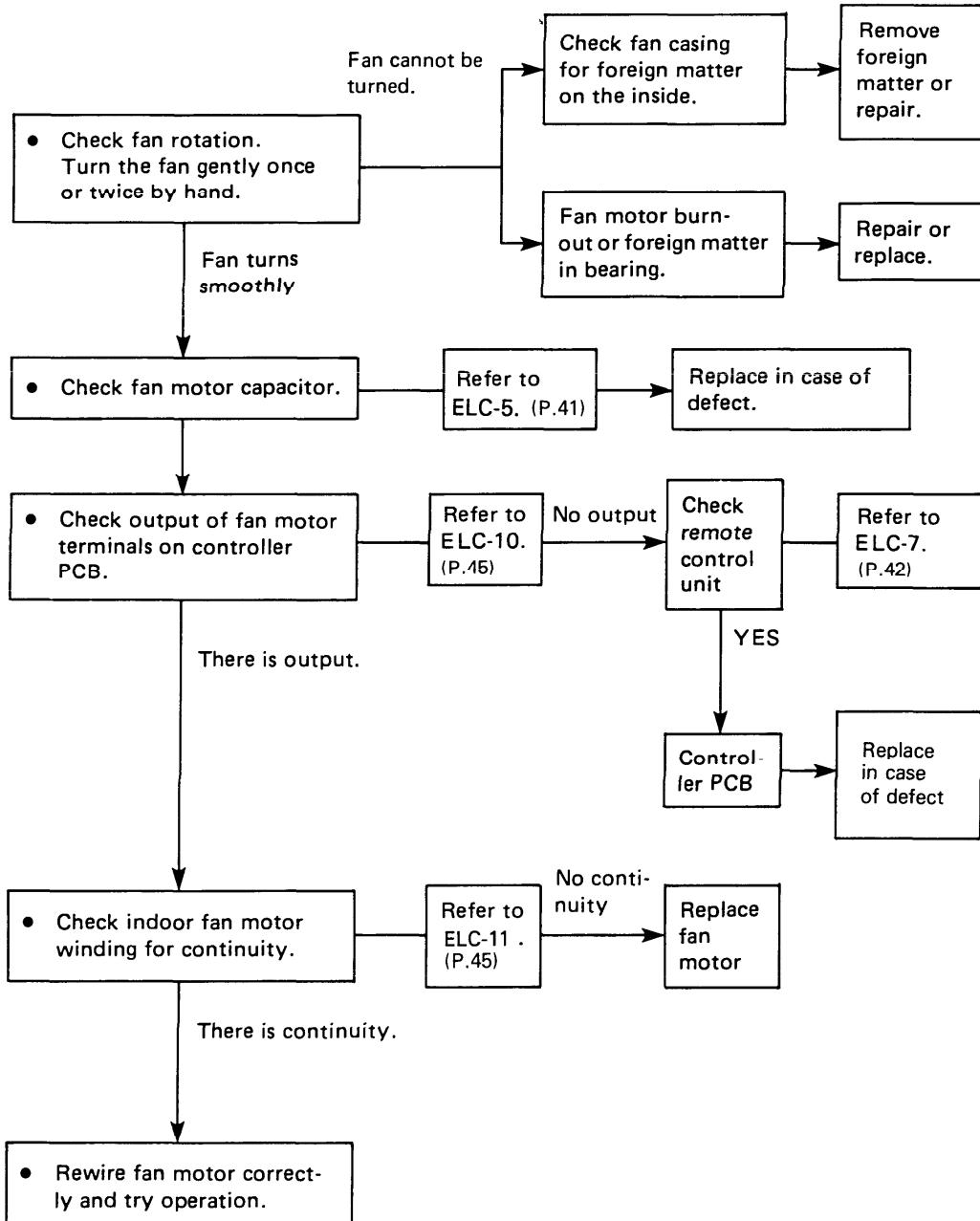


1.2 Neither indoor unit nor outdoor unit runs



2. Some part of air conditioner does not operate

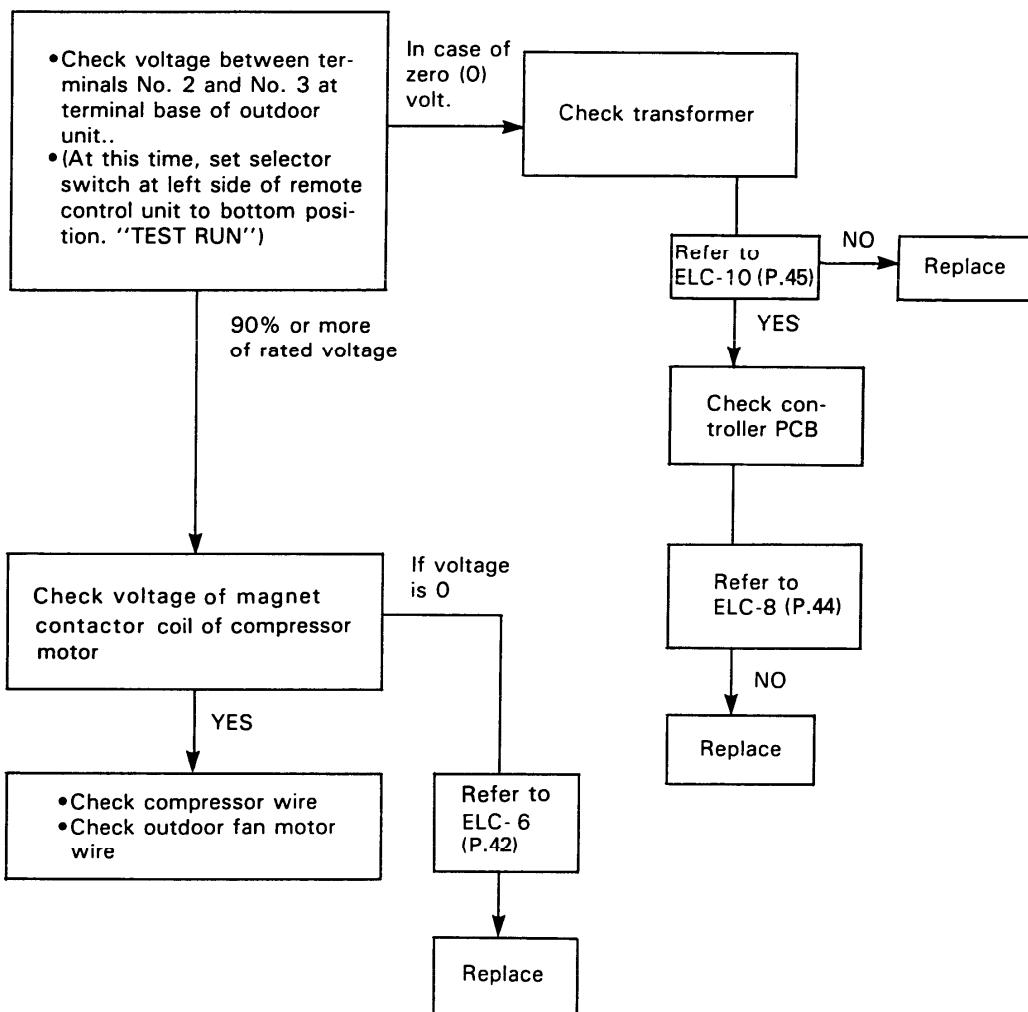
2.1 Indoor fan does not run



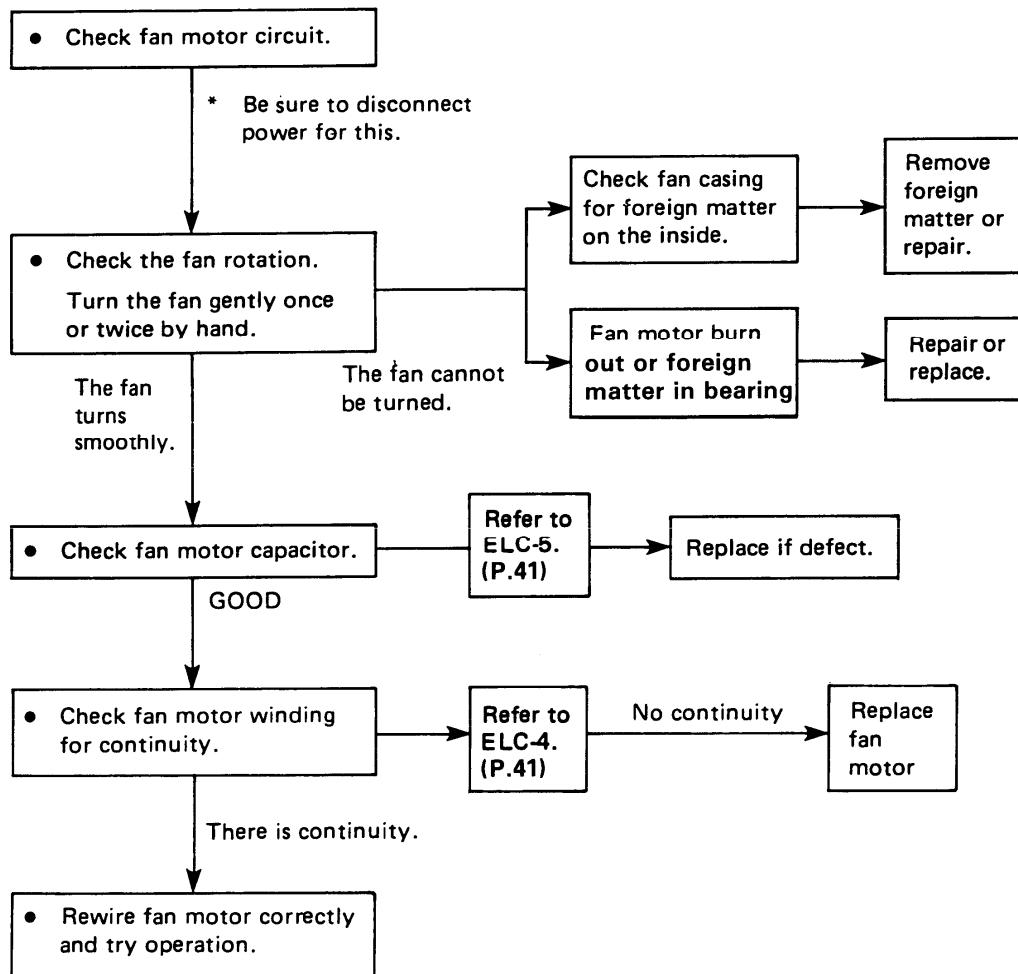
2.2 Neither outdoor fan nor compressor runs

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.)

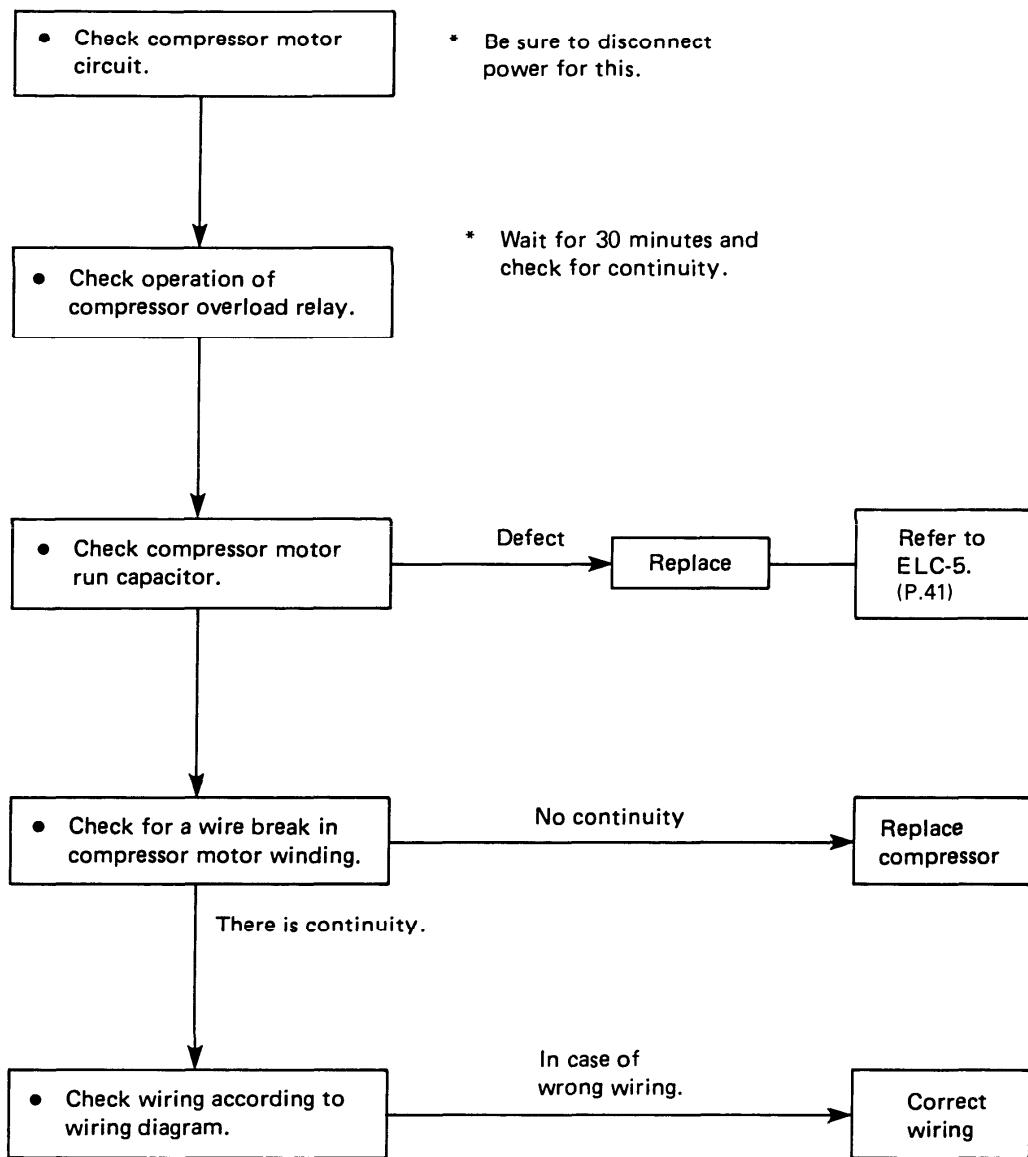


2.3 Only outdoor fan does not run



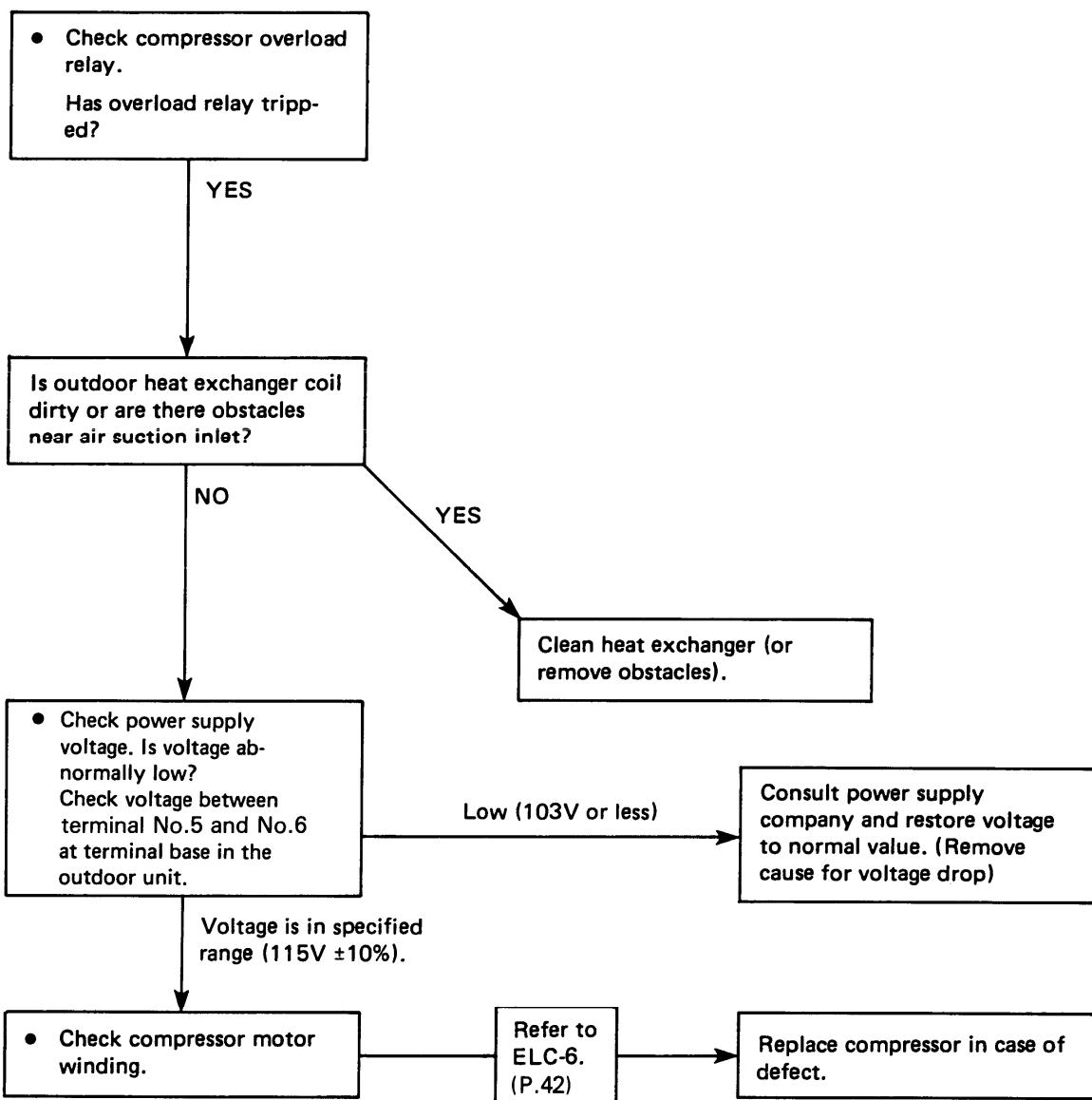
NOTE: The fan motor does not run until the winding temperature lowers and automatic resetting works if the internal thermostat operates.

2.4 Only compressor does not run



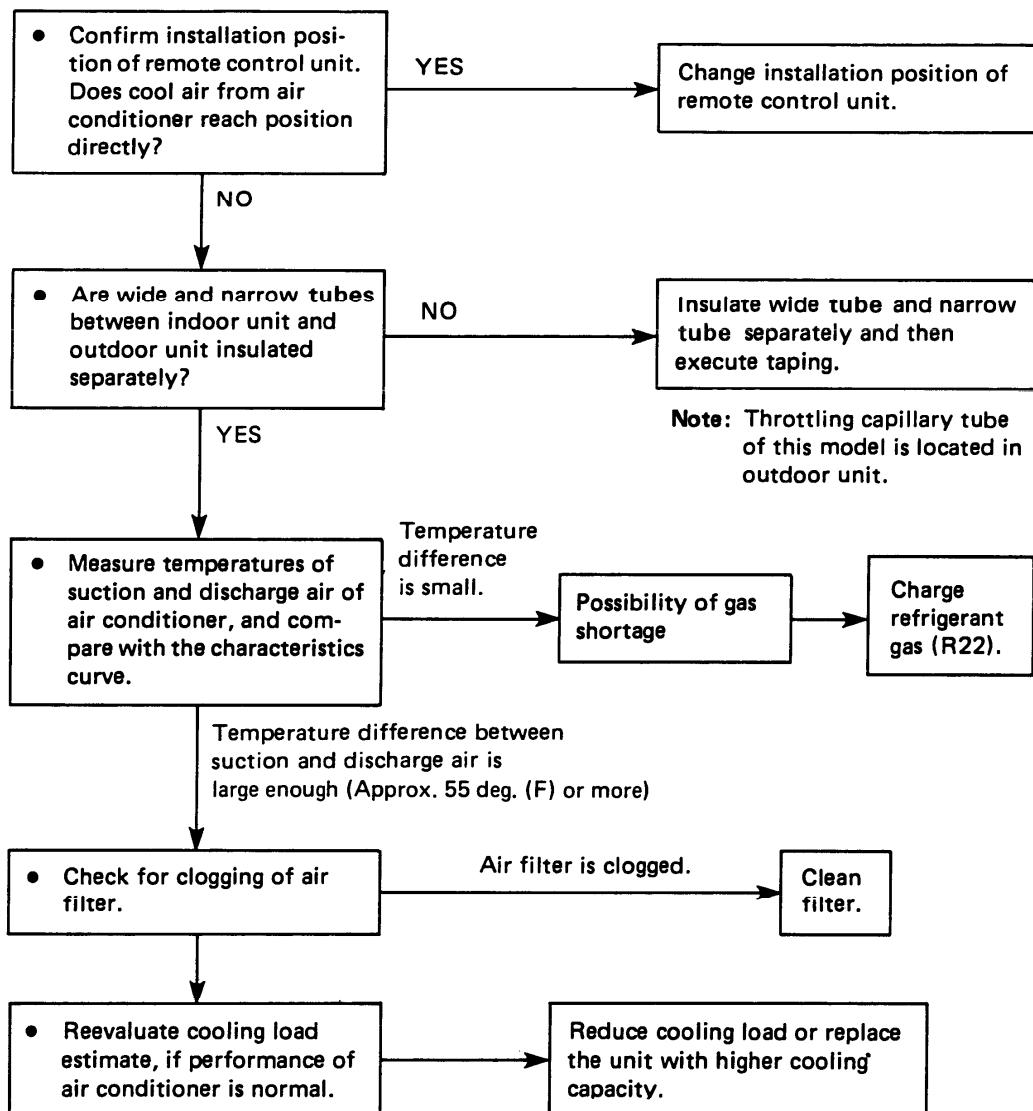
2.5 Compressor frequently repeats ON and OFF

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

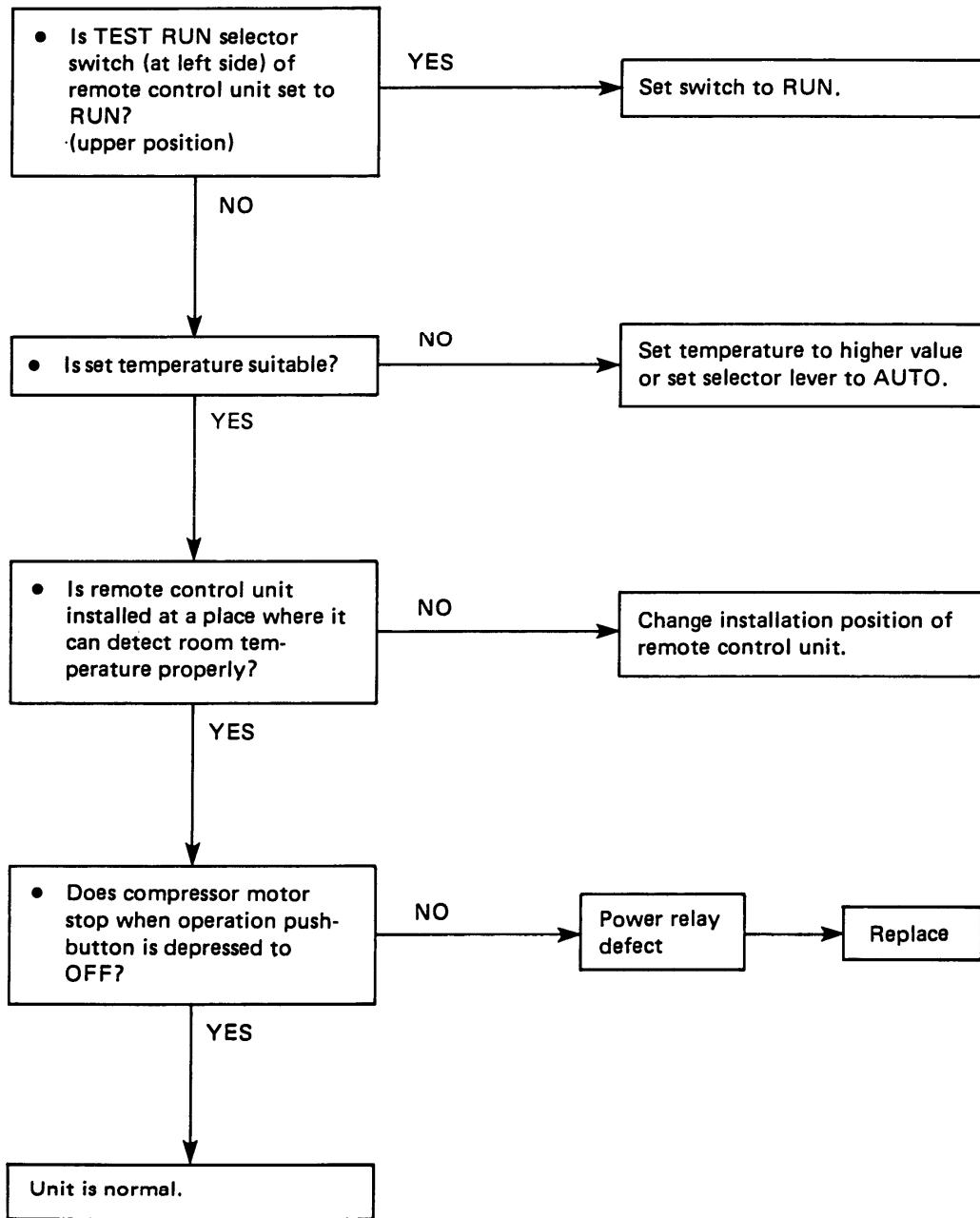


3. Air conditioner operates, but abnormalities are observed

3.1 Poor cooling



3.2 Excessive cooling



8. CHECKING AND REPLACING ELECTRICAL COMPONENTS

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E1A. Connector Identification on Controller PCB

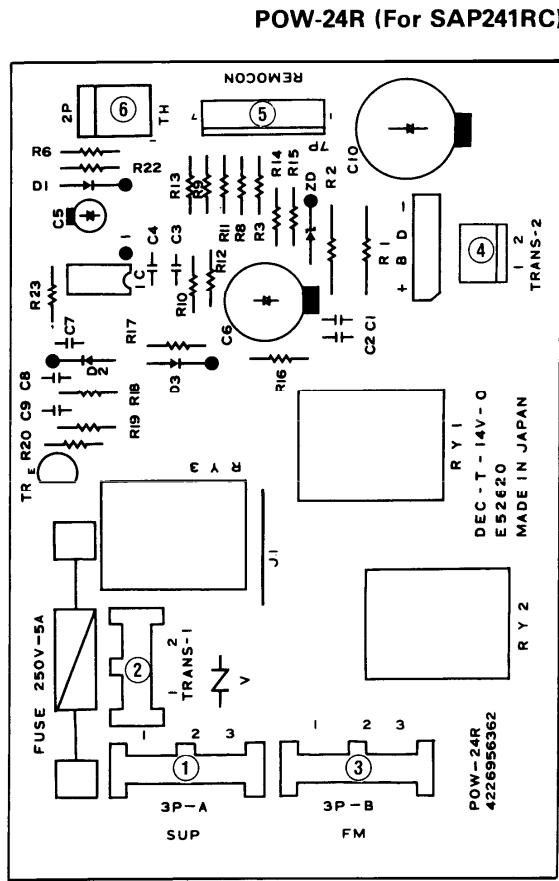


Fig. E-A

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

* 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 (P39, 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.

3.3. Crankcase heater

Disjoin and check both ends of the crankcase heater

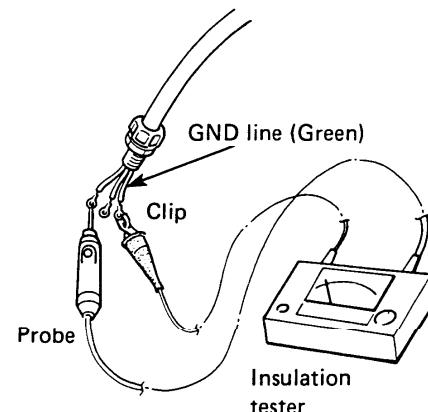


Fig. E-1

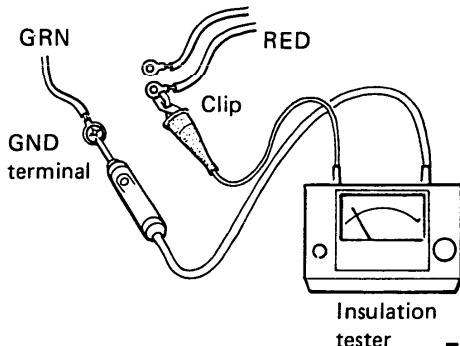


Fig. E-2

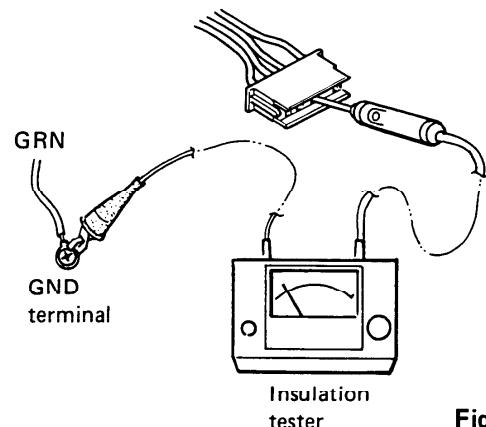


Fig. E-3

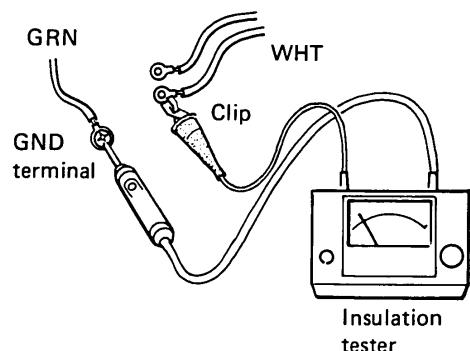


Fig. E-4

ELC-4. Checking of the Outdoor Fan Motor

Remove the fan motor lead wires (WHT, BRN, PNK) and check 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

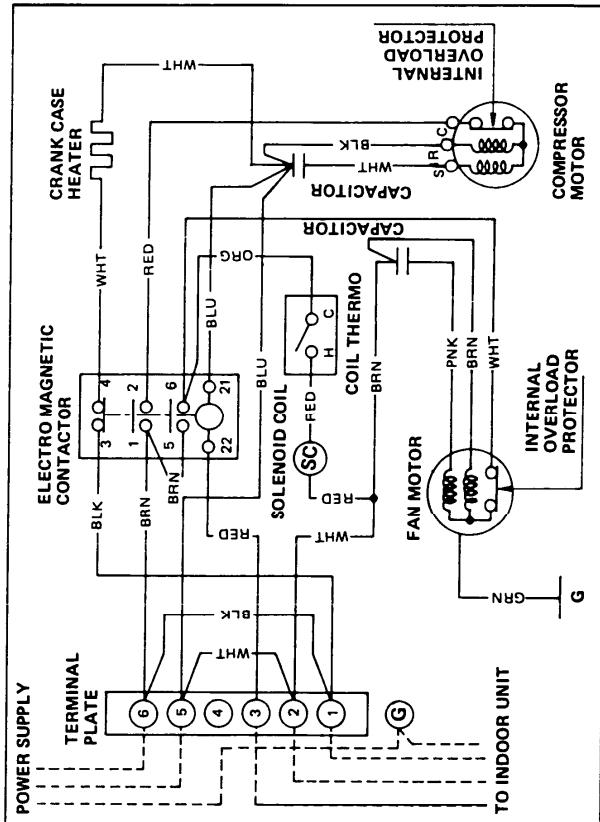


Fig. E-5

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.

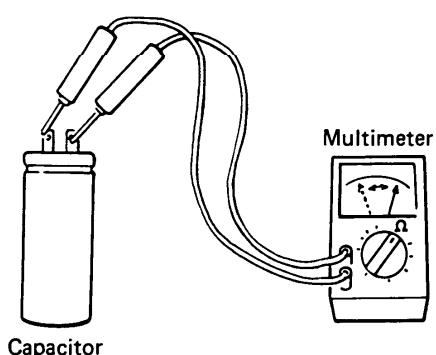


Fig. E-6

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

Leadwire 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 Remote 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.)

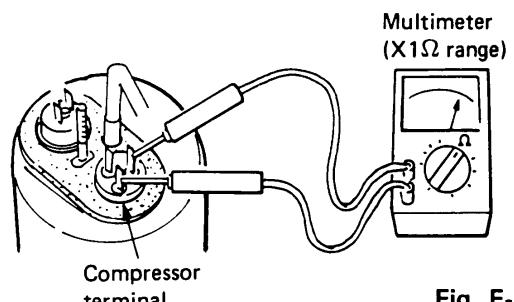


Fig. E-7

1. REMOTE CONTROL UNIT

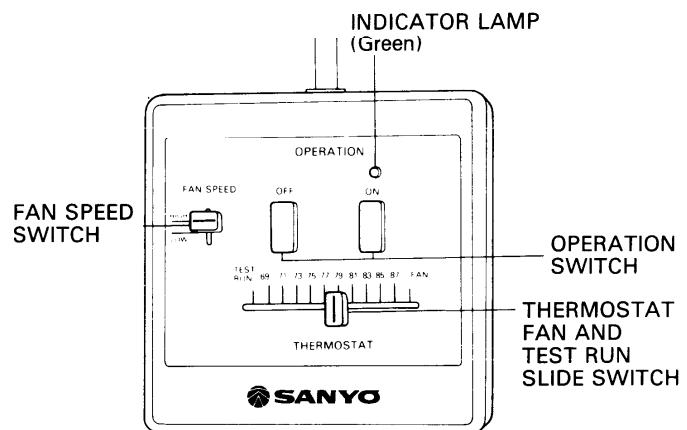


Fig. E-7A

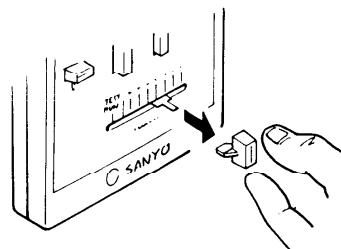


Fig. E-8

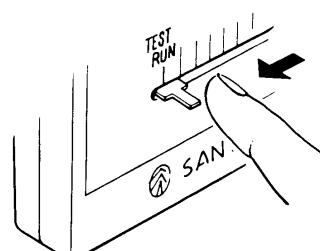


Fig. E-9

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).

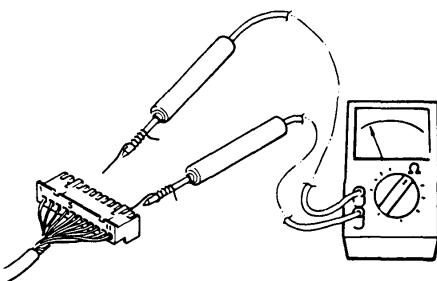


Fig. E-10

(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	YES

(Table-3)

NOTE: YES Continuity
NO Discontinuity

(2) 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.

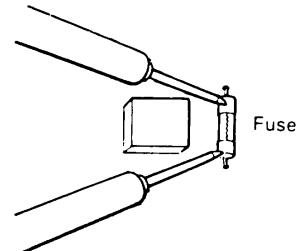


Fig. E-11

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.

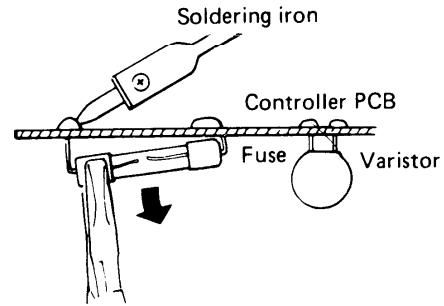


Fig. E-12

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-4.

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

(Table-4)

NOTE: Ambient room temp 70°F

SAP241R ELECTRIC WIRING DIAGRAM

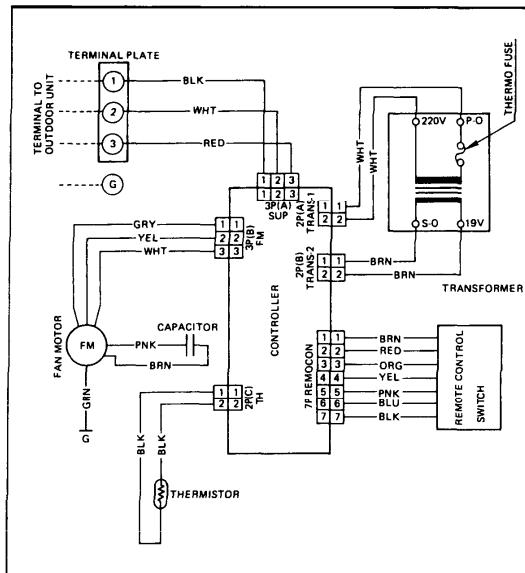


Fig. E-13

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-5.

Lead wires	Value of resistance
WHT-BRN	About 56 Ω
WHT-YEL	About 54 Ω
WHT-PNK	About 75 Ω

(Table-5)

Note: Ambient room temp. 68°F

ELC-12. 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-13. 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 follows. (Table 6)

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

(Table 6)

ELC-14. 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-15. 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.

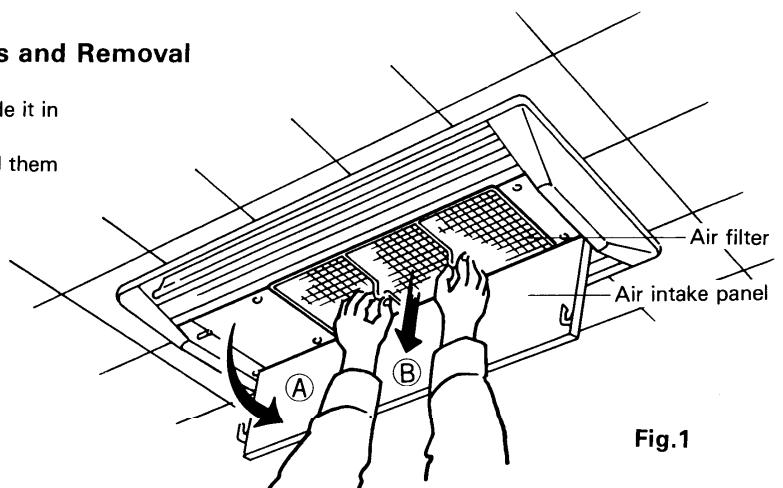
9. DISASSEMBLY AND SERVICE PROCEDURES

—Quick and Index—

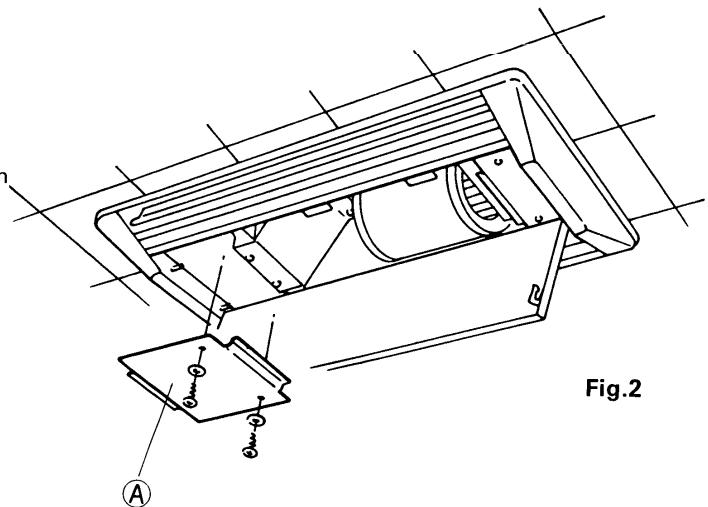
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[INDOOR UNIT]
9-1 Electrical Component Box — Access and Removal

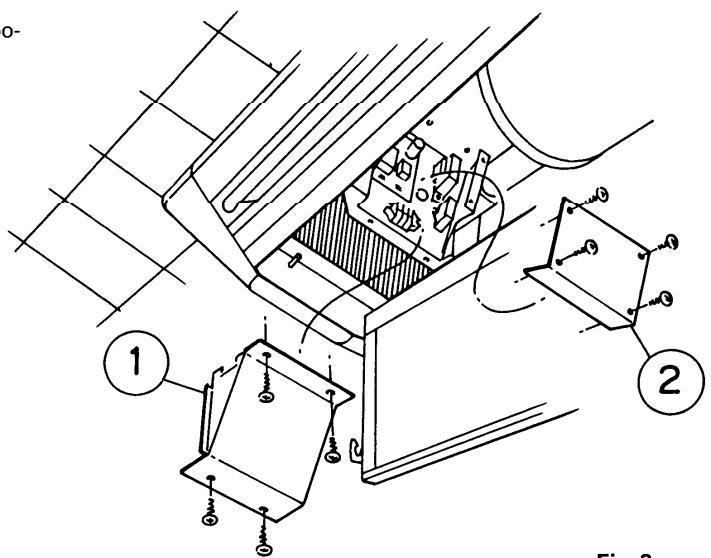
- ① Lift the air intake panel slightly upward and then slide it in the direction shown by arrow (A).
- ② To remove the air filter, grasp the filter tabs and pull them downwards (arrow (B)). Fig.1


Fig.1

- ③ The electrical component box becomes accessible when the cover (A) (black color) is removed. Fig.2


Fig.2

- ④ Remove the cover plates ① and ② of the electrical component box. Fig.3


Fig.3

- ⑤ The electrical components can be checked in this condition.
- ⑥ For removal of the electrical component box, remove the four screws shown by the arrows. (A) Fig.4.

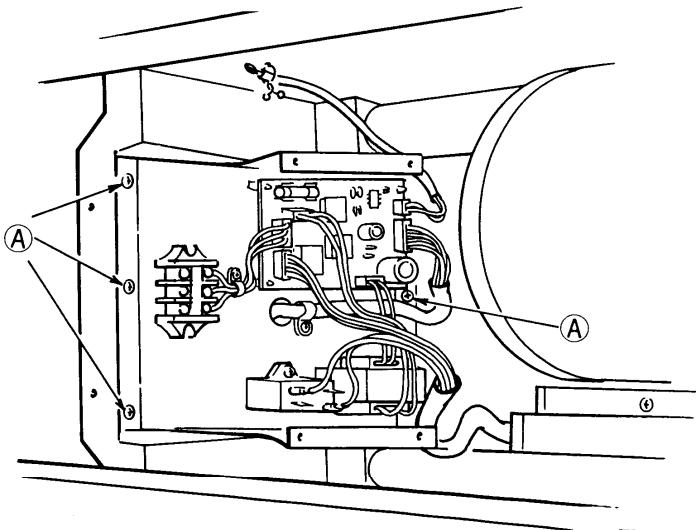


Fig.4

[CAUTION]

Do not use excessive force for removal of connector sockets or lead wires.

9-2 Ceiling Panel — Removal

- ① Loosen the four screws (C) (black color).
- ② The ceiling panel screw heads have a special shape as shown in the figure.
Slide the entire ceiling panel to the side. The ceiling panel can be removed when the screw heads have moved from (A) to (B). Fig 5.

[CAUTION]

Support the ceiling panel at the time of removal, so that it will not drop down.

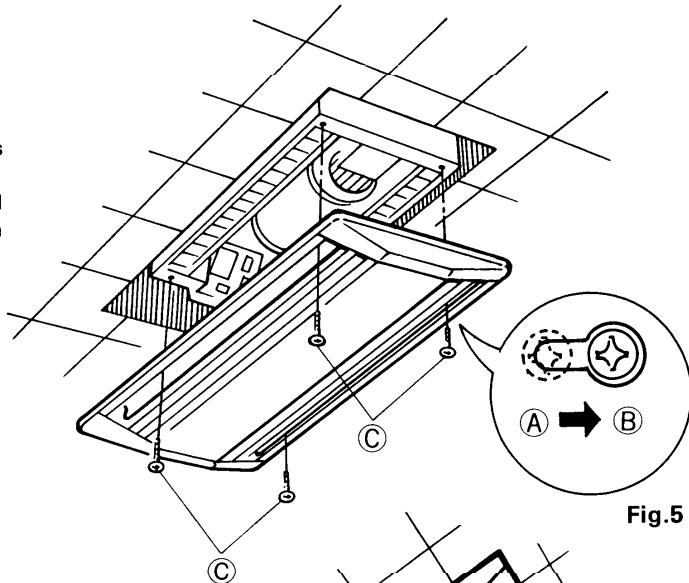


Fig.5

9-3 Fan and Fan Motor — Removal

- ① Remove the cover (A), (B), and (C). Fig. 6

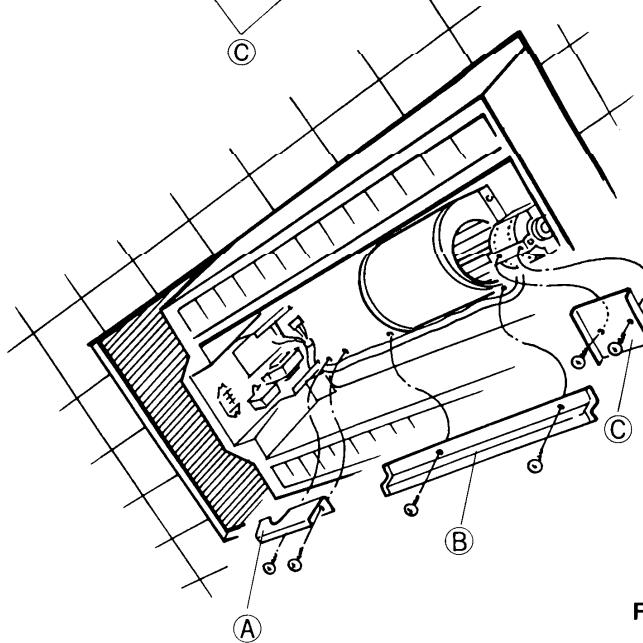
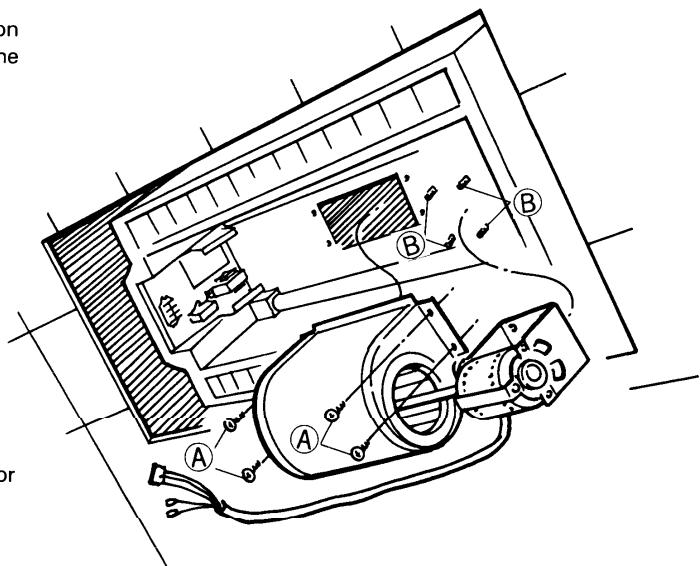
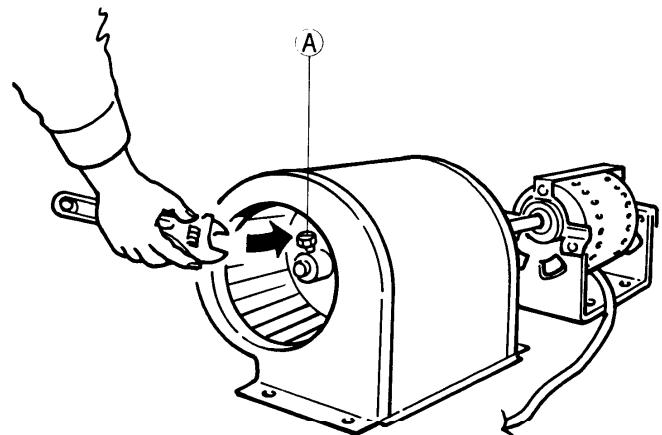


Fig. 6

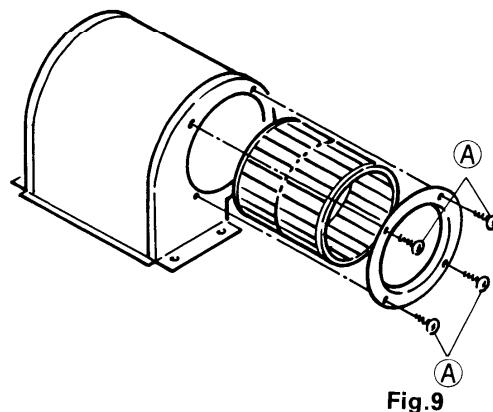
- ② Remove the four screws (A) fixing the fan casing.
 ③ When the four nuts (B) fixing the fan motor installation base are removed, removal is possible as shown in the figure. Fig. 7.


Fig.7

- ④ Loosen the bolt (A) fixing the fan boss on the motor shaft.
 ⑤ Pull the motor shaft from the fan. Fig.8.


Fig.8

- ⑥ When the four screws (A) around the nozzle circumference are removed as shown in the figure, the fan can be removed. Fig.9


Fig.9

- ⑦ When the four screws (A) are removed as shown in the figure, the fan motor can be removed. Fig. 10.

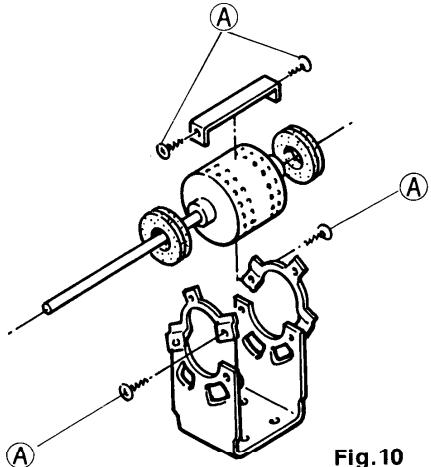


Fig.10

9-4 Control Switch Unit — Removal

- ① Remove the two knobs ①.
- ② When the screwdriver ② is inserted for about 1/8" into the notch of the control name plate ③ and raised to the front, the name plate can be removed.

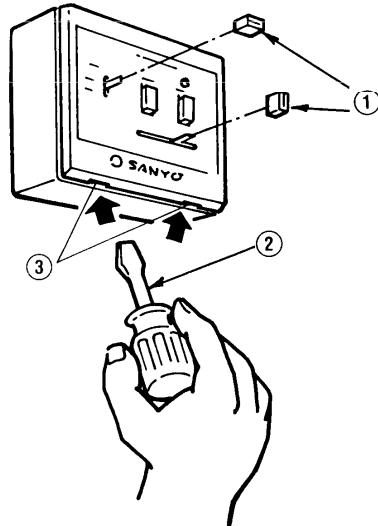


Fig. 11

- ③ When the four screws ④ are removed, the cover plate ⑧ and the control switch PCB assembly ⑤ can be separated from the box.
- The control switch unit can be checked in this condition.
- ④ For removal of the control switch PCB assembly ⑤, removed the connection of the lead wires ⑥ and remove the four screws ⑦. Fig.12.

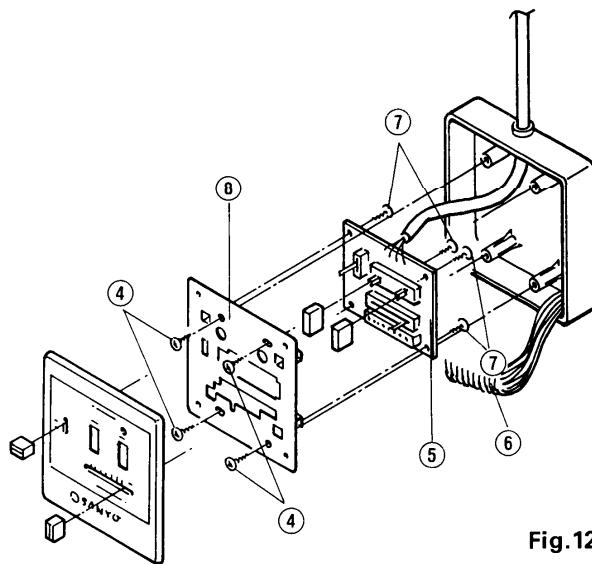


Fig.12

OUTDOOR UNIT

9-5 Cabinet-Removal

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

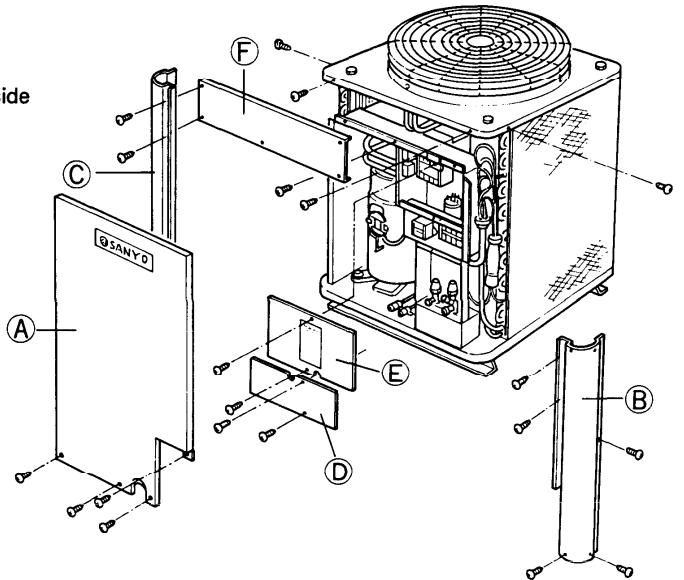


Fig.13

9-6 Fan and Fan Motor — Removal

- ① Remove the guard (A) first, and then remove the bolts (a) of the propeller fan (B) to remove the propeller fan by lifting it up.
- ② Remove the fan motor wire from the electrical component box, and remove the top cover (C) with the fan motor fixed to the top cover. Fig. 14.

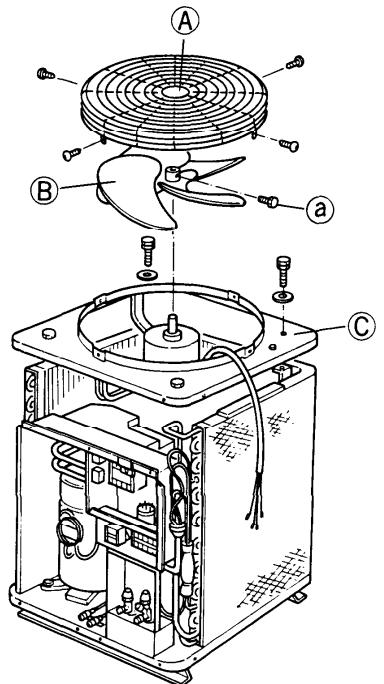


Fig.14

9-7 Electrical Component Box — Removal

- ① Remove 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 fixed sensor (B).
 - (2) Remove the insulation (C), loosen the fitting fixing the sensor (D), and remove it.
- ③ When the above work has been completed, the electrical component box can be removed by removing the screw (E).
- ④ Loosen the screw (H) of the mounting plate (F) fixing the solenoid valve, and remove the cover (G). Fig. 15

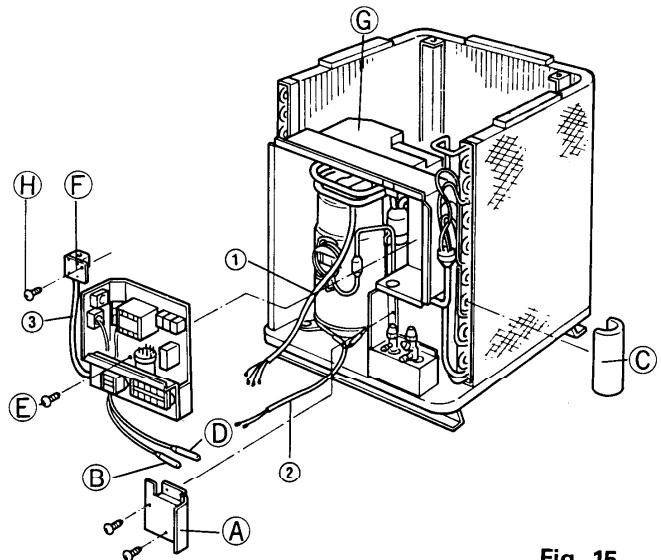


Fig. 15

9-8 Compressor Cover — Removal

- ① Remove the four screws ① fixing the cover (B) and lift the cover (B) to remove it. Fig. 16

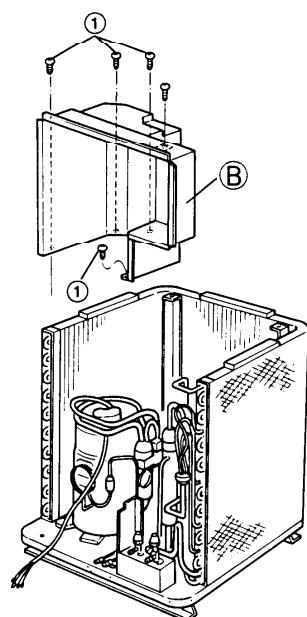


Fig. 16

9-9 Compressor — Removal

- ① Use an oxyacetylene torch to cut the four places (A), (B), (C), and (D) where the tubing is welded to the compressor.
- ② Remove the three nuts (E) fixing the compressor, and raise the compressor to remove it. Fig. 17

[CAUTION]

As there are many places where wires must be removed, execute removal after checking against the electric diagram attached on the rear of the cover plate (E) (Fig. 13), and also refer to this electric diagram for reconnection after compressor exchange.

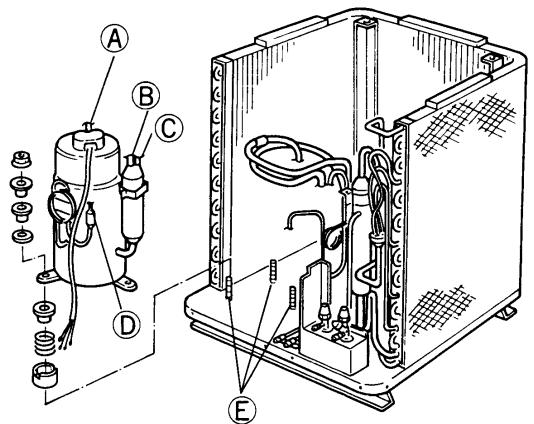


Fig. 17

- ③ For the new service compressor, tubes are attached at the three points (A), (B) and (C) to prevent entry of dirt and moisture. At the time of exchange, connect the unit tubing after removing these tubes. Fig. 18

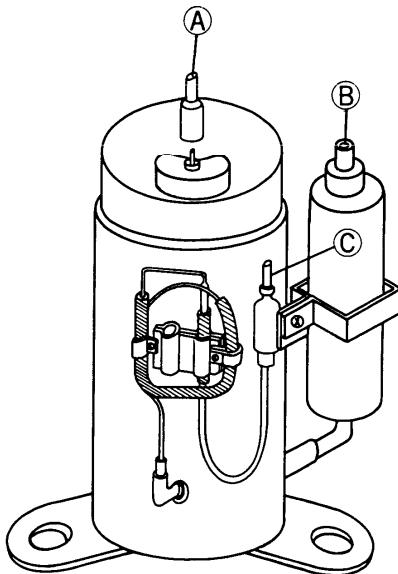


Fig. 18

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, never locate face or any other parts of the human body in direct line with the tubing 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 overload relay and the compressor terminal. Fig. 20.
- 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 unbraze 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. 19 shows unbrazing points with arrows.

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

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

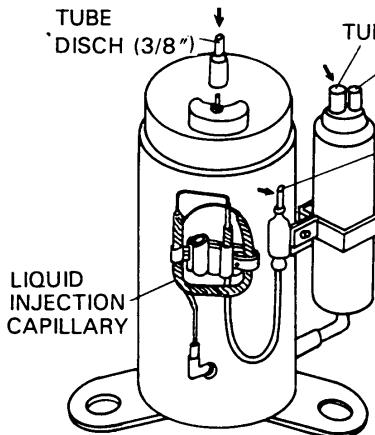


Fig. 19

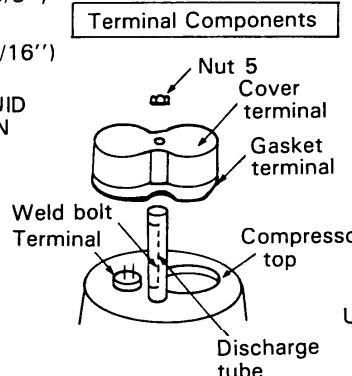


Fig. 20

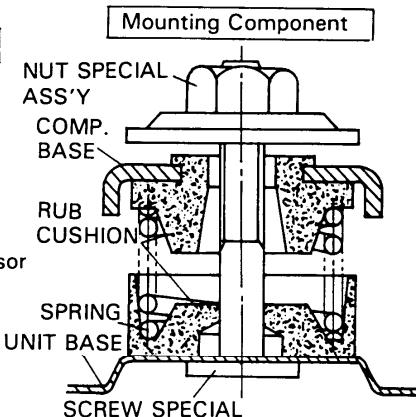


Fig. 21

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, unbrazing 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. System Leak Test at the Service Site

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. 22.

1) Prepare the system analyzer valve set and connect charging hoses as in Fig. 23. Be sure to close all valves before connection. (Refer to page 25, Fig. 35-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. 24)

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 25 in regard to the operation method for the service valve **V7**.

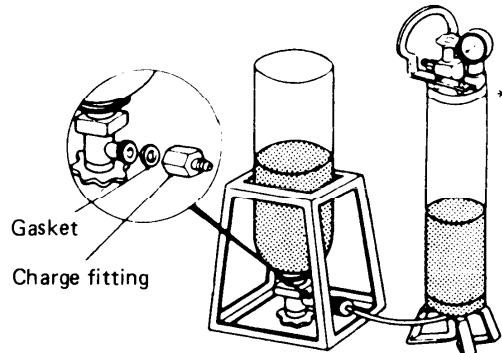


Fig. 22

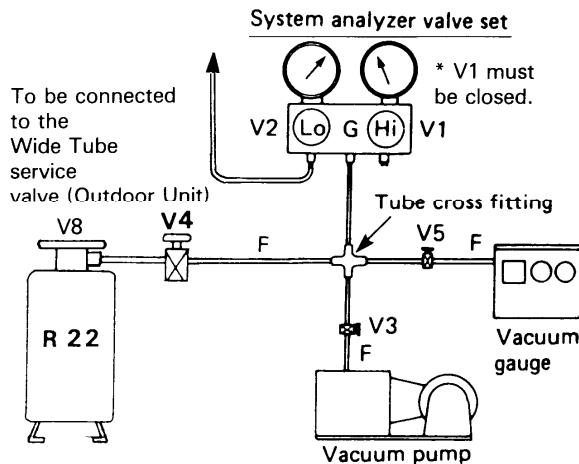


Fig. 23

9-11-3. Evacuation

- 1) Connect instrument as in Fig. 24.
 - 2) Confirm that all connections are made correctly and check all valves are closed. * **V6** and **V7** should be fully opened. (Refer to page 25, Fig. 35-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. 25)
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.

NOTE:

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

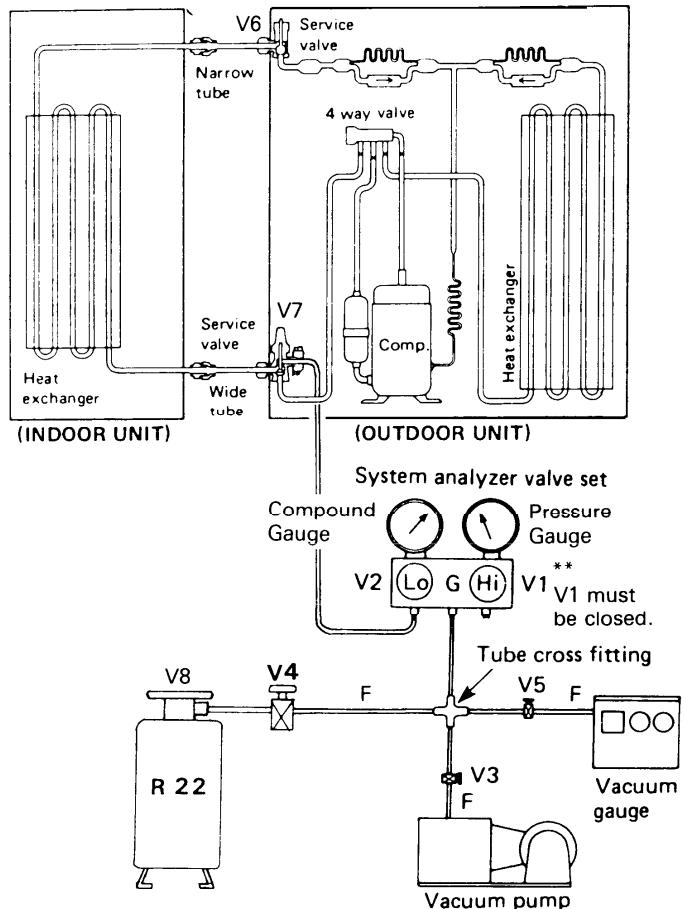


Fig.24

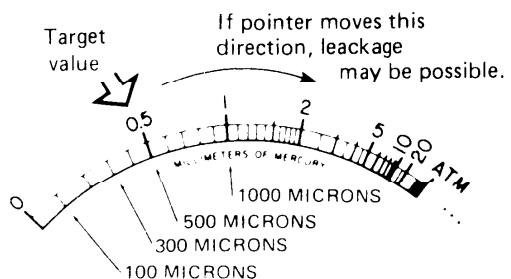


Fig.25

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. 26.

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 memories 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 25, fig. 35-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 25, Fig. 35-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.

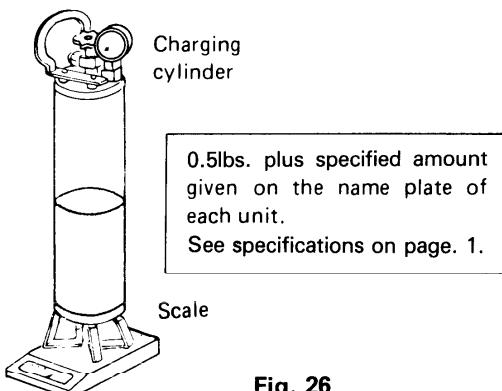
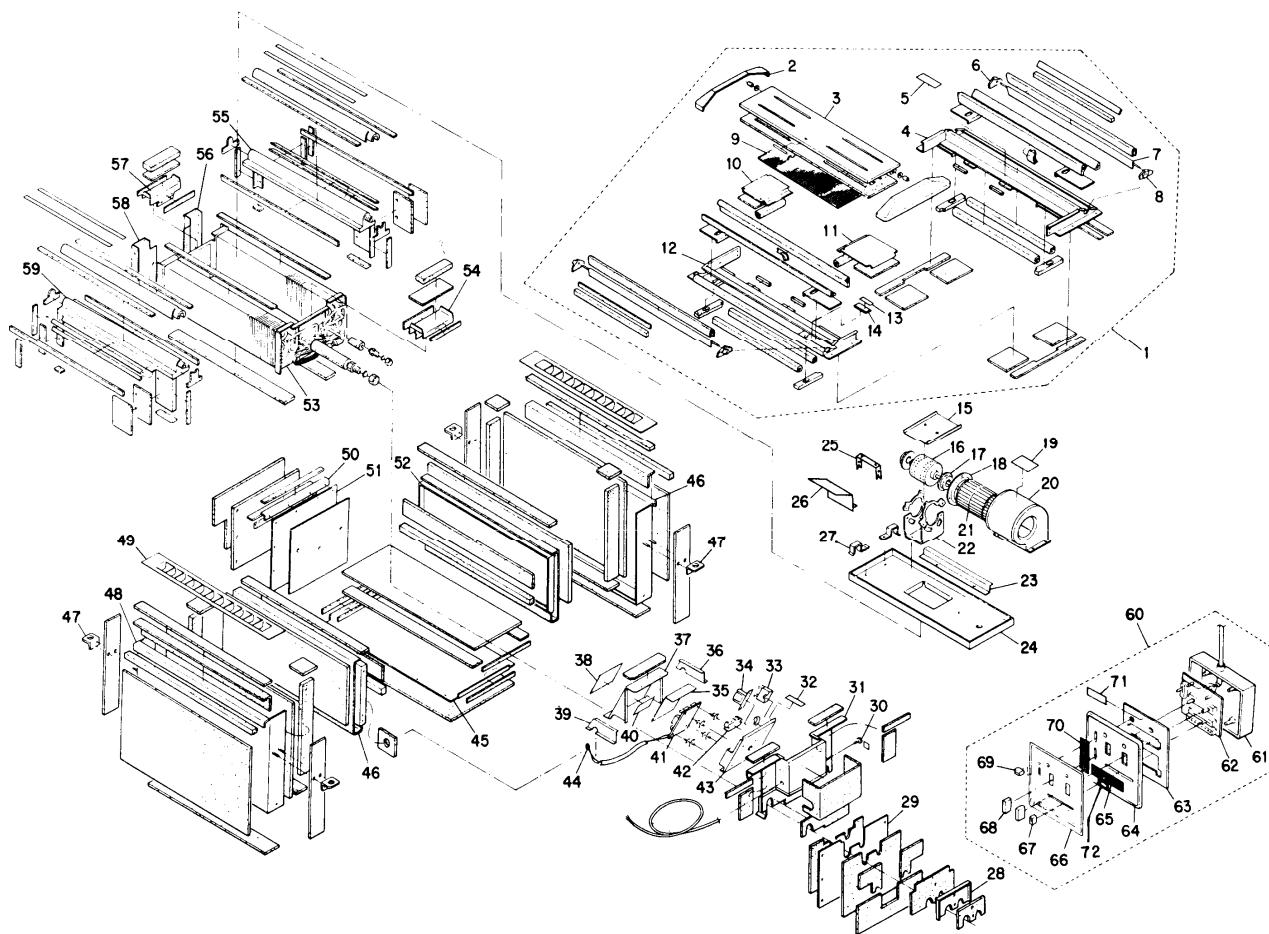


Fig. 26

MEMO

10. PARTS LIST



■ Accessory Parts List

LIST OF PACKAGED PARTS

Description	Shape	Q'ty	Remarks	Description	Shape	Q'ty	Remarks
PVC elbow		1	854-2-2334-12300	Flanged hex nut		4	854-0-1355-10201
PVC T-fitting		1	854-2-2334-12200	Special washer		4	854-2-1355-13101
PVC pipe		4	854-2-2334-12400	Remote control unit		1	859-2-1463
PVC socket		2	854-2-2334-12100				
Pan-head screw	5x40mm	4	3-9231-54003	Read wire for remote control unit		1	851-0-5292-14600
Countersunk-head wood screw	3.1x13mm	2	3-9261-21301				
Drain Hose adaptor		1	854-2-2334-13600				

ATTENTION !

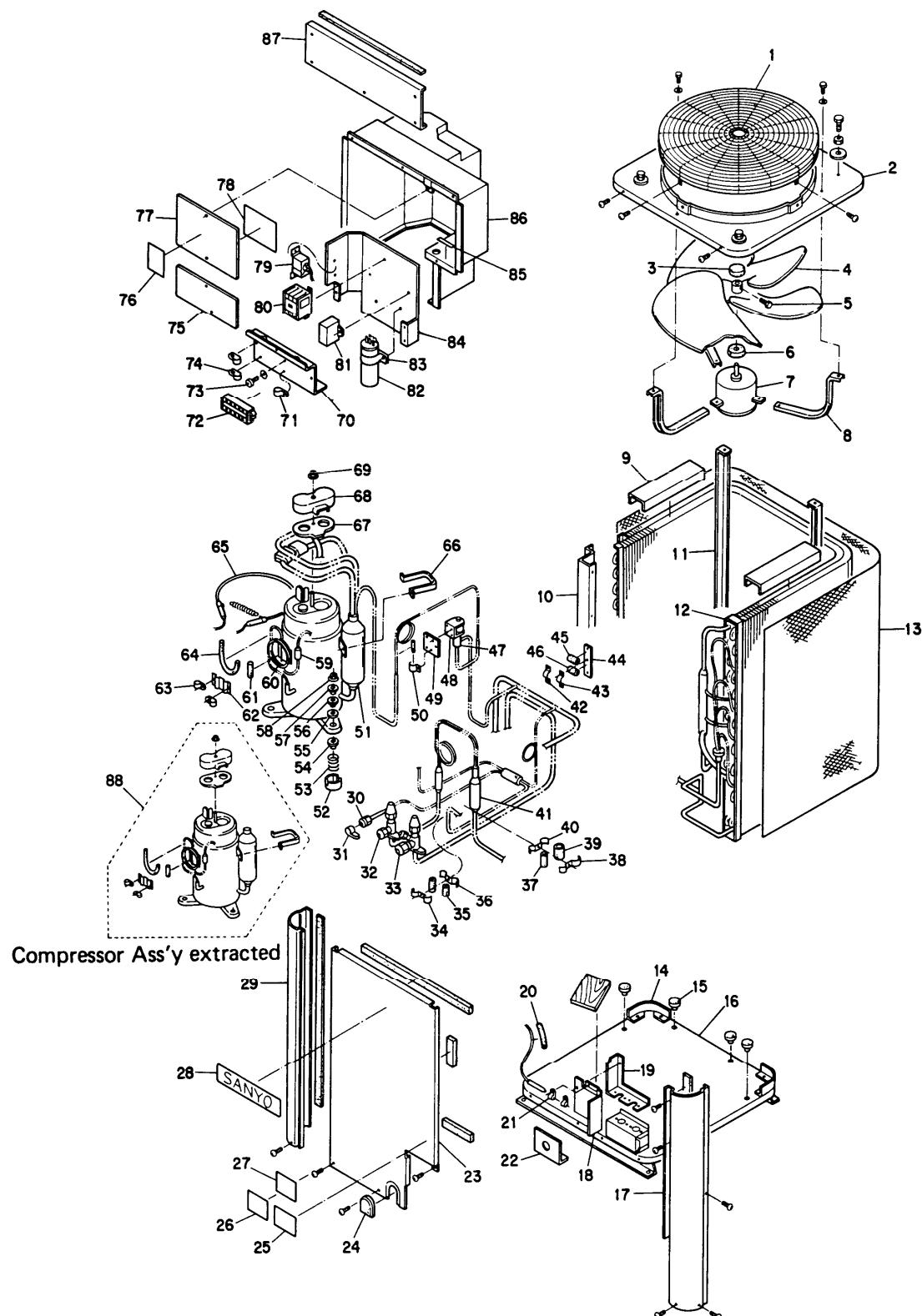
To ensure correct parts supply, please let us know followings, when you make service parts order:

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	859-3-4123	Panel Ass'y	1	61	854-2-5301-44711	Bottom Plate	1
2	854-2-1114-10713	Cover, Top Panel	2	62	851-0-5158-08000	Control Switch PCB Ass'y	1
3	854-0-1105-224H2	Top Panel Ass'y	1	63	854-0-5302-14201	Mounting Plate Ass'y	1
4	854-0-1105-216H4	Top Panel Ass'y	1	64	854-2-5304-28100	Cover Plate	1
5	854-6-4729-71600	Label	1	65	800-2-5367-11300	Filter	1
6	854-2-1521-11300	Mounting Rubber, Blade	2	66	854-2-1359-21701	Indicator Plate	1
7	854-0-1505-178H2	Blade Louver Ass'y	2	67	854-2-1311-12401	Knob	1
8	854-2-1521-11400	Mounting Rubber, Blade	2	68	854-2-1311-10904	Knob	2
9	854-0-2308-23700	Air Filter Ass'y	1	69	854-2-1311-12002	Knob	1
10	854-2-1133-193H2	Cover Plate Ass'y	1	70	800-2-5367-11600	Filter	1
11	854-2-1133-194H2	Cover Plate Ass'y	1	71	851-2-5261-24100	Label	1
12	854-0-1105-230H3	Top Panel Ass'y	1	72	851-2-5261-26600	Label	1
13	854-2-1301-25001	Ornamental Sash	1	■	854-6-4119-38200	Opertation Manual	1
14	852-2-1504-16414	Badge	1	■	854-6-4139-34200	Installation Instructions	1
15	854-2-2307-11901	Cover Plate	1				
16	851-0-5290-687M1	Fan Motor Ass'y KFG4S-81B6P	1				
17	854-2-2534-13510	Cushion Rubber	2				
18	854-2-2519-11400	Air Guide	1				
19	854-2-1367-35300	Name Plate	1				
20	854-0-2502-17801	Blower Casing Ass'y	1				
21	854-0-2501-14800	Blower Ass'y	1				
22	854-0-2511-15401	Support Motor Ass'y	1				
23	854-2-2360-41501	Mounting Plate	1				
24	854-0-2516-12401	Partition Plate Ass'y	1				
25	854-2-2518-28700	Mounting Plate	1				
26	854-2-2307-12401	Cover Plate	1				
27	854-2-2352-12300	Guide	2				
28	854-2-1133-181H3	Cover Plate Ass'y	1				
29	854-2-1101-450H2	Front Panel Ass'y	1				
30	852-2-2396-10103	Screw Special	1				
31	854-0-5301-335H1	Electrical Component Box Ass'y	1				
32	852-6-4729-17300	Label	1				
33	4-2239-56220	Fixed Capacitor 440V 3MFD	1				
34	851-0-5290-687P1	Transformer Ass'y ATR-J122U	1				
35	854-2-5304-26601	Cover Plate	1				
36	854-2-5301-49401	Mounting Plate	1				
37	854-2-5304-265H1	Cover Plate Ass'y	1				
38	854-2-1358-46700	Label	1				
39	854-2-5301-49501	Mounting Plate	1				
40	851-2-5250-83800	Wiring Diagram	1				
41	859-4-7411	Controller POW-24R	1				
42	4-2379-56168	Terminal Base 3P 20A	1				
43	854-0-5301-33701	Electrical Component Box Ass'y	1				
44	851-0-5290-687T1	Thermistor Ass'y OCS5K-UL	1				
45	854-0-1105-191H3	Top Panel Ass'y	1				
46	854-2-2314-184H2	Partition Plate Ass'y	1				
47	854-2-1130-12200	Mounting Plate	4				
48	854-0-1102-196H2	Side Panel Ass'y	2				
49	854-2-1110-14001	Blade Louver	2				
50	854-0-1306-177H2	Mounting Plate Ass'y	1				
51	854-2-1102-275H2	Side Panel Ass'y	1				
52	854-2-2314-183H2	Partition Plate Ass'y	1				
53	854-0-4118-35001	Evaporator Ass'y	1				
54	854-0-2301-300H0	Drain Pan Ass'y	1				
55	854-0-2301-302H2	Drain Pan Ass'y	1				
56	854-2-4134-31601	Cover Plate, Evaporator	1				
57	854-0-2301-301H0	Drain Pan Ass'y	1				
58	854-2-4134-31501	Cover Plate, Evaporator	1				
59	854-0-2301-303H2	Drain Pan Ass'y	1				
60	859-2-1463	Remote Control Switch Ass'y RCS-24R	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.

10. PARTS LIST



ATTENTION !

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

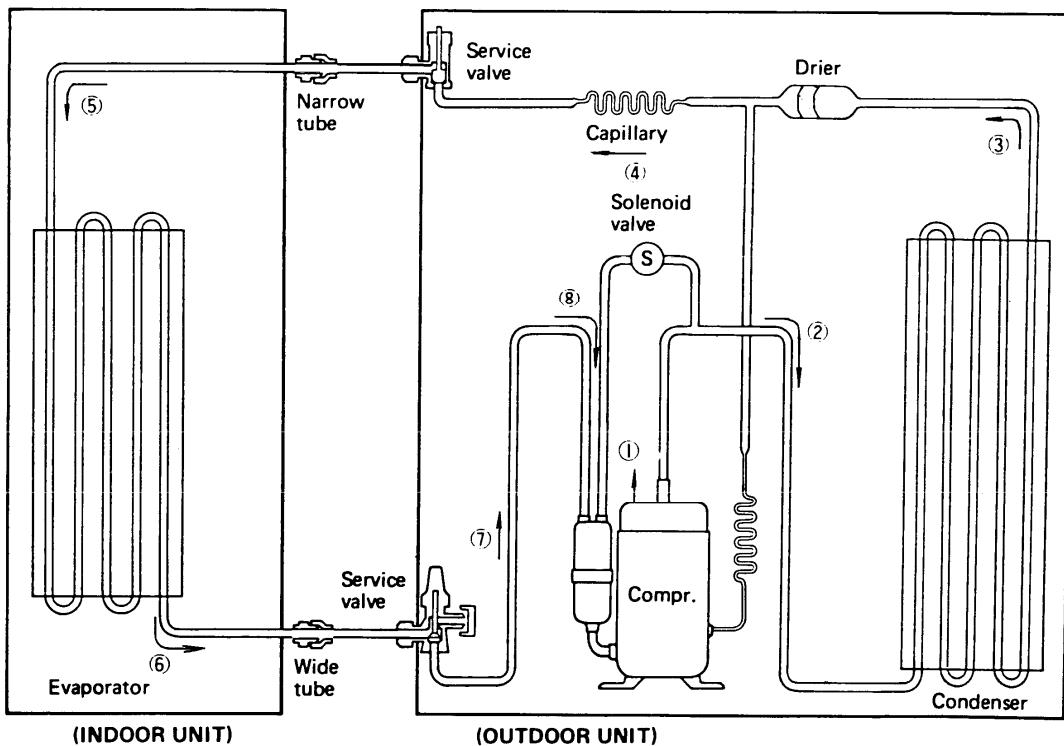
1. Part No. 2. Description 3. Q'ty 4. Volts - Hz - Ph 5. PRODUCT MODEL NO.

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've	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 5MF	1
24	852-2-1320-10500	Eyelet Rubber	1	82	4-2239-56339	Fixed Capacitor 400VAC 35MF	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	Dehydrator 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

(Model: SAP241RC)



NOTE:

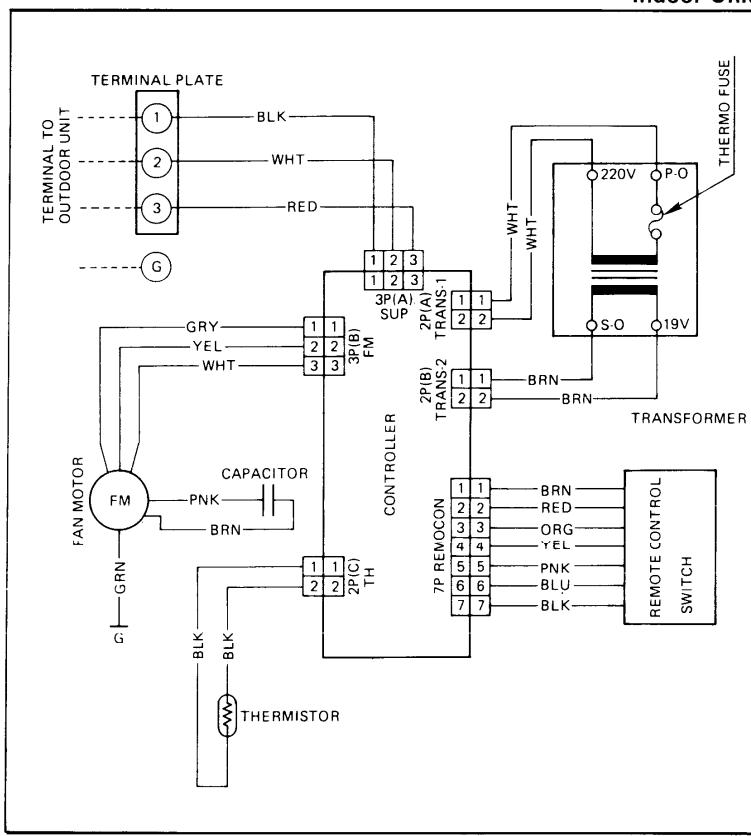
→ with sequential number shows flow
of refrigerant in COOLING CYCLE.

The solenoid valve is provided to keep the unit running in cool atmosphere. It opens to by-pass refrigerant flow when the outdoor ambient temperature drops below 75°F, and closes at 78°F.

12. ELECTRIC WIRING DIAGRAM

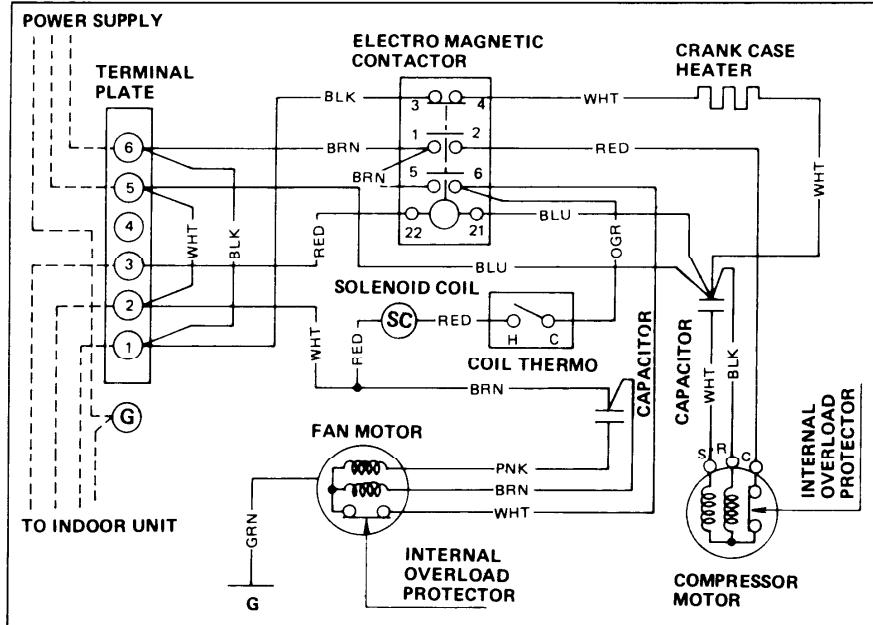
SAP241R ELECTRIC WIRING DIAGRAM

Indoor Unit

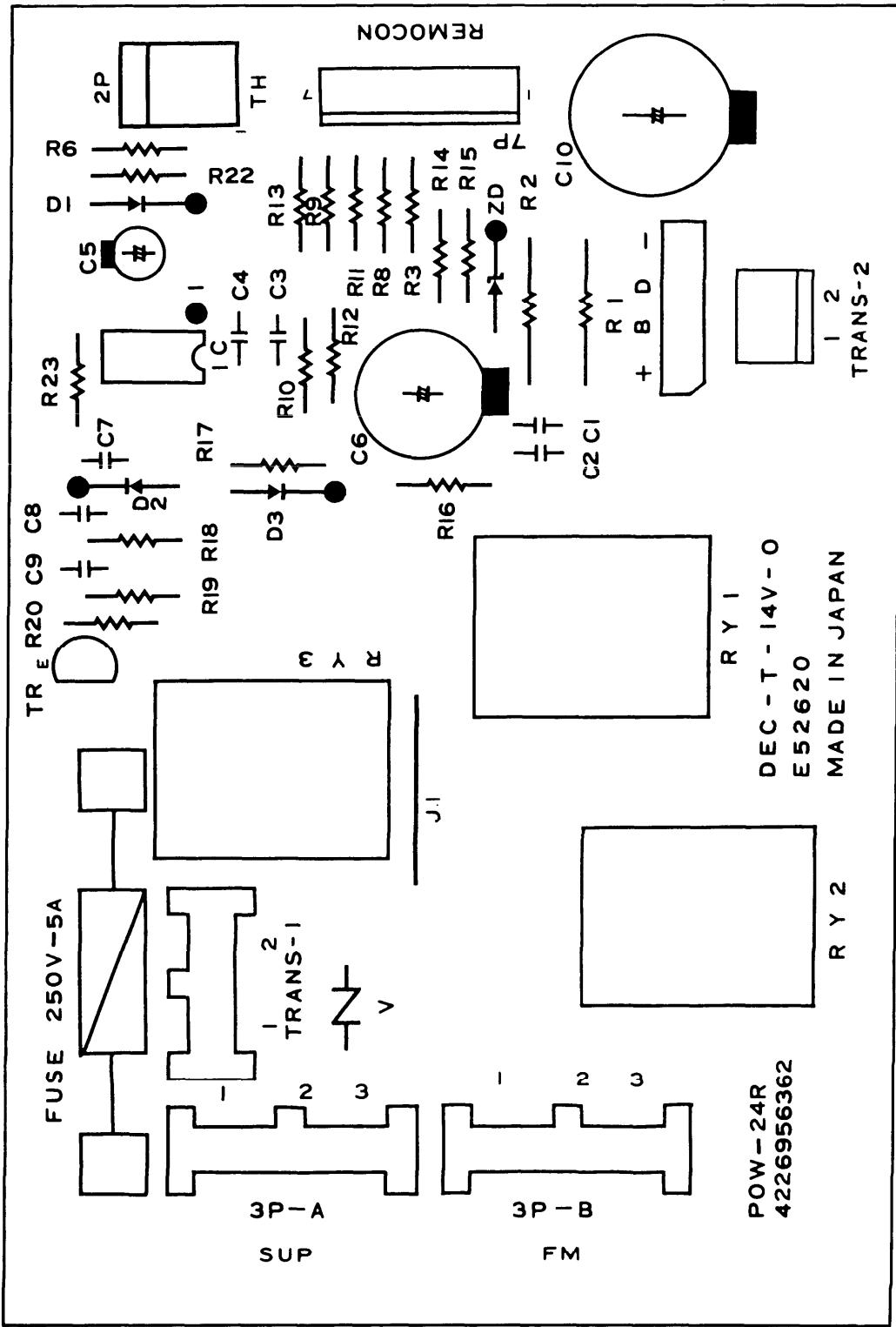


SAP 241C ELECTRIC WIRING DIAGRAM

Outdoor Unit



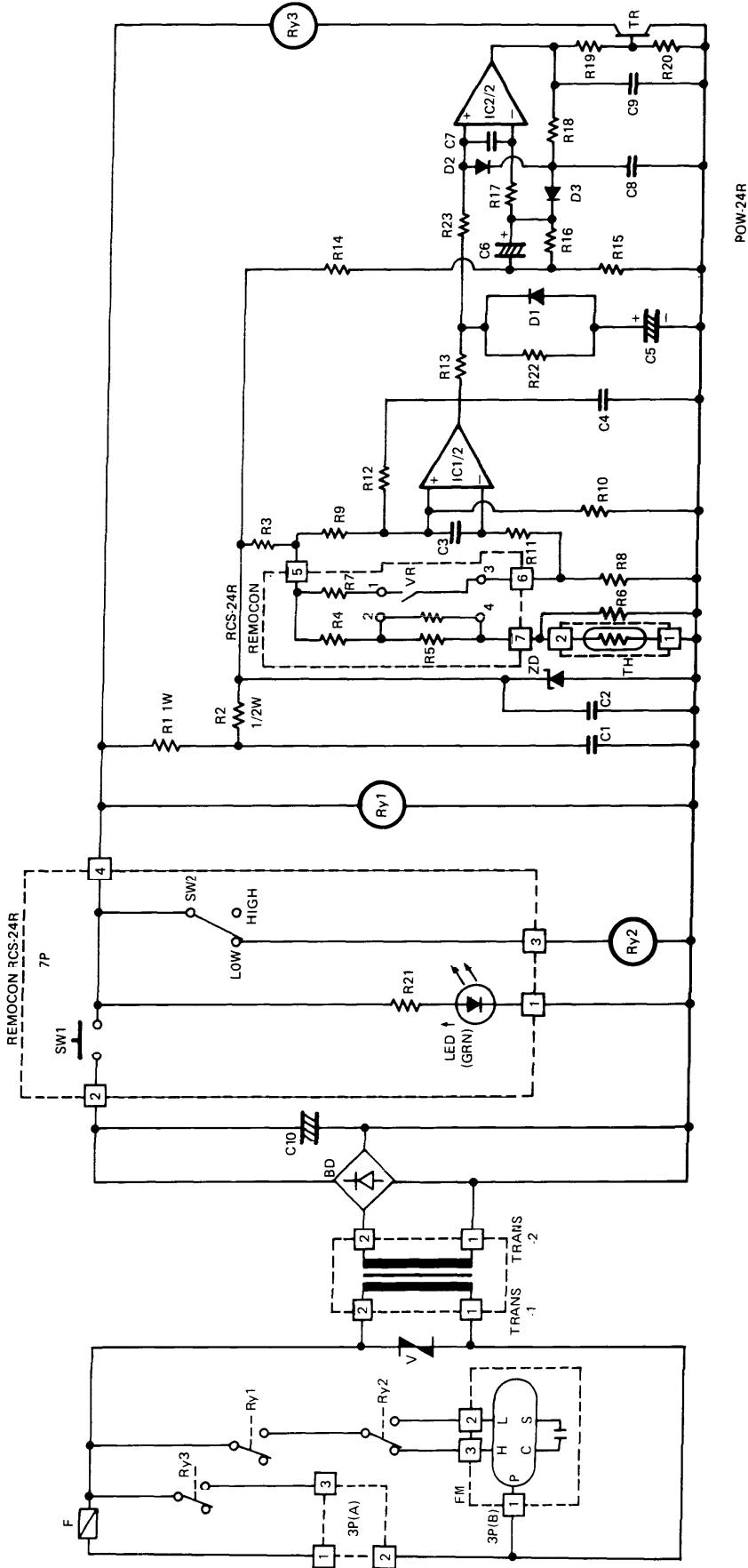
CONTROLLER P.C.B. POW-24R (PRINTED PATTERN)



POW - 24 R

ELECTRIC WIRING DIAGRAM
CONTROLLER P.C.B. POW-24R

Key No.	Description	Key No.	Description
R1	Resistor 1W 560Ω	R23	Resistor 1/4W 2.2kΩ
R2	Resistor 1/2W 100Ω	F	Fuse 250V 5A
R3	Resistor 1/4W 3.3kΩ	C1	Connector NJM4558D or LA658D
R6	Resistor 1/4W 18kΩ ±1%	C2	Capacitor LZG-24HE DC24V
R8	Resistor 1/4W 560kΩ	C3	Capacitor LZG-24HE DC24V
R9	Resistor 1/4W 3kΩ ±1%	C4	Capacitor SNR-A420K
R10	Resistor 1/4W 3kΩ ±1%	C5	Capacitor 2-172629-2
R11	Resistor 1/4W 10kΩ	C6	Capacitor 16V 4.7μF
R12	Resistor 1/4W 470kΩ	C7	Capacitor 10V 330μF
R13	Resistor 1/4W 11kΩ	C8	Capacitor 50V 0.022μF
R14	Resistor 1/4W 10kΩ	C9	Capacitor 50V 0.022μF
R15	Resistor 1/4W 3.3kΩ	C10	Capacitor 50V 0.022μF
R16	Resistor 1/4W 330kΩ	BD	Diode DBA-10C
R17	Resistor 1/4W 10kΩ	ZD	Diode GZA-12L
R18	Resistor 1/4W 4.3kΩ	D1	Diode DS-442X
R19	Resistor 1/4W 6.8kΩ	D2	Diode DS-442X
R20	Resistor 1/4W 2.2kΩ	D3	Diode DS-442X
R22	Resistor 1/4W 12kΩ	TR	Transistor 2SC536 E or F



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	554.0
									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
									151.7	305	581.0
									154.4	310	590.0
									157.2	315	599.0
									160.0	320	608.0
									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	24.8	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 (1 lit. = 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/in.²)

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 ($1\text{cm}^2 = 0.155 \text{ in.}^2$)

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 ($1\text{m}^2 = 10.76 \text{ ft.}^2$)

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 ($1\text{cm}^3 = 0.061 \text{ in.}^3$)

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 ($1\text{m}^3 = 35.3 \text{ ft.}^3$)

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	3.56	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	0.015625	0.396785	17/64	0.205823	5.746375	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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