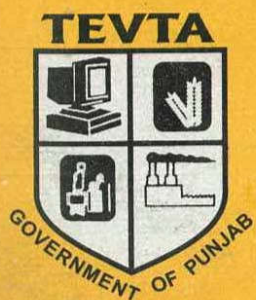
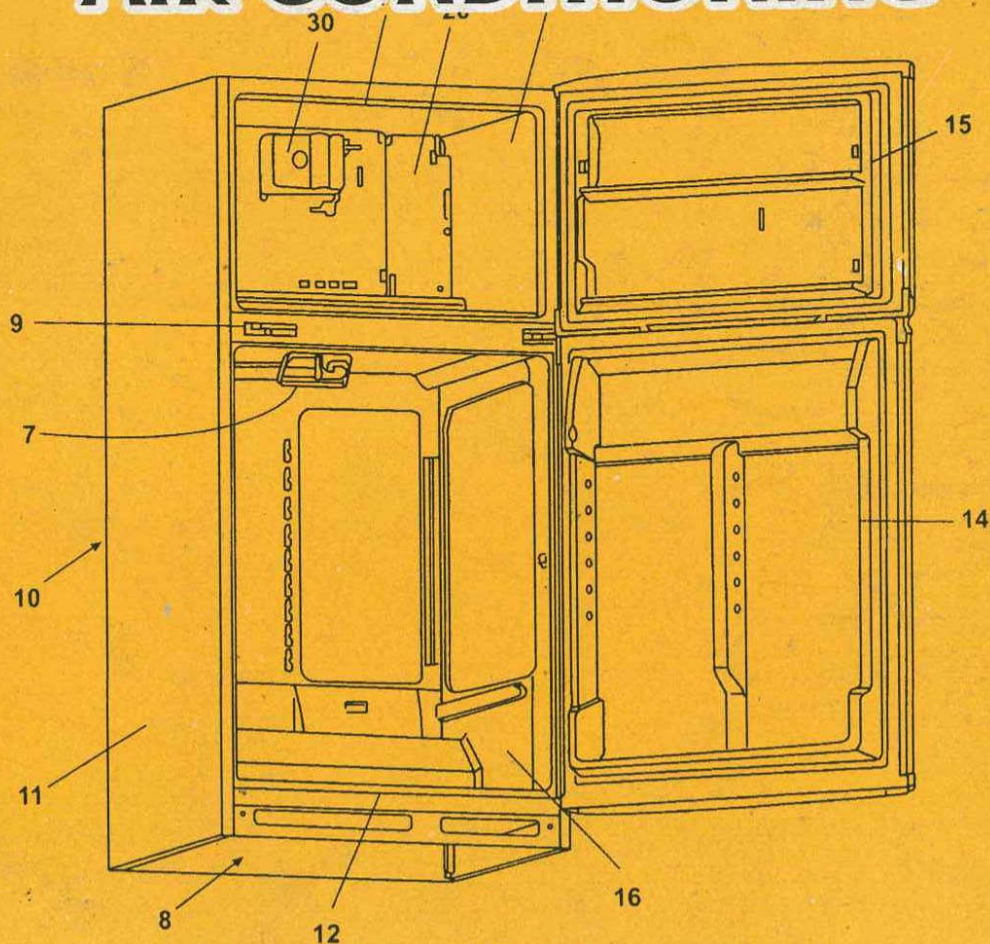


# **BASIC TRAINING**

## **TTC PROGRAMME**

### **REFRIGERATION AND AIR CONDITIONING**



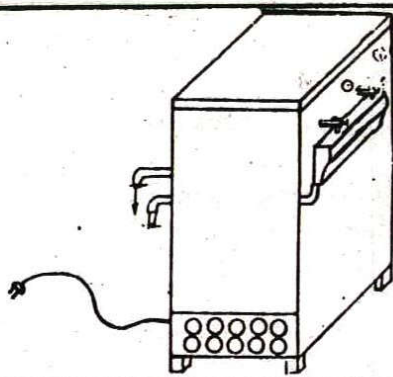
**GOVERNMENT OF THE PUNJAB**  
TECHNICAL EDUCATION & VOCATIONAL TRAINING AUTHORITY  
**TRADE TESTING BOARD**  
DEVELOPMENT CELL LAHORE

**T.T.P. Series No. 93**

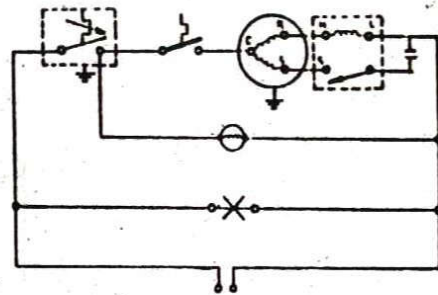
**Price Rs. 32/-**



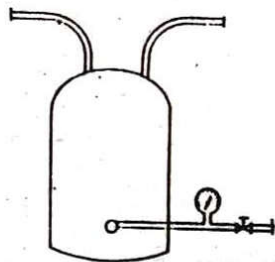




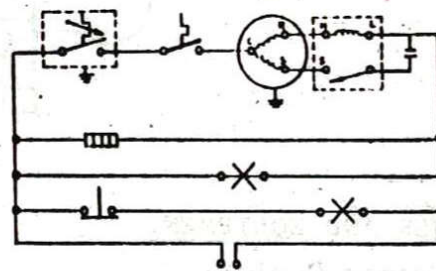
1



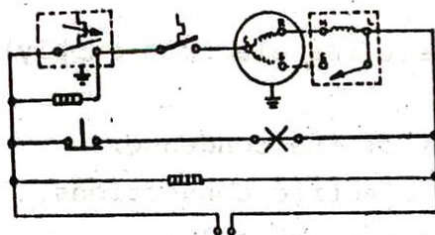
2



3



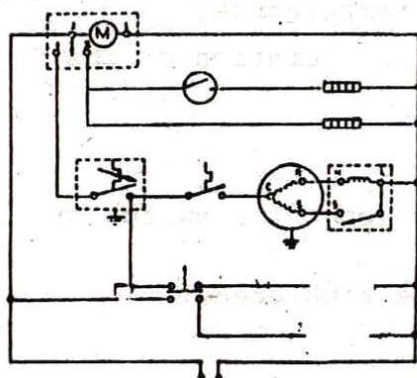
5



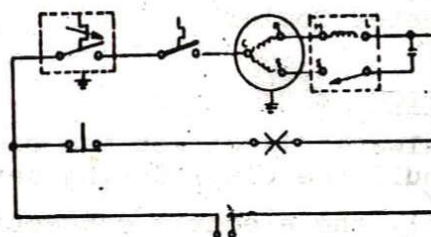
6

TROUBLESHOOTING  
FOR  
REFRIGERATORS

7



8



9

TRADE TRAINING II

LAY OUT

RP/3.15.1

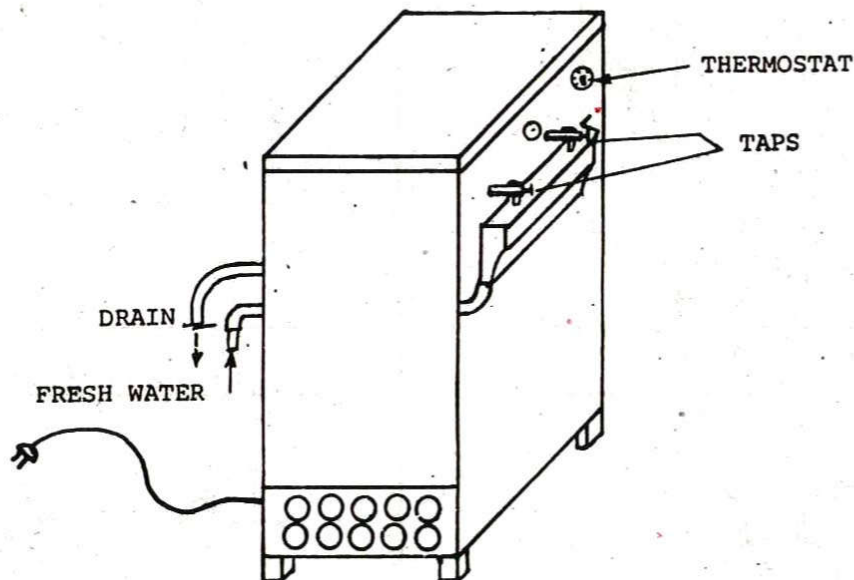
REFRIGERATION



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Relg.  
&  
Air Cond.



#### TOOLS AND EQUIPMENT

- Water Cooler
- Clamp-on ammeter
- Hand electric blower
- Screw driver set
- Ohmmeter

#### SEQUENCE OF OPERATIONS

- Turn off the electric supply (disconnect the electric supply).
- Clean the taps and drain.
- Remove the dust and dirt from the fins of the condenser.
- Clean the thermostat sensing bulb and electric connections.
- Check and replace the worn wires and loosen thimbles.
- Check the external short of the compressor motor.
- Turn "ON" the electric supply.
- Adjust the thermostat knob at proper temperature.
- Check cooling, after about 2-3 hours of operation of the Water Cooler.

#### CAUTION

- Always disconnect the electric supply (open the switch or pull the plug) during servicing.
- All the electric connections should be tightened.

SCALE:

MAT:

## SERVICING OF WATER COOLER

RP/3.15.1/01

REFRIGERATION

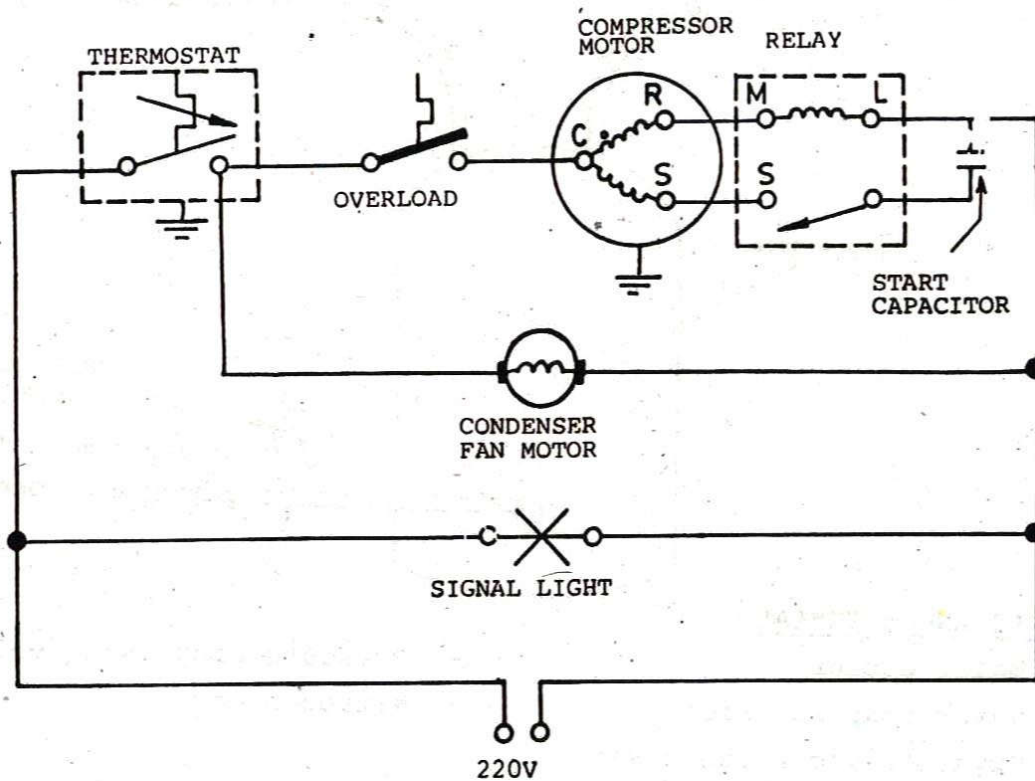


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





MAKE THE ELECTRIC WIRING CIRCUIT OF WATER COOLER  
ACCORDING TO THE ABOVE DIAGRAM.

SCALE:

MAT:

## ELECTRIC WIRING CIRCUIT OF WATER COOLER

RP/3.15.1/02

REFRIGERATION

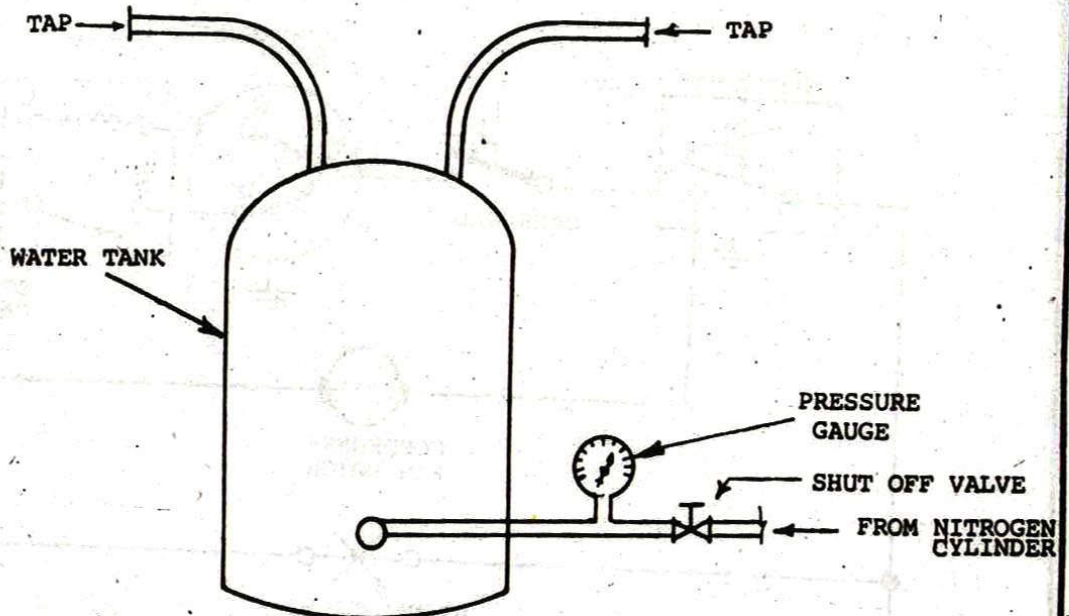


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refr.  
&  
Air Cond.





#### TOOLS AND MATERIAL

- Water cooler
- Water soap solution
- Oxyacetylene welding set
- Pressure gauge with valve
- Nitrogen gas

#### SEQUENCE OF OPERATIONS

- Disconnect the electric supply of the water cooler.
- Close the water supply valve and disconnect the water supply connection.
- Drain all the water from the water tank of the water cooler.
- Remove the insulation all around the water tank.
- Make connection of gas cylinder with water supply line of the water tank.
- Pressurize the water tank at 100 psi.
- Check leakage of water tank and mark the leakage points.
- Release gas pressure and repair leakage.
- Check leakage again at 100 psi.
- Insulate the water tank.
- Make water supply connection and open the water supply valve.
- Make electric connections of the cooler and turn "ON" the electric supply.
- Check cooling after about 2-3 hours of operating the water cooler.

#### CAUTION

- All the taps of the cooler should be sealed during detecting leaks.

SCALE:

MAT:

## TESTING FOR LEAKS OF WATER TANK

RP/3.15.1/03

REFRIGERATION



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refr.  
&  
Air Cond.



## ABSORPTION TYPE REFRIGERATION SYSTEM

The operation of this refrigeration system is based on Dalton's law. This absorption system uses ammonia, water and hydrogen. This system consists on the following main parts.

1. Generator.
2. Condenser.
3. Evaporator.
4. Absorber.

### GENERATOR

It contains water ammonia solution. Heat applied to the generator, ammonia and water vapors evaporates from the solution.

Ammonia vapors are separated from the water vapors in the separator and rises to the condenser. The condensed water vapors (liquid water) flows to absorber.

### CONDENSER

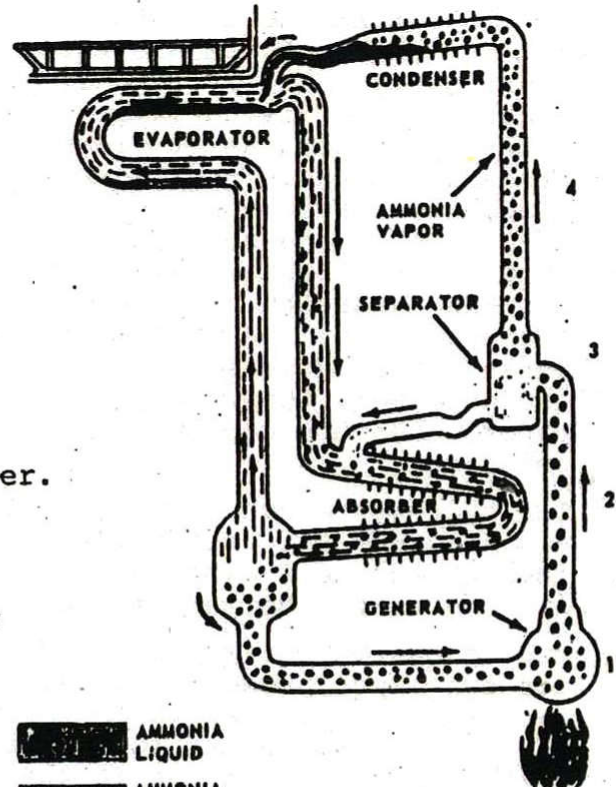
Ammonia vapors condenses in the condenser, so liquid ammonia seeks in evaporator through the restrictor.

### EVAPORATOR

Evaporator is the part of absorber which contains hydrogen vapors, due to Dalton's law, ammonia evaporates with the heat of the compartment (things in the compartment). The ammonia vapors (low temperature vapors) go to absorber with hydrogen vapors.

### ABSORBER

Water absorbs ammonia vapors which are coming from the evaporator (creates low pressure in the evaporator). Hydrogen does not mix with water, so the dissolved ammonia (ammonia + water) solution flows to generator.



SCALE:

MAT:

## INFORMATION SHEET

RP/3.15.1/04

REFRIGERATION



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



## DOMESTIC ABSORPTION TYPE REFRIGERATION SYSTEM

This absorption type refrigeration system has four main sections. 1. Generator (boiler). 2. Condenser. 3. Evaporator. 4. Absorber. These four sections are made of steel connected by steel tubes and the entire system is welded together. The system is shown on page No. RP/3.15.1/04b. It is charged with ammonia, water and hydrogen.

The boiler contains a solution of water and ammonia. When the solution is heated, the ammonia vapor and a weak solution are driven out and up the tube, C. The weak solution passes into the tube, D, while the ammonia vapor passes into the outer tube, E. It moves on to point F. Here it is enriched by bubbling through the liquid before rising into the vapor pipe, C, and flowing on to the water separator. As it flows into the separator, any water vapor present condenses and flows back through tube, G, into the absorber. The ammonia vapor flows up through tube, H, to the condenser, where it is cooled and condensed to a liquid. The liquid ammonia flows into the evaporator. The evaporator and part of the absorber contain hydrogen. The vaporised ammonia and hydrogen mixture from the evaporator are heavier than hydrogen. Gravity flow brings these vapors down through the tube, I, back to the absorber. In the absorber, the water is relatively cool. It absorbs the ammonia vapor. Then the cool water and ammonia solution returns to the generator.

The hydrogen which flows down to the absorber with the ammonia is not absorbed and, being very light, returns to the evaporator through the heat exchanger. This cycle operates continuously as long as the boiler is heated.

Due to Dalton's Law, in a mixture of gases, each gas develops its own vapor pressure. So in this refrigeration system the ammonia in the spaces which include hydrogen will evaporate at a low pressure and low temperature. Since the hydrogen is a large part of the gas in the space, the ammonia keeps on boiling or vaporizing at its own low pressure, absorbing heat. Pressure throughout the system is about 200 psi.

SCALE:

MAT:

## INFORMATION SHEET

RP/3.15.1/04a

REFRIGERATION

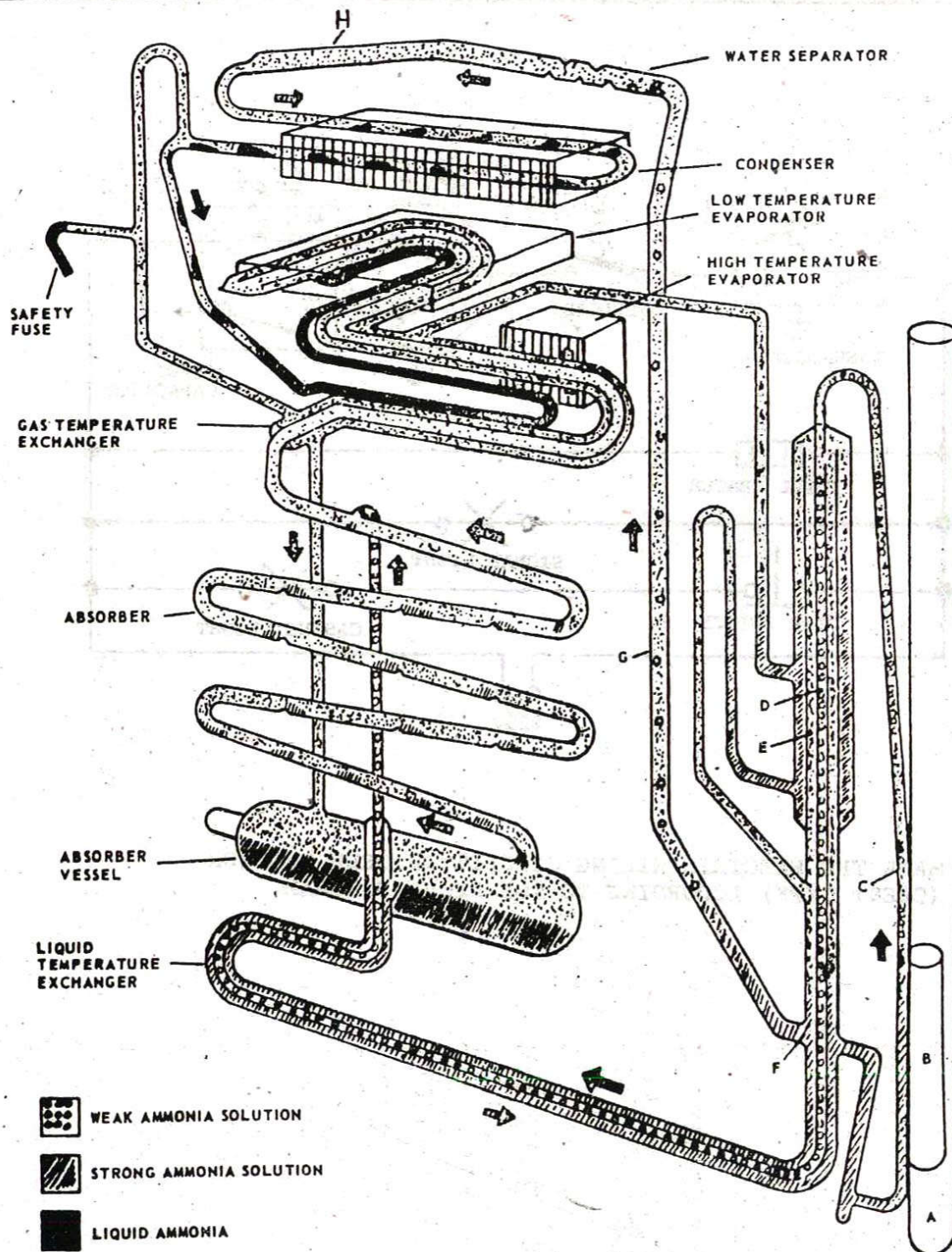


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





OBSERVE THE FUNCTION OF CONTINUOUS CYCLE ABSORPTION SYSTEM  
ON ABSORPTION TYPE REFRIGERATOR.

SCALE: \_

MAT: \_

## INFORMATION SHEET

RP/3.15.1/04b

REFRIGERATION

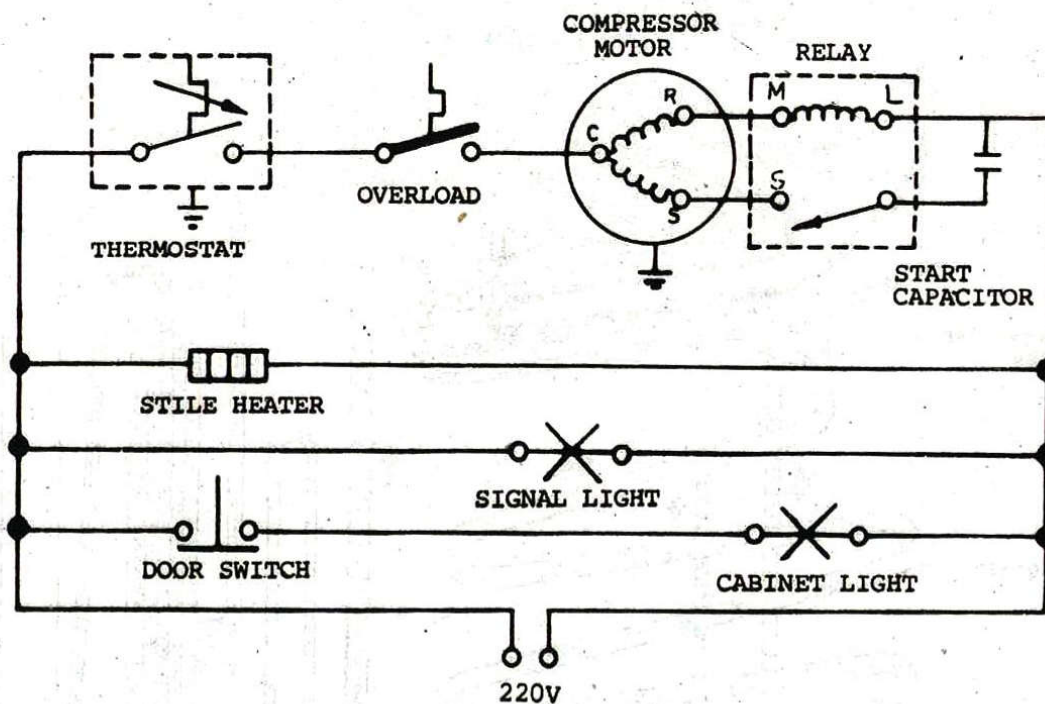


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





MAKE THE ELECTRIC WIRING CIRCUIT OF DEEP FREEZER  
(CHEST TYPE) ACCORDING TO THE ABOVE DIAGRAM.

SCALE:

MAT:

## ELECTRIC WIRING CIRCUIT OF FREEZER (DEEP FREEZER)

RP/3.15.1/05

REFRIGERATION

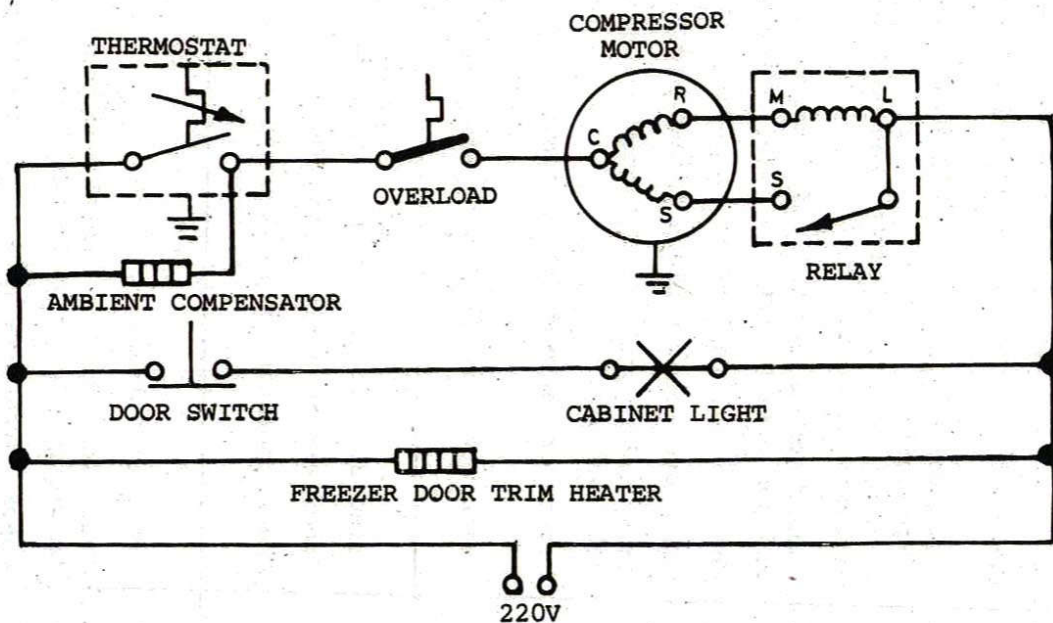


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond





MAKE THE ELECTRIC WIRING CIRCUIT OF REFRIGERATOR  
(DOUBLE DOOR) ACCORDING TO THE ABOVE DIAGRAM.

SCALE:

## ELECTRIC WIRING CIRCUIT OF REFRIGERATOR

RP/3.15.1/06

MAT:

REFRIGERATION



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



# TROUBLESHOOTING CHART

TROUBLE	COMMON CAUSE	REMEDY
Unit does not run.	<p>Blown fuse</p> <p>Low voltage</p> <p>Broken/Burnt motor winding or temperature control.</p> <p>Broken (defective) relay</p> <p>Broken (defective) overload</p> <p>Defective service cord</p> <p>Broken lead to compressor timer or cold control</p> <p>Broken (faulty) timer</p>	<p>Check circuit for short or ground, replace fuse.</p> <p>Check voltage, should be 220 volts plus or minus 10 percent.</p> <p>If circuit is overloaded reduce load or install separate circuit.</p> <p>Jumper across terminal of control. If unit runs and connections are all tight, replace control.</p> <p>Check relay, replace if necessary.</p> <p>Check overload, replace if necessary.</p> <p>Check test cord, if defective, repair or replace with new one.</p> <p>Repair or replace broken leads.</p> <p>Check with test light and replace if necessary.</p>
Compressor starts, motor does not get off starting winding.	<p>Low line voltage</p> <p>Improperly wired</p> <p>Defective relay</p>	<p>Bring up voltage 220V plus or minus 10%</p> <p>Check wiring against diagram</p> <p>Check operation-replace relay</p>
Compressor starts and runs but cycles on protector.	<p>Low line voltage</p> <p>Additional current passing through protector.</p> <p>Protector weak (defective)</p>	<p>Bring up voltage.</p> <p>Check for added fan motor and heaters collected to wrong side of protector.</p> <p>Check current-replace protector if defective.</p>

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.1/07

REFRIGERATION



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



TROUBLE	COMMON CAUSE	REMEDY
Starting capacitor burn-out.	Short cycling. Relay contacts sticking. Improper relay.	Reduce Nos. of starts. Clean contacts or replace relay. Replace relay.
Relay burnout.	Excessive line voltage.  Low line voltage.  Short cycling. Relay vibrating. Incorrect relay.	Reduce voltage to maximum of 10 percent above compressor motor rating. Increase voltage to not less than 10 percent under compressor motor rating. Reduce number of starts per hour. Mount relay rigidly. Use relay recommended for specific motor compressor.
Refrigerator section too warm.	Many times door openings. Overloading of shelves, blocking normal air circulation. Warm or hot food placed in cabinet.  Poor door seal/gasket. Interior light stays on. Refrigerator section airflow control on warmer.  Cold control knob set at too warm a position. Freezer section grille not properly positioned. Freezer fan not running properly. Air duct seal not properly sealed or positioned. Defective intake valve (suction flapper valve of compressor).	Instruct user. Instruct user.  Instruct user to allow foods to cool to room temperature before placing in cabinet. Level the cabinet, adjust door seal (gasket). Check light switch; if faulty, replace. Turn the control knob to colder position. If control inoperative, replace control. Check airflow heater. Turn knob to colder position.  Reposition the grille.  Replace fan, fan switch, or defective wiring. Check and reseal or put in correct position.  Replace motor compressor.

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.1/07a

REFRIGERATION



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

 Refg.  
&  
Air Cond.







TROUBLE	COMMON CAUSE	REMEDY
Refrigerator section too cold.	Refrigerator section airflow control knob turned to coldest position. Airflow control remains open. Broken airflow control. Broken airflow heater.	Turn control knob to warmer position.  Remove obstruction. Replace control. Replace heater.
Freezer section and refrigerator section too warm.	Fan motor not running. Cold control set too warm or broken (defective). Finned evaporator blocked with ice. Shortage of refrigerant. Not enough air circulation around cabinet. Dirty condenser or obstructed condenser ducts. Poor door seal (gasket). Too many door openings.	Check and replace fan motor if necessary. Check and replace if necessary. Check defrost heater thermostat or timer. Either one of these could cause this condition. Check for leak, repair, evacuate and recharge system. Relocate cabinet or provide clearances to allow sufficient air circulation. Clean the condenser and the ducts. Level cabinet, adjust door seal (gasket). Instruct customer (user).
Freezer section too cold	Cold control knob improperly set. Cold control capillary not properly clamped to evaporator. Broken (defective) cold control.	Turn knob to warmer position. Tighten clamp or reposition. Check control. Replace if necessary.
Stuck motor compressor.	Broken or defective valve. Insufficient oil. Overheated compressor.	Replace motor compressor. Add oil; if unit still will not operate, replace motor compressor. If compressor faulty for any reason, replace motor compressor.

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.1/07b

REFRIGERATION



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME


 Refg.  
 &  
 Air Cond.





TROUBLE		COMMON CAUSE	REMEDY
Unit runs all the time.		Not enough air circulation around cabinet or air circulation is restricted. Poor door seal (gasket). Freezing large quantities of ice cubes, or heavy loading after shopping. Refrigerant charge. Room temperature too warm. Cold control defective. Defective light switch. Excessive door openings.	Relocate cabinet or provide proper clearance around cabinet - remove restriction.  Check and make necessary adjustments. Explain to customer(user) that heavy loading causes long running time.  Undercharge or overcharge - check, evacuate and recharge with proper charge. Ventilate room as much as possible. Check control; If it allows unit to operate all the time, replace control. Check if light goes out. Replace switch if necessary. Instruct customer(user).
	Noisy operation.	Loose flooring or floor not firm. Tubing contacting cabinet or other tubing. Cabinet not level. Drip tray vibrating. Fan hitting liner or mechanically grounding. Compressor mechanically grounded.	Tighten flooring or brace floor. Move tubing.  Level the cabinet. Move tray - place on styrofoam pad if necessary. Move fan (adjust fan).  Replace compressor mounts.
Unit cycles on overload.	Broken or defective relay. Weak/defective overload protector. Low voltage. Poor compressor.	Replace relay. Replace overload protector. Check outlet with voltmeter. underload voltage should be 220V, plus or minus 10%. Check with test cord and also for ground before replacing.	

SCALE:	TROUBLESHOOTING CHART	RP/3.15.1/07c
MAT:		REFRIGERATION

	DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING	Refig. & Air Cond.
	PAK-GERMAN TECHNICAL TRAINING PROGRAMME	





TROUBLE	COMMON CAUSE	REMEDY
Frost or ice on finned evaporator.	Broken (defective) timer Defective defrost heater. Defective thermostat.	Check with test light and replace if necessary. Replace heater. Replace thermostat.
Ice on drip catcher.	Defective drip catcher heater.	Replace drip catcher heater.
Unit runs all the time, temperature normal.	Ice builds up on the evaporator. Control bulb on thermostat not in contact with evaporator surface.	Check door gaskets - replace if necessary. Place control bulb in contact with the evaporator surface.
Freezer runs all the time. Temperature too cold.	Faulty thermostat.	Check thermostat - test and replace if necessary.
Freezer runs all the time. Temperature too warm.	Ice buildup in insulation.	Remove breaker strips, stop unit, melt ice and dry insulation, seal outer shell leaks and joints and then assemble.
Rapid ice buildup on the evaporator.	Leaky door gasket.	Adjust door hinges. Replace door gasket if cracked, brittle or worn.
Door on freezer compartment freezes shut.	Faulty electric gasket heater. Faulty gasket seal.	Use alternate gasket heater or install new one. Inspect and check gasket. If worn, cracked or hardened, replace it.
Freezer works then warms up.	Moisture in refrigerator.	Install drier in liquid line.
Gradual reduction in freezing capacity.	Wax buildup in capillary tube.	Use capillary tube cleaning tool or replace capillary tube.
Compressor hums but does not run.	Bad (defective) starting relay. Stuck compressor. Low voltage.	Replace starting relay. Replace compressor. Increase voltage to not less than 10 percent under compressor motor rating.

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.1/07d

REFRIGERATION

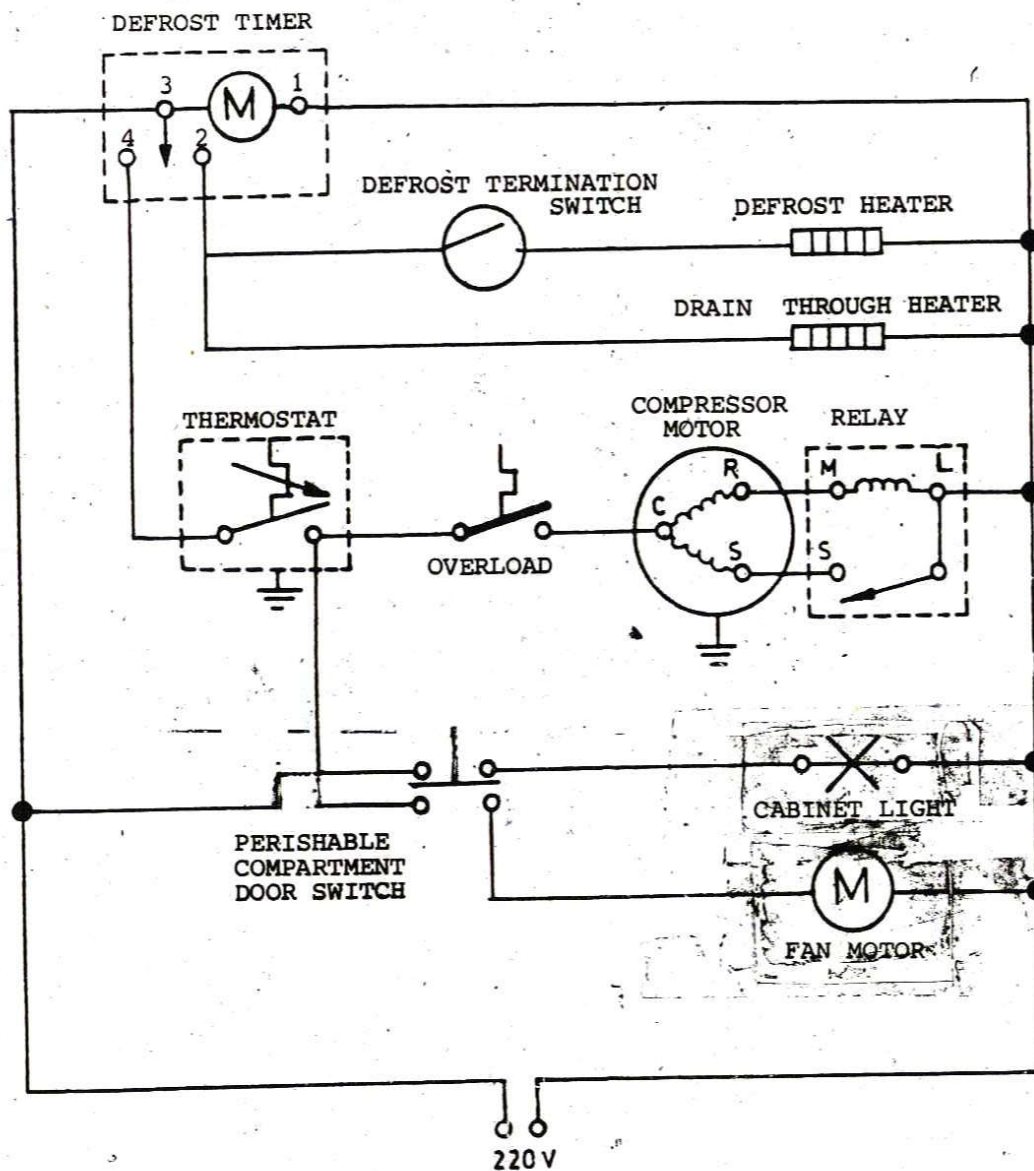


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

 Refg.  
&  
Air Cond.





MAKE THE ELECTRIC WIRING CIRCUIT OF FROST FREE REFRIGERATOR (NON FROST REFRIGERATOR) ACCORDING TO THE ABOVE DIAGRAM.

SCALE:

MAT:

## ELECTRIC WIRING CIRCUIT OF REFRIGERATOR (NON FROST)

RP/3.15.1/08

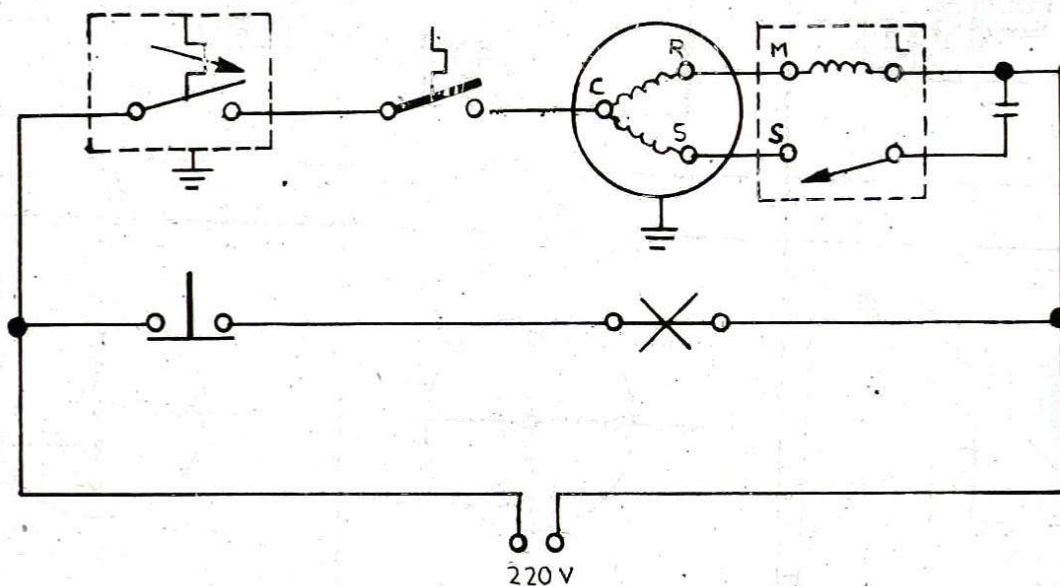
REFRIGERATION



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



MAKE THE ELECTRIC WIRING CIRCUIT OF REFRIGERATOR  
ACCORDING TO THE ABOVE DIAGRAM.

SCALE:

## ELECTRIC WIRING CIRCUIT OF REFRIGERATOR

RP/3.15.1/09

MAT:

REFRIGERATION

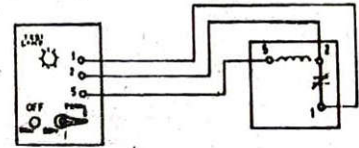
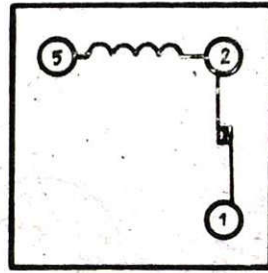
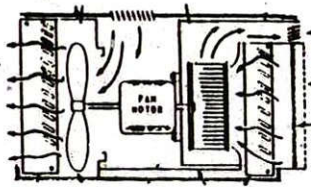


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refr.  
&  
Air Cond.

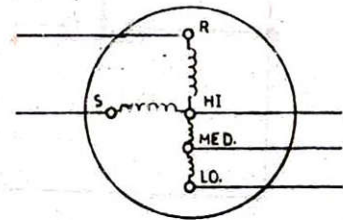
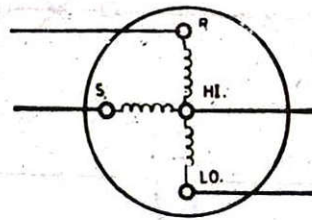
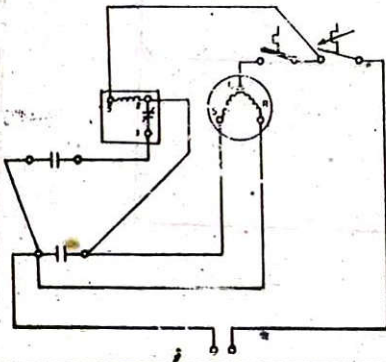




2

3a

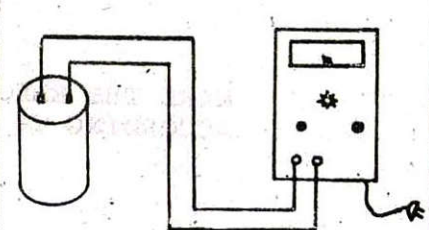
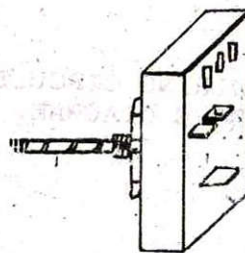
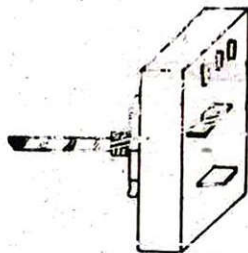
4



5

6

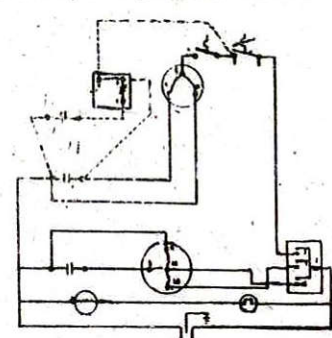
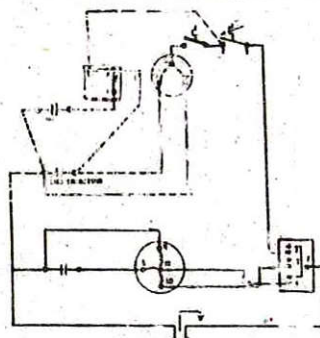
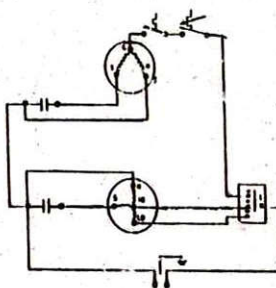
7



8

9

10



11

12

13

TRADE TRAINING II

LAY OUT

RP/3.15.2

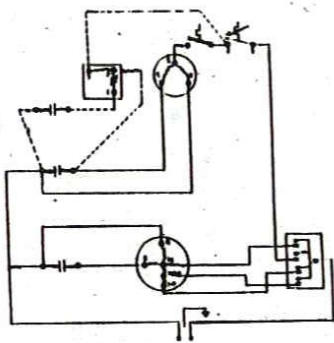
FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

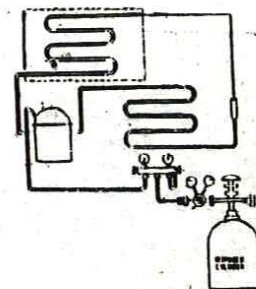
Refg.  
&  
Air Cond.



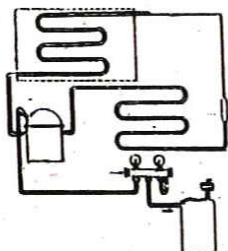
14



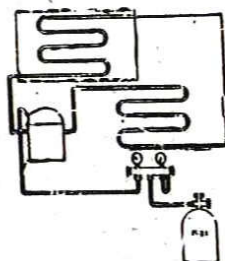
15



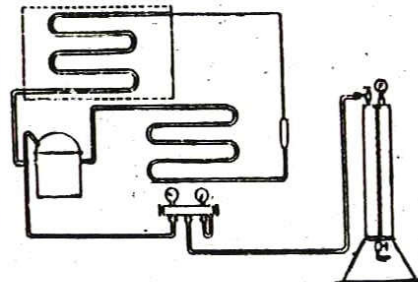
16



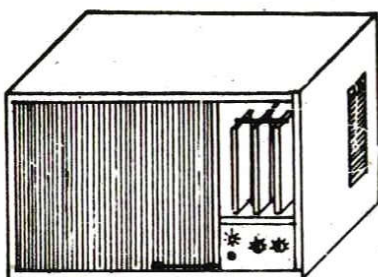
17



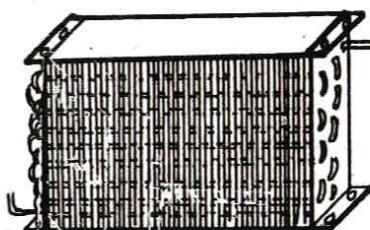
18



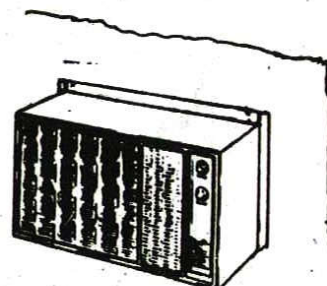
19



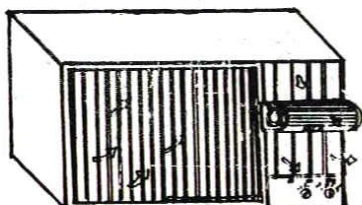
20



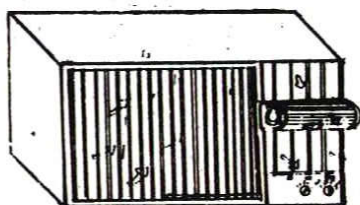
21



22



23



24

TROUBLESHOOTING FOR  
WINDOW AIR CONDITIONING  
UNITS

25

TRADE TRAINING II

LAY OUT

RP/3.15.2

FUNDAMENTALS OF  
AIR CONDITIONING

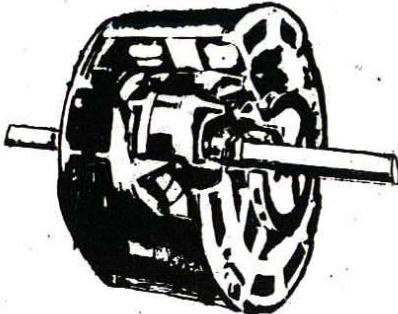
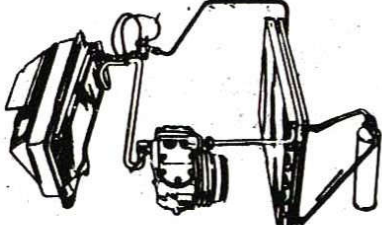
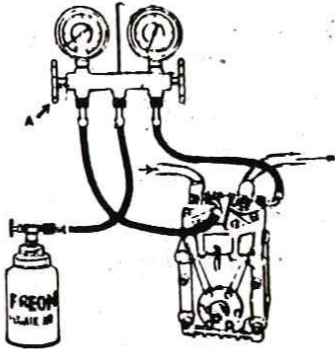

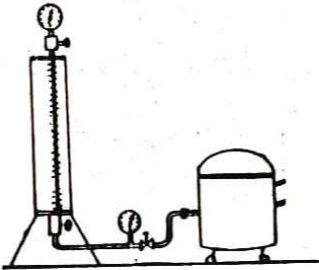
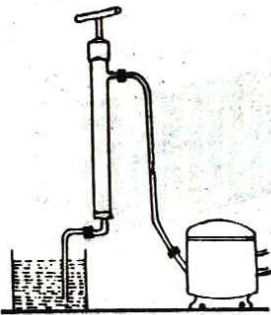



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



		
26	28	29
	<p>TROUBLESHOOTING FOR AUTO AIR CONDITIONING UNITS</p>	
30	31	32
		
33		
TRADE TRAINING II	LAY OUT	
 <p>DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING</p> <p>PAK-GERMAN TECHNICAL TRAINING PROGRAMME</p>		<p>RP/3.15.2</p> <p>FUNDAMENTALS OF AIR CONDITIONING</p> <p>Refg. &amp; Air Cond.</p>

**MATERIAL REQUIRED**  
**Trade Training II**

(Weight given in kilograms)

EXERCISE NO.

**FUNDAMENTALS OF  
AIR CONDITIONING  
No. RP/3.15.2**

	15	18	19	29	32	33	Material per trainee	Total material for a batch of 16 trainees.
Soft copper tube Ø 1/4"	20 Cm.						20 Cm	3.2 meters
Refrigerant F-22		1.5	1.5				3 Kgs.	48 Kgs.
Refrigerant F-12				0.5			0.5 Kg.	8 Kgs.
Compressor oil					2 Litres	2 Litres	4 Litres	64 Litres



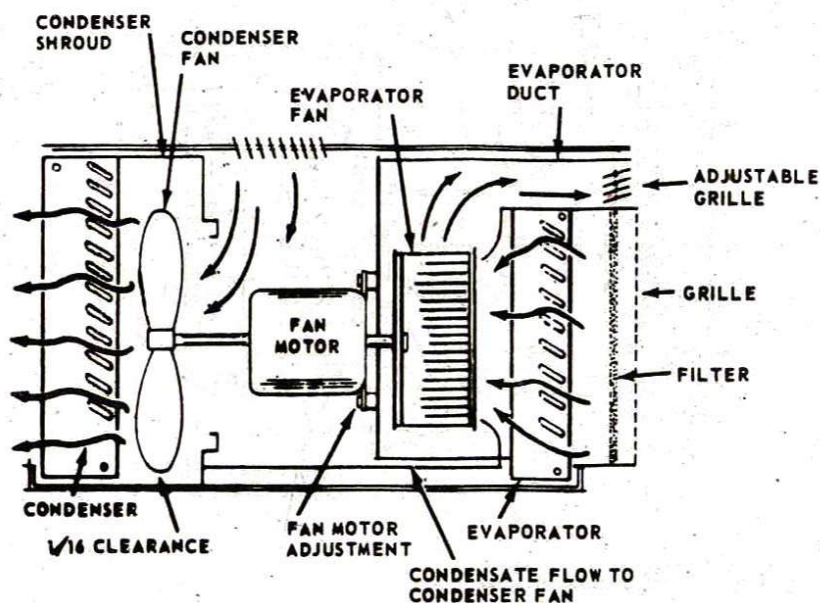
**DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING**

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.







DISMANTLE A WINDOW AIR CONDITIONER, OBSERVE THE FUNCTION AND ADJUSTMENT OF ITS PARTS

SCALE:

MAT:

## INFORMATION SHEET

RP/3.15.2/01

FUNDAMENTALS OF  
AIR CONDITIONING

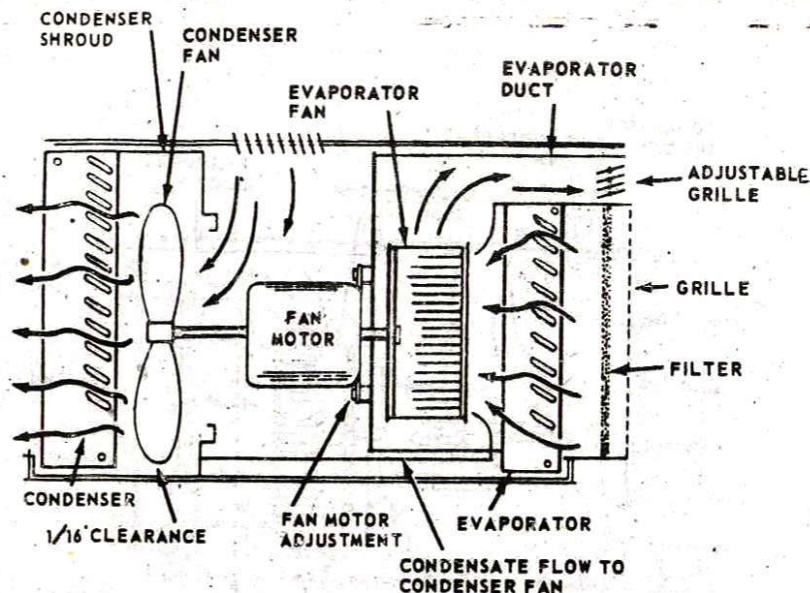


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





#### TOOLS, MATERIAL AND MACHINERY

- Window air conditioner.
- Screw driver set.
- Clamp-on ammeter.
- Allen key set.
- Lubricating oil.
- Electric blower (portable).
- Fin straightener.
- Ohmmeter.
- High pressure washer system.
- Washing powder.

#### SEQUENCE OF OPERATIONS

- Disconnect the electric supply.
- Remove front grille and filter
- Wash filter. If it is worn, replace with new one.
- Remove the air conditioner from its casing.
- Straighten the fins of the condenser and evaporator.
- Clean the fan motor and electrical components with air pressure.
- Inspect the bushes or bearings of the fan motor. Replace, if faulty.
- Cover the fan motor and electric components with polythene paper (waterproof covering).
- Clean the drain.
- Wash the air conditioner and dry it.
- Remove the polythene paper, from the fan motor and electric components.
- Check and make sure that the fan and blower are tightly fitted on the shaft of fan motor.
- Check, make certain that the nuts and bolts are tight.

SCALE:

MAT:

## SERVICING OF WINDOW AIR CONDITIONER

RP/3.15.2/02

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

BM90

Refg.  
&  
Air Cond.




- Lubricate the fan motor.
- Assemble the air conditioner and put it in its casing.
- Adjust the filter and front grille.
- Adjust the thermostat's knob at proper temperature.
- Make the electric supply connections.
- Check the air conditioner for proper operation.

#### PRECAUTIONS

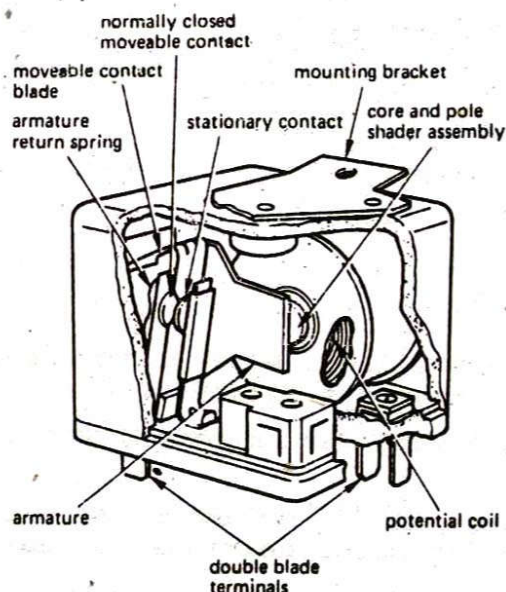
- Always wipe away excess oil. Oil mist on the fan blades collect lints and reduces air movement efficiency.
- Never use metal blades (with vacuum brush) for cleaning, they may cause leaks.
- Fan should be balanced. An off balanced fan will have vibration which will cause the fan motor bearings to wear out.
- Clean casing with vacuum brush.
- Before replacing the unit in the cabinet (casing), run it to check noise.

#### NOTE

- Clean the filter after every 15 days.
- Oil the fan motor bushes monthly during summer season.
- If the window unit drips water into the room, it is not correctly installed, check the slope of the unit from inside to outside with a spirit level. It must be sloped to the outside (condenser edge) about 1/4 inch.
- After servicing of the air conditioner, check the external short (earth leakage).

SCALE:	SERVICING OF WINDOW AIR CONDITIONER	RP/3.15.2/02a
MAT:		FUNDAMENTALS OF AIR CONDITIONING
 DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		Refg. & Air Cond.





## POTENTIAL RELAY

Potential relays are nonpositional. The sizing of these relays are not as critical as with the amperage relay and hot wire relay. This relay operates on the electromagnetic principle. This incorporates a coil of very fine wire wound around a core. The contacts on this relay are normally closed and are caused to open, when a plunger is pulled into the relay coil. These relays have three connections to the inside in order for relay to perform its function. These terminals are numbered 1, 2 and 5. Other terminals numbered 4 and 6 are sometimes used as auxiliary terminals.

This relay is installed with terminal No.5, connected to both the electric line to the motor and to the common terminal of the motor (in series of the overload). Terminal No.2 is connected to the start winding of the motor. Terminal No.1 is connected to the starting capacitor. When motor controller completes the electric circuit to the motor, electric supply is also supplied to the starting winding through the relay contacts between terminals No.1 and No.2. As motor reaches approximately 75 percent of its rated speed, the counter emf. in the start winding has increased sufficiently to cause the relay to "pick up" opening the contacts and removing the starting components from the circuit. Its operation is based on the increase in the voltage as the unit approaches and reaches on its rated speed. The contacts points remain close during the off part of the cycle. A good way to determine what relay is required to manually start the motor and check the voltage between the start and common terminals, while the motor is operating at full speed. Multiply the voltage obtained by 0.75 and this will be the "pick up" voltage of the required relay. This relay sometimes called voltage relay. It is usually used with high torque capacitor start motor. Remember, it is the voltage in the start winding that causes to relay to function.

SCALE:

MAT:

## INFORMATION SHEET

RP/3.15.2/03

FUNDAMENTALS OF  
AIR CONDITIONING

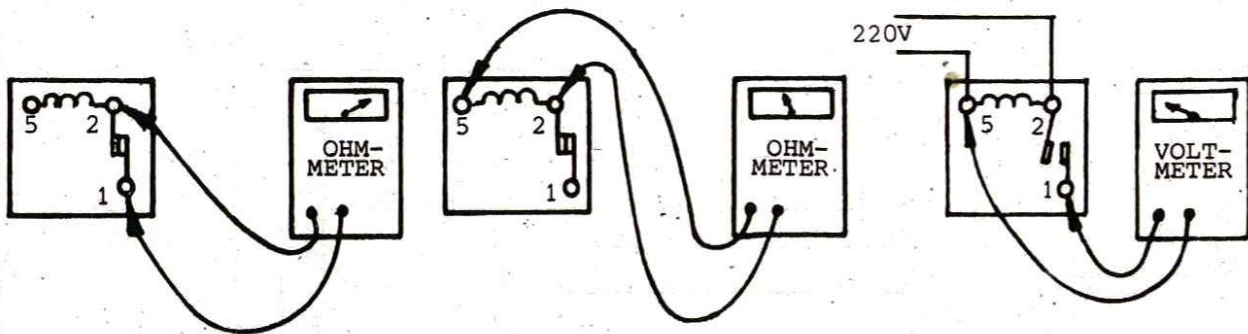


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





Ohmmeter is showing continuity between terminals No.1 and No.2

Ohmmeter is showing resistance between terminals No.2 and No.5

Electric supply 220V is connected at terminals No.2 and No.5, Voltmeter is showing zero volt between terminals No.1 and No.5

#### INSTRUMENT AND COMPONENT

- Potential relay.
- Multimeter.

#### SEQUENCE OF OPERATIONS

- Check continuity between terminals No.1 and No.2 - (Ohmmeter shows continuity).
- Check the resistance of relay's coil between terminals No.2 and No.5 - (Ohmmeter shows resistance).
- Connect the electric supply(220V) with the relay terminals (No.2 and No.5) and check voltage between terminals No.1 and No.5 - (Voltmeter shows zero volt and contacts of terminals No.1 and No.2 are opened).

#### RESULT

- Relay is correct.

SCALE:

## CHECKING OF POTENTIAL RELAY

RP/3.15.2/03a

MAT:

FUNDAMENTALS OF AIR CONDITIONING

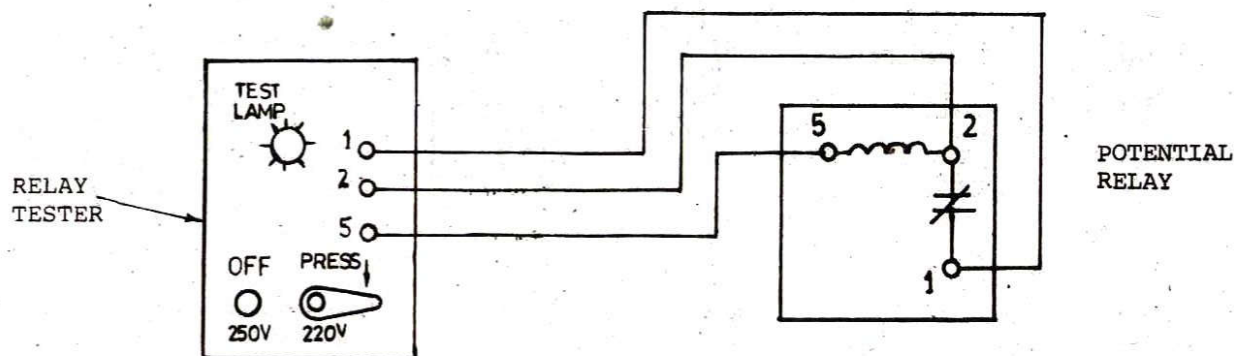


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





#### TOOLS AND MATERIAL

- Potential relay
- Potential relay checker

#### SEQUENCE OF OPERATIONS

- Put voltage selector to full counter clockwise or "zero" position.
- Put voltage selector switch to "off" position.
- Connect the analyzer to 220 V power source.
- Connect analyzer testing leads, as follows:-  
 White lead to #1 terminal on relay  
 Black lead to #2 terminal on relay  
 Red lead to #5 terminal on relay
- Set voltage selector switch to correspond with voltage of relay being tested.
- "Relay contacts" indicator must now come on. If there is no light, relay contacts are open, relay is defective and must be replaced.
- Increase relay voltage control (clockwise, until relay armature "pulls-in". Note voltage on meter scale just before pickup; this is the "pull-in" voltage of the relay being tested. "Relay contacts" indicator light must go out at "pull-in" voltage. If the "relay contacts" light remains on, the relay contacts are welded closed, indicating the relay is defective and should be replaced.
- If the armature of the relay does not pull in at the maximum applied voltage, as noted on the meter, the coil is defective.

SCALE:

## CHECKING OF POTENTIAL RELAY

RP/3.15.2/04

MAT:

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.

- Decrease applied voltage to the relay until the armature drops out. Note the reading on the voltmeter scale just before dropout: this is the "dropout" voltage. Light must come on when relay armature drops out or the relay contacts are sticking. (Replace relay).

#### NOTE

See your wholesaler for complete pull-in and dropout relay voltages from various relay manufacturers.

#### CAUTIONS

- Attach power cord to 230 V AC power source.
- Set relay voltage control to "zero" or minimum setting.
- Put voltage selector switch at 350 volts.
- Use white and black analyzer testing leads for continuity testing. "Relay contacts" indicator lamp will indicate open or closed circuit.

SCALE:

MAT:

## CHECKING OF POTENTIAL RELAY

RP/3.15.2/04a

FUNDAMENTALS OF  
AIR CONDITIONING

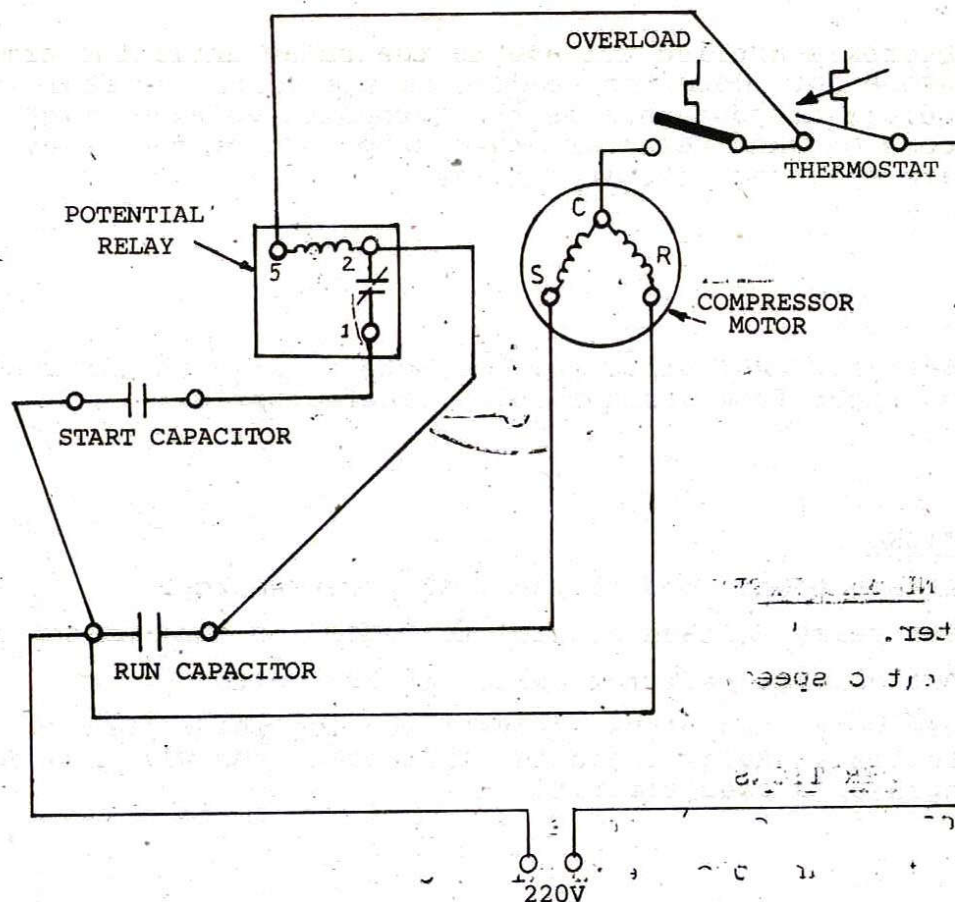


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





#### TOOLS, COMPONENTS AND MACHINERY

- Multimeter.
- Starting capacitor.
- Electric motor (CSCR).
- Clamp-on ammeter.
- Running capacitor.
- Potential relay.

#### SEQUENCE OF OPERATIONS

- Clean the electric motor terminals, potential relay terminals and wires.
- Check the electric motor terminals (C, S and R).
- Make connections of electric motor with potential relay according to the above shown diagram with proper rating capacity of capacitors.
- Check electric motor for proper operation.

#### CAUTION

- If the potential relay is positional type then adjust the relay at its correct position.
- Make electric connections tightly.

SCALE:

MAT:

## INSTALLATION OF POTENTIAL RELAY

RP/3.15.2/05

FUNDAMENTALS OF  
AIR CONDITIONING

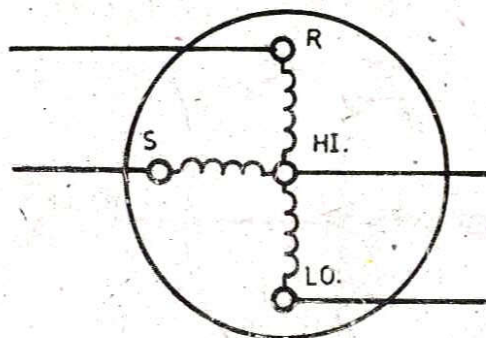


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





#### INSTRUMENT AND MACHINERY

- Multimeter.
- Fan motor (two speed)

#### SEQUENCE OF OPERATIONS

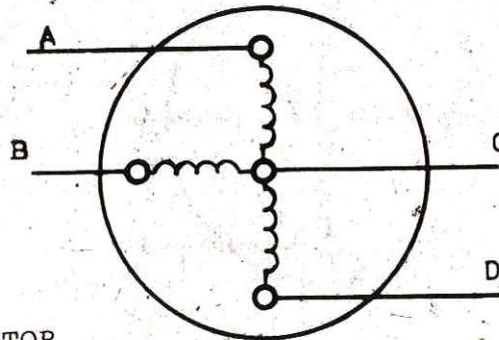
- Clean the fan motor terminals.
- Numbered the fan motor terminal leads (wires).
- Measure the resistance between each of the two terminals and record the measured resistance between each of two terminals of the motor.
- The most (maximum) resistance indicates between the start and run terminals and other two terminals are the motor speed terminals.
- From both terminals (run and start), which terminal shows least (minimum) resistance with other two terminals (motor speed terminals), that terminal is the run terminal and other one is the start terminal.
- From motor speed terminals, which terminal shows least resistance with run terminal, that terminal is the high speed terminal and other motor speed terminal is low speed terminal of the fan motor.

#### NOTE

If the fan motor has five terminal leads (wires), the motor has three speeds (low, medium and high).

SCALE:	FINDING OF SPEED WIRES OF FAN MOTOR	RP/3.15.2/06
MAT:		FUNDAMENTALS OF AIR CONDITIONING
 DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		Refg. & Air Cond.





TWO SPEED FAN MOTOR

### EXAMPLE

In the above diagram, a two speed fan motor is shown with terminals A, B, C and D, which have the following resistances between each other.

A B	=	15 ohms.	B C	=	10 ohms.	C D	=	3 ohms.
A C	=	5 ohms.	B D	=	13 ohms.	A D	=	8 ohms.

From above data, the maximum resistance is between two terminals (A and B), which are run and start terminals. So the other two terminals (C and D) are motor speed terminals.

Terminal A shows less resistance with terminals (motor speed terminals) than terminal B. Resultantly, the terminal A is running terminal and terminal B is starting terminal of the fan motor.

Now check the resistance of motor speed terminals (C and D) with terminal A.

It is the least resistance between the terminal A and terminal C than terminal A and terminal D. Resultantly, the terminal C is the high speed terminal and terminal D is the low speed terminal of the fan motor.

SCALE:

MAT:

## FINDING OF SPEED WIRES OF FAN MOTOR

RP/3.15.2/06a

FUNDAMENTALS OF  
AIR CONDITIONING

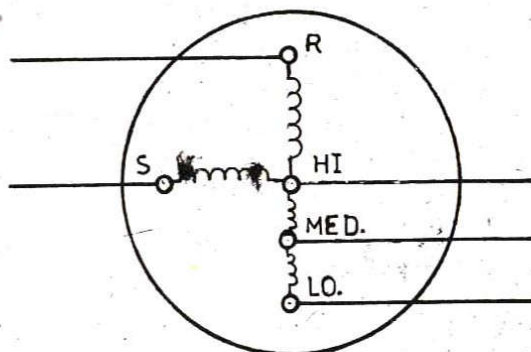


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





### INSTRUMENT AND MACHINERY

- Multimeter.
- Fan motor (three speed).

### SEQUENCE OF OPERATIONS

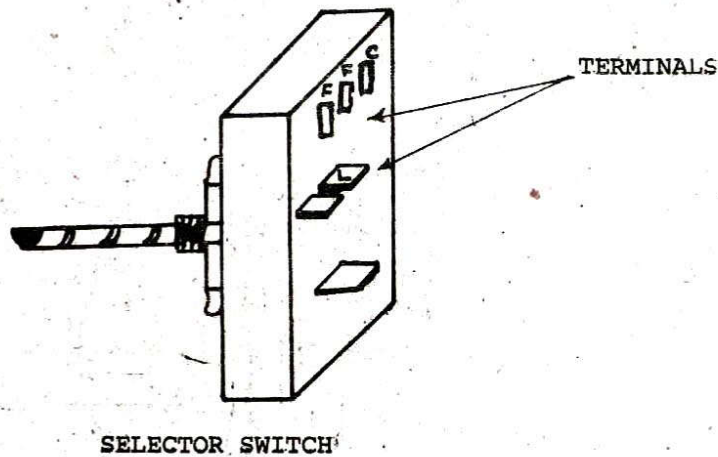
- Clean the fan motor terminals.
- Numbered the fan motor terminal leads (wires).
- Measure the resistance between each of the two terminals and record the measured resistance between each of the two terminals of the motor.
- The most (maximum) resistance indicates between the start and run terminals and other three terminals are the motor speed terminals.
- From both terminals (run and start), which terminal shows least (minimum) resistance with other three terminals (motor speed terminals), that terminal is the run terminal and other one is the start terminal.
- From motor speed terminals, which terminal shows least resistance with run terminal, that terminal is high speed terminal and other two motor speed terminals are medium and low speed terminals of the fan motor.
- From both motor speed terminals (medium and low) which terminal shows least resistance with run terminal, that terminal is medium speed terminal and other motor speed terminal is low speed terminal of the fan motor.

### NOTE

- If the fan motor has four terminal leads (wires), the motor has two speeds (low and high).

SCALE:	<b>FINDING OF SPEED WIRES OF FAN MOTOR</b>	RP/3.15.2/07
MAT:		FUNDAMENTALS OF AIR CONDITIONING
 <b>DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING</b> PAK-GERMAN TECHNICAL TRAINING PROGRAMME		<b>Refg. &amp; Air Cond.</b>





#### INSTRUMENT AND COMPONENT


- Multimeter.
- Selector switch of air conditioner.

#### SEQUENCE OF OPERATIONS

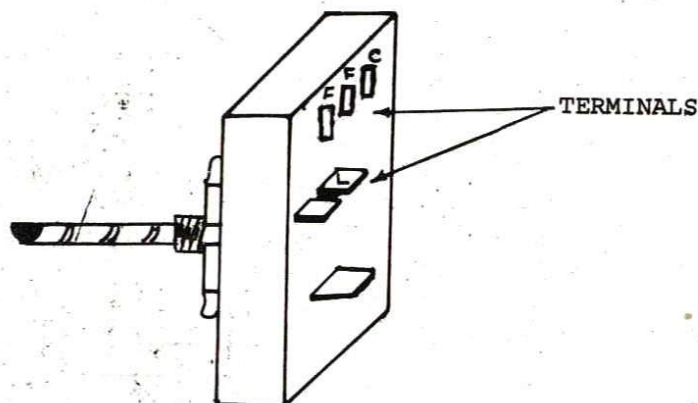
- Clean the terminals of the selector switch.
- Adjust the selector knob of the multimeter at "R x 1K".
- Put the knob of selector switch of air conditioner at "off" position, meter shows no continuity.
- Put the knob of selector switch of air conditioner at "low fan" position. The terminal at this position, which shows continuity with main supply terminal "L" will be the "low fan" terminal.
- Put the knob of selector switch of air conditioner at "high fan" position. The terminal at this position, which shows continuity will be the "high fan" terminal.
- Put the knob of the selector switch of air conditioner at "low cool" position. Check continuity of terminal "L" with "low fan" terminal and with an other terminal (except "high fan" terminal). The meter shows continuity. Resultantly, the other terminal is the "cool" terminal for compressor.
- Put the knob of selector switch of air conditioner at "high cool" position. Check continuity of terminal "L" with "high fan" terminal and with an other terminal (except "low fan" terminal). The meter shows continuity with both terminals. Resultantly, the other terminal is the "cool" terminal for compressor.

#### NOTE

- Compressor terminal (cool terminal) will show continuity, only with high fan or low fan terminals when the knob of the selector switch is at high cool or low cool position.
- Terminal "L" will show continuity at any step (low fan, high fan, low cool and high cool) except in "off" position.
- Put main supply lead at terminal "L".

SCALE:	<b>FINDING OF TERMINALS OF SELECTOR SWITCH</b>	RP/3.15.2/08.
MAT:		FUNDAMENTALS OF AIR CONDITIONING
 <b>DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING</b> PAK-GERMAN TECHNICAL TRAINING PROGRAMME		Refg. & Air Cond.





#### INSTRUMENT AND COMPONENT

- Multimeter.
- Selector switch of air conditioner.

#### SEQUENCE OF OPERATIONS

- Clean the terminals of the selector switch.
- Adjust the selector knob of the multimeter at "R x 1K".
- Put the knob of selector switch of air conditioner at "off" position, meter shows no continuity.
- Put the knob of selector switch of air conditioner at "low fan" position and check "low fan" terminal.
- Put the knob of the selector switch of air conditioner at "high fan" position and check "high fan" terminal.
- Put the knob of selector switch at "low cool" position and check continuity of terminal "L" with two terminals (low fan and cool [compressor] terminals). Meter shows continuity.
- Put the knob of selector switch at "high cool" position and check continuity of terminal "L" with two terminals (high fan and cool [compressor] terminals). Meter shows continuity.

#### RESULT

The selector switch of air conditioner is correct.

#### NOTE

- Compressor terminal (cool terminal) will show continuity, only with high fan or low fan terminals when the knob of the selector switch is at high cool or low cool position.
- Terminal "L" will show continuity at any step (low fan, high fan, low cool and high cool), except in "off" position.

SCALE:

## CHECKING OF SELECTOR SWITCH

RP/3.15.2/09

MAT:

FUNDAMENTALS OF  
AIR CONDITIONING

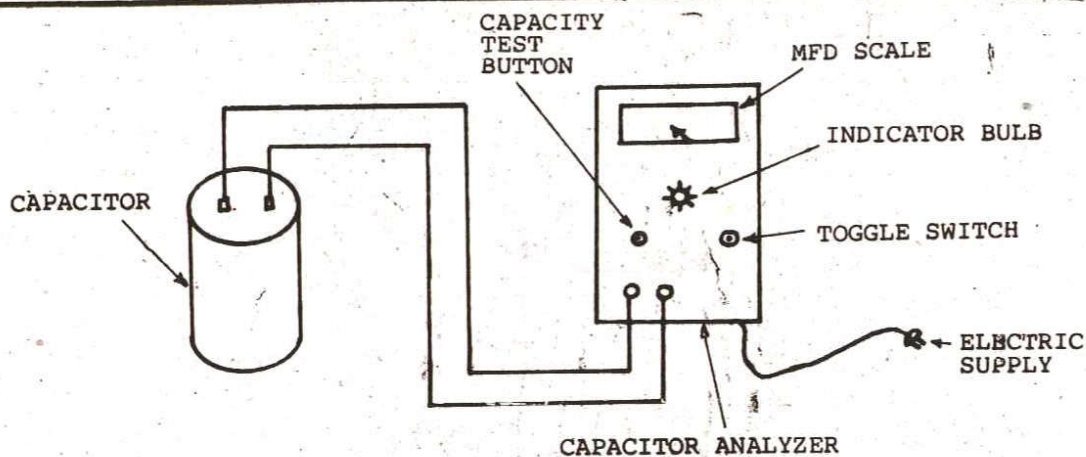


DEVELOPMENT-CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





### INSTRUMENT AND COMPONENT

- Capacitor.
- Capacitor analyzer.

### SEQUENCE OF OPERATIONS

- Clean the terminals of the capacitor.
- Connect the probs of the capacitor analyzer with terminals of the capacitor in accordance with operating instructions.
- Put "ON" the toggle switch of the capacitor analyzer and watch the light of the indicator bulb.
  - (1) If the indicator bulb does not show light, the capacitor is open (do not press the capacity test button).
  - (2) If the indicator bulb shows light continuously, the capacitor is short (do not press the capacity test button).
  - (3) If the indicator bulb shows light, but then dims, the capacitor is leaking (do not press the capacity test button).
  - (4) If the indicator bulb shows light, then goes off, press the capacity test button for the actual reading of the capacitance. If the meter of the analyzer shows capacitance according to the capacitor rating, the capacitor is good.

### DISCARD CAPACITORS

Run capacitor      5% below rating.  
 Start capacitor    20% below rating.

### CAUTION

- For meter protection, check for highest Mfd. rating first.
- Never place fingers across the terminals of a capacitor. It may be charged and give a shock. Always short it with a coated wire before handling it. Mostly capacitor analyzers are automatically discharge the capacitor when the toggle switch is returned to the "OFF" position.

SCALE:

MAT:

## TESTING OF CAPACITOR

RP/3.15.2/10

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



## CAPACITOR TESTING WITH OHMMETER

- Place one prob of the Ohmmeter on one terminal of the capacitor to be checked. While observing the Ohmmeter, place the other prob to the other terminal of the capacitor. The meter needle will immediately register zero resistance and then slowly increase in resistance until it approaches infinity. If the meter reads infinity at beginning, the capacitor is open. If the meter continues to read zero, the capacitor is shorted. In either case capacitor must be replace. To check a metal-clad capacitor for grounded condition, set the ohmmeter on the highest scale and place one prob on the metal casing of the capacitor, and alternately touch each terminal of the capacitor. A high resistance (250,000  $\Omega$ ) or infinity should be indicated on a good capacitor.
- If the capacitor shows visual evidence of liquid leakage or if the case of the capacitor is bulged or cracked, replace the capacitor even though it may seem to be good through testing.

### NOTE

- The lower the rating, the higher the ohmmeter setting required for testing the capacitors.
- Discharge the capacitor with a 20,000  $\Omega$  resistor before testing the capacitor.

## SIMPLEST CAPACITOR TEST

The simplest capacitor test is to substitute a good capacitor for the one being tested. If the motor operates, the old capacitor is faulty.

### NOTE

- The replacement capacitor should be the same capacity as the old one. If one must be used of a different capacity, it should be 5 to 10 percent over capacity rather than under.

SCALE:

## TESTING OF CAPACITOR

RP/3.15.2/10a

MAT:

FUNDAMENTALS OF  
AIR CONDITIONING

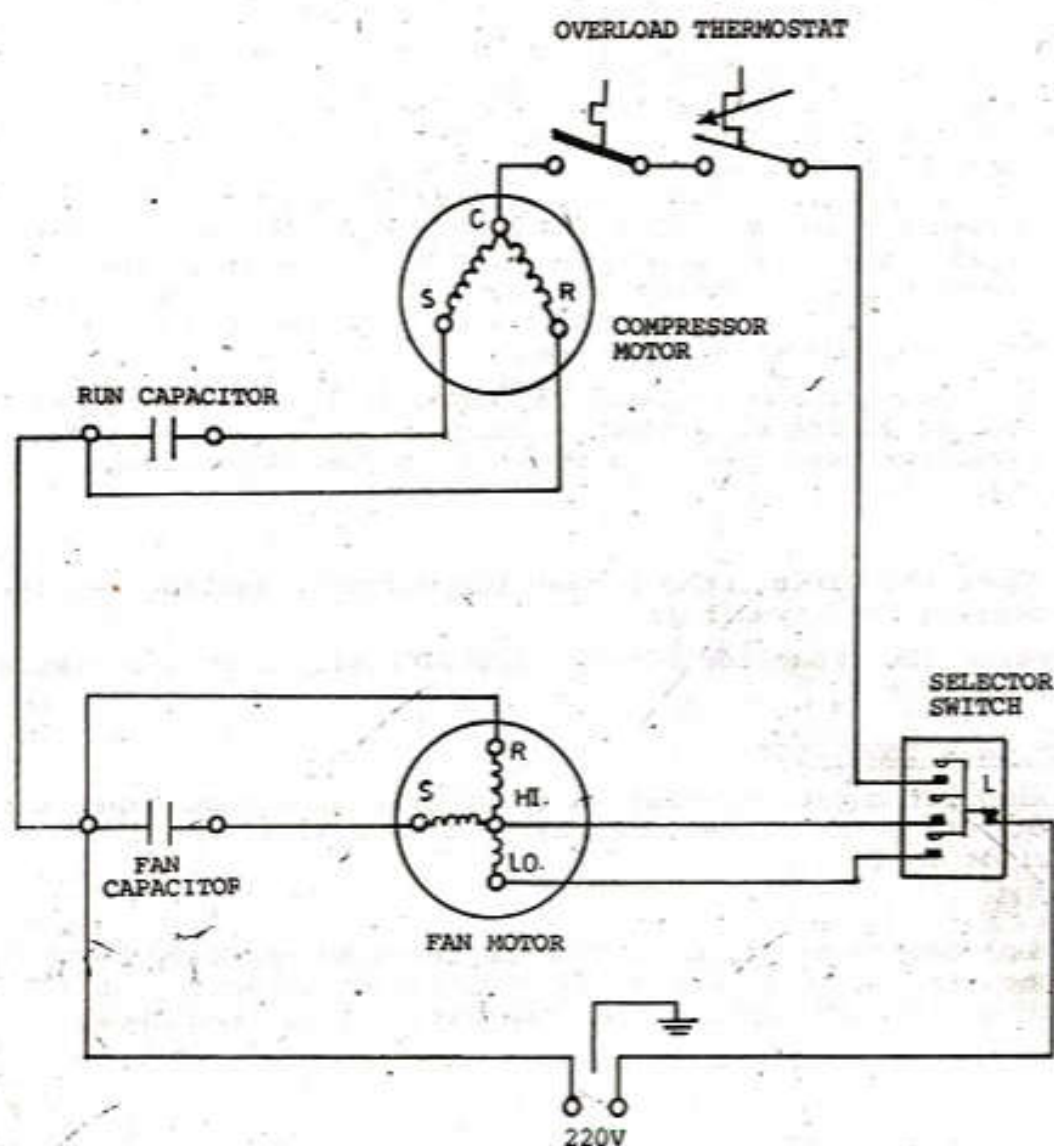


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





MAKE ELECTRIC WIRING CIRCUIT OF WINDOW AIR CONDITIONING UNIT ACCORDING TO THE ABOVE DIAGRAM.

SCALE:

MAT:

## ELECTRIC WIRING CIRCUIT OF WINDOW AIR CONDITIONER

RP/3.15.2/11

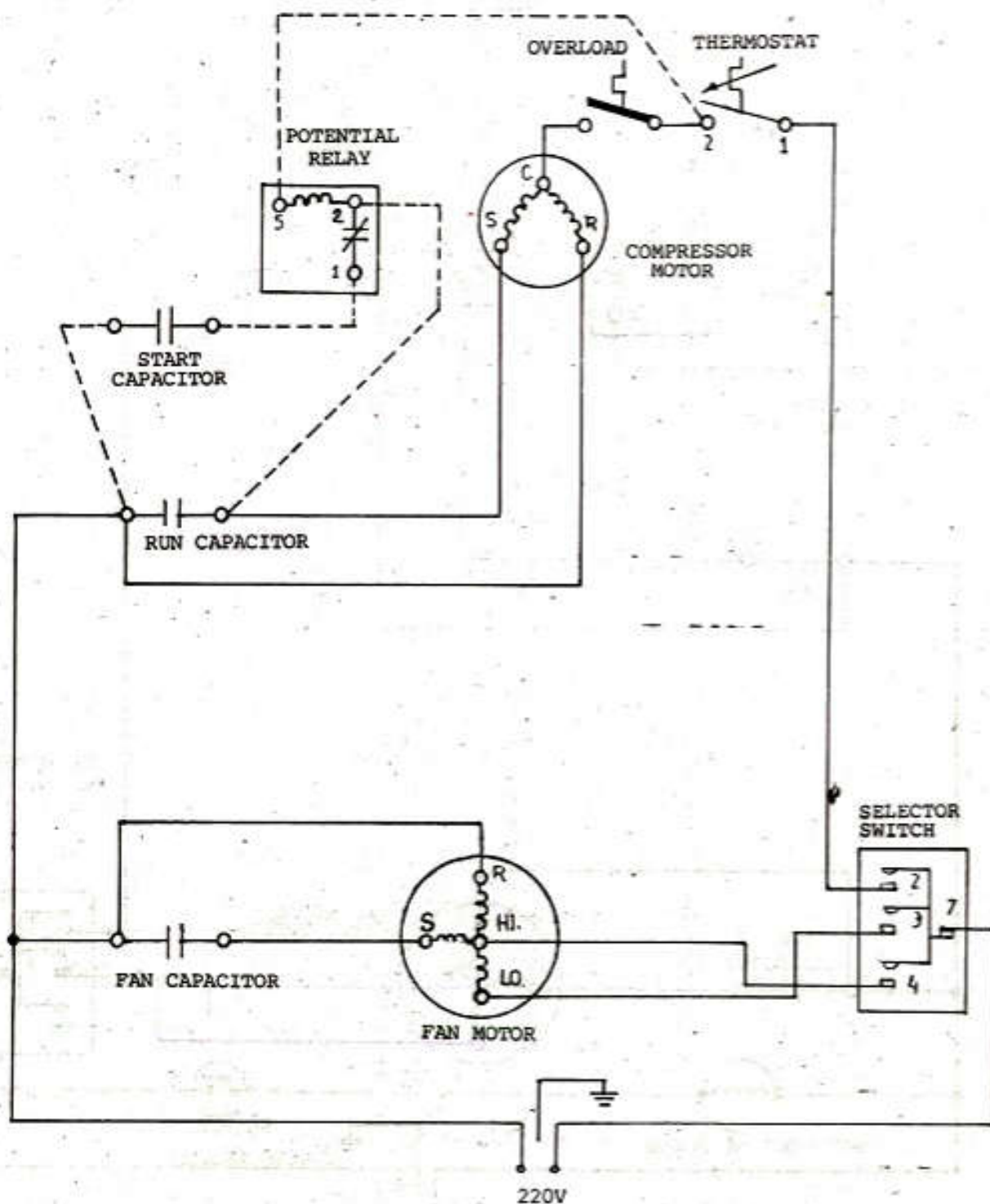
FUNDAMENTALS OF AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



MAKE ELECTRIC WIRING CIRCUIT OF WINDOW AIR CONDITIONING UNIT ACCORDING TO THE ABOVE DIAGRAM.

SCALE:

# ELECTRIC WIRING CIRCUIT OF WINDOW AIR CONDITIONER

RP/3.15.2/12

MAT:

FUNDAMENTALS OF  
AIR CONDITIONING

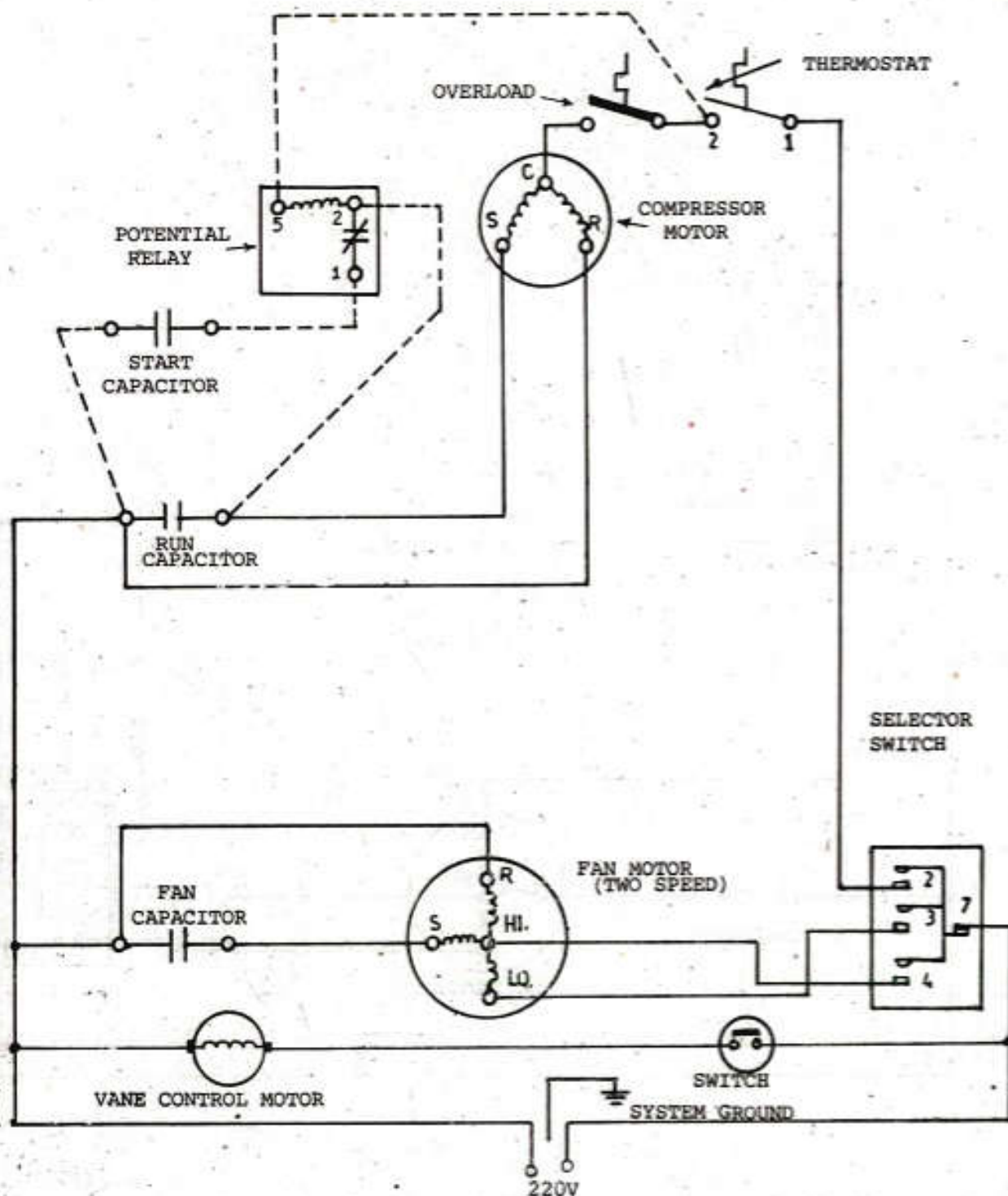


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

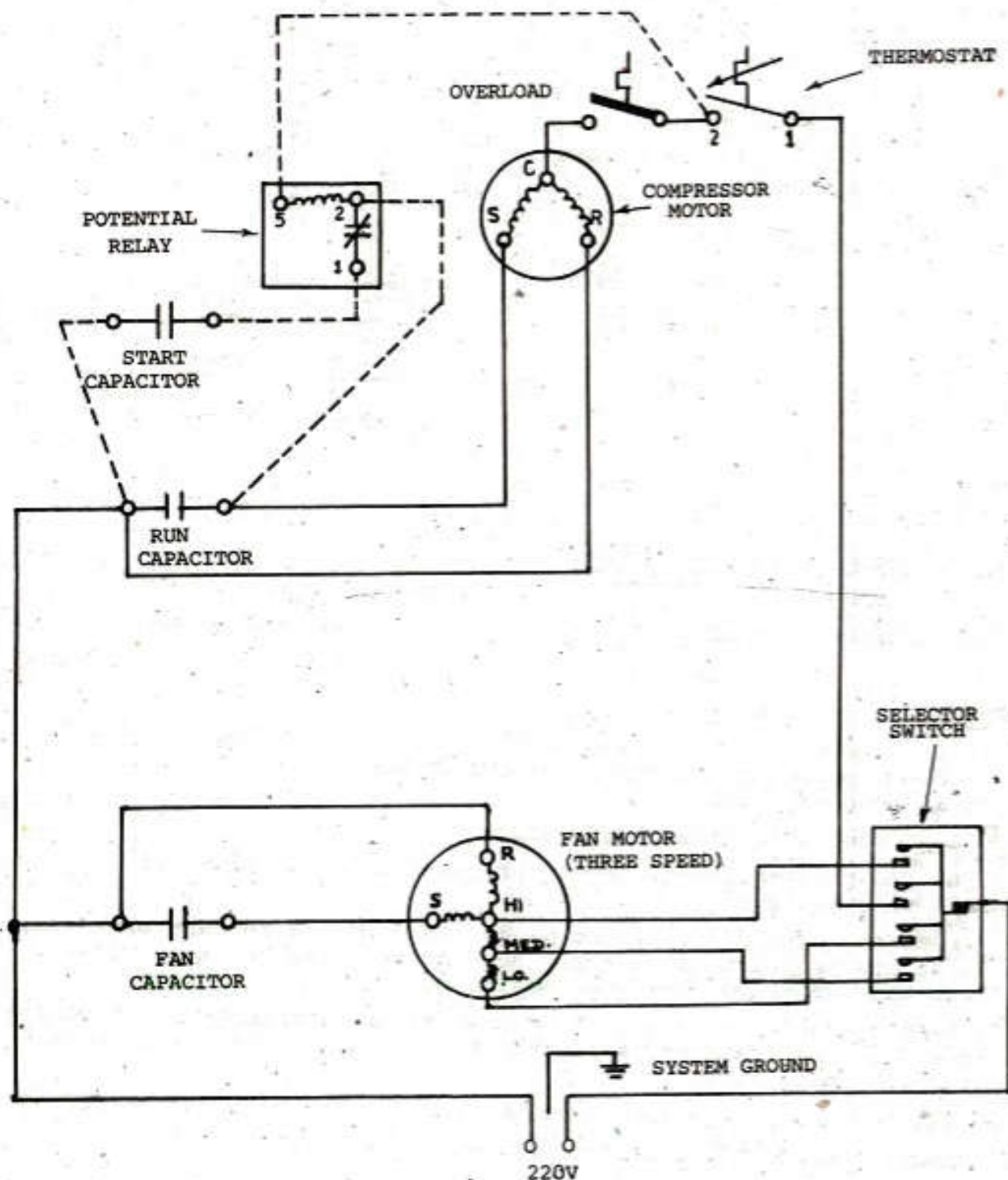
Refg  
&  
Air Cond





MAKE ELECTRIC WIRING CIRCUIT OF WINDOW AIR CONDITIONING UNIT ACCORDING TO THE ABOVE DIAGRAM.

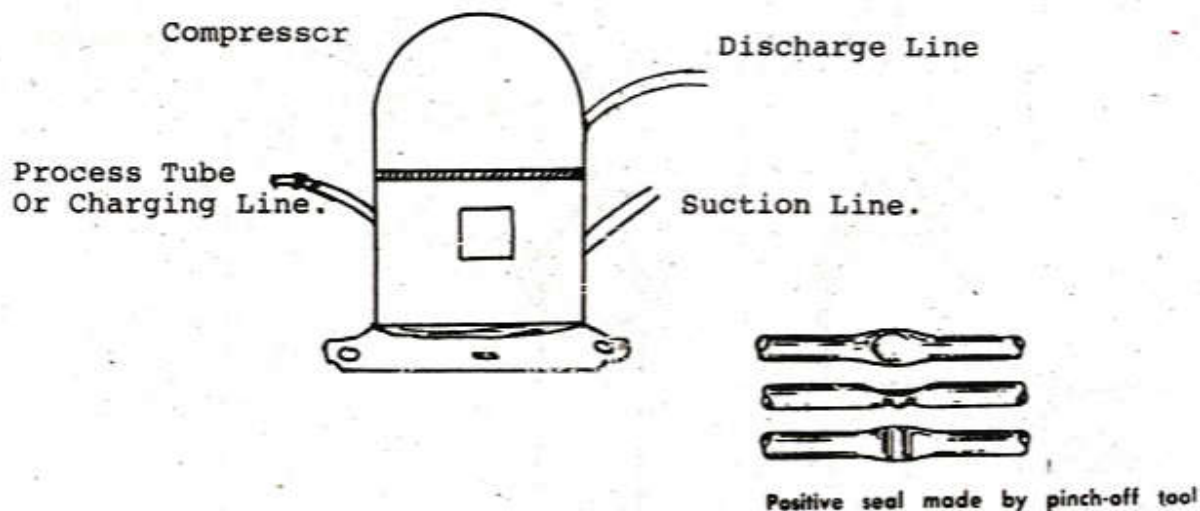
SCALE:	ELECTRIC WIRING CIRCUIT OF WINDOW AIR CONDITIONER	RP/3.15.2/13
MAT:		FUNDAMENTALS OF AIR CONDITIONING
 DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING		Refg. & Air Cond.
PAK-GERMAN TECHNICAL TRAINING PROGRAMME		



MAKE ELECTRIC WIRING CIRCUIT OF WINDOW AIR CONDITIONING UNIT ACCORDING TO THE ABOVE DIAGRAM.

SCALE:	ELECTRIC WIRING CIRCUIT OF WINDOW AIR CONDITIONER	RP/3.15.2/14
MAT:		FUNDAMENTALS OF AIR CONDITIONING
 DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		Refg. & Air Cond.





#### TOOLS, MATERIAL AND MACHINERY

- Pinch-off tool.
- Water-soap solution.
- Refrigerant charged unit.
- Oxyacetylene welding set.

#### SEQUENCE OF OPERATIONS

- Check the refrigerant charged unit operation (cooling, suction pressure, compressor motor current and compressor head temperature).
- Close the hand valve of the gauge manifold.
- Put the pinch-off tool on the process tube and pinch-off the process tube.
- Crack the hand valve of the gauge manifold and release pressure, (the low pressure gauge will show no pressure and then close the hand valve of the gauge manifold).
- Check pressure on gauge, if it does not show pressure then remove the gauge manifold and separate the fittings from the process tube (charging line).
- Dead the end of the process tube by making a leakproof joint.
- Remove the pinch-off tool from the process tube.
- Check joint to ensure that it is leakproof.

#### CAUTION

- Pinch-off the process tube atleast at two places with narrow distances, near to the compressor housing.
- Do not remove pinch-off tool from the process tube, before making a leakproof joint at the end of process tube.

SCALE:

MAT:

### PINCH-OFF CHARGING LINE

RP/3.15.2/15

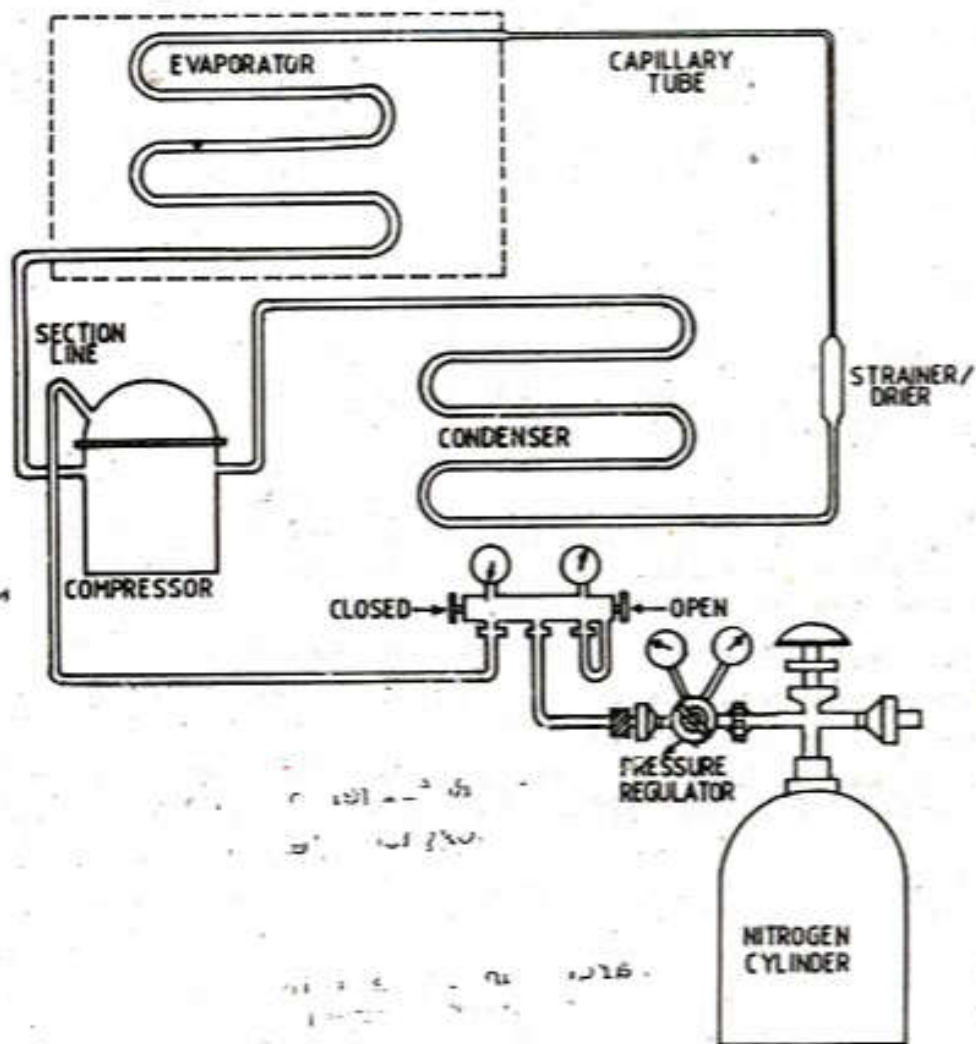
FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



#### TOOLS, MATERIAL, EQUIPMENT AND MACHINERY

- Gauge manifold..
- Window air conditioning unit.
- Tool kit complete.
- Water-soap solution.
- Nitrogen gas.

#### SEQUENCE OF OPERATIONS

- Connect the centre hose of the gauge manifold with nitrogen gas cylinder tightly.
- Connect the high pressure side gauge hose of the gauge manifold with process tube (charging line) of the air conditioning unit.
- Pressurize the air conditioning unit 30 to 100 psi (311 to 794 kPa) and test for leaks by applying the water-soap solution.
- If no leakage forms (no pressure drop and no bubbles appear) then raise the test pressure up to 170 psi (1277 kPa).
- Test for leaks once more, with water-soap solution.

SCALE:

MAT:

## TESTING FOR LEAKS

RP/3.15.2/16

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAX-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



### RESULT

- If no bubbles appear and gauge does not show drop in pressure, there is no leakage in the unit.
- If bubbles appear and gauge shows drop in pressure, there is leakage in the unit. Mark-out the point of leakage and repair it.

### CAUTION

- Unit must be stopped when test for leaks.
- Use high pressure gauge of the gauge manifold, calibrated from 0 psi to 500 psi.

### NOTE

- A pressure reducing device (pressure regulator and pressure relief valve) must be used, when testing for leaks with nitrogen gas or carbon-dioxide gas.
- Detect leaks, more carefully at the joints.
- Never use oxygen, air or any flammable gas for detecting leaks. An explosion may occur.
- When repair leaks, check the pressure to be sure it is 0 psi. (no vacuum or pressure) in the system.

SCALE:

MAT:

## TESTING FOR LEAKS

RP/3.15.2/16a

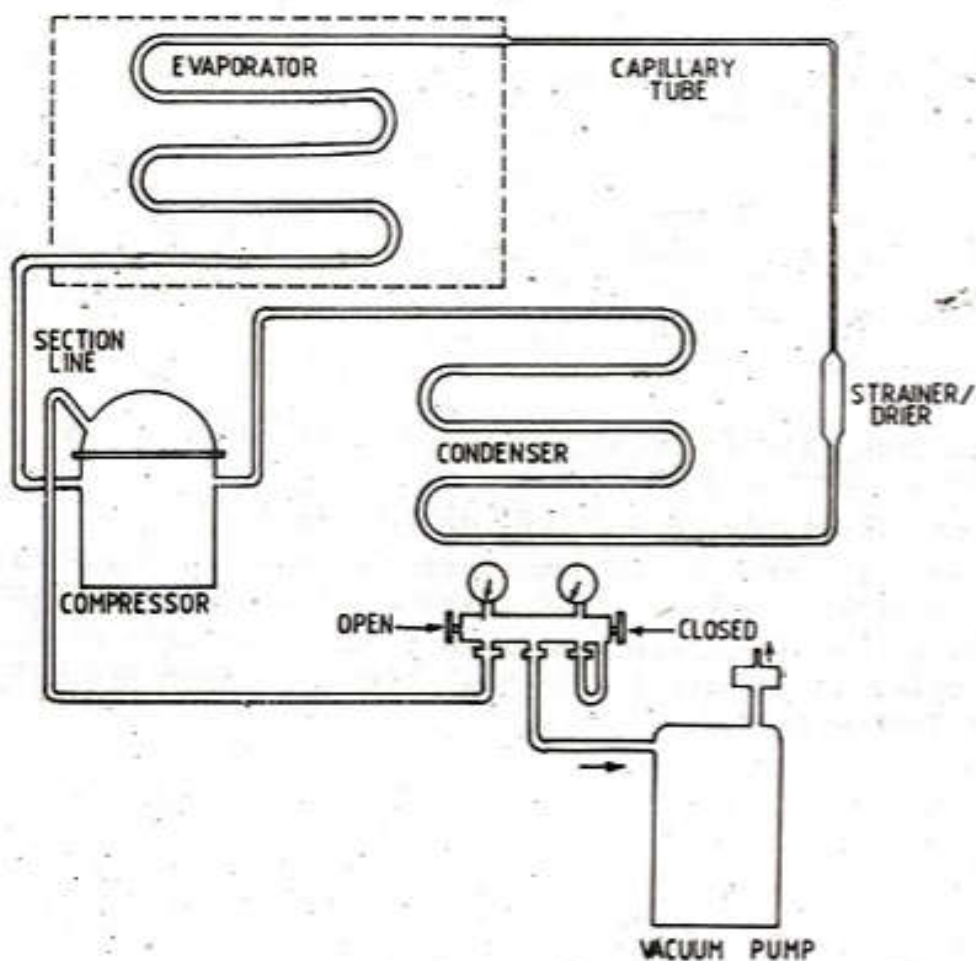
FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



#### TOOLS, EQUIPMENT AND MACHINERY

- Vacuum pump.
- Gauge manifold.
- Heat gun.
- Window air conditioner.

#### SEQUENCE OF OPERATIONS

- Connect the low side gauge (compound gauge) hose to charging line (process tube) of the air conditioning system.
- Connect the centre hose of the gauge manifold with vacuum pump.
- Start the vacuum pump and draw a vacuum atleast 29.92 in. Hg.
- Close the low side hand valve of the gauge manifold.
- Stop the vacuum pump.

SCALE:

MAT:

**VACUUM**

RP/3.15.2/17

FUNDAMENTALS OF  
AIR CONDITIONING



**DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING**

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



- Watch the vacuum gauge (low side gauge), if it rises, there is still moisture in the system.
- Start vacuum pump again.
- Open the low side hand valve of the gauge manifold and draw a vacuum of at least 29.92 in. Hg.
- Close the hand valve of the gauge manifold (low side hand valve).
- Stop vacuum pump.
- Watch the vacuum gauge (low side gauge). If it rises, there is still moisture in the system and now the system is ready for charging refrigerant.

#### NOTE

- High side hand valve of the gauge manifold should be closed during evacuation process.
- Check oil of the vacuum pump before use.
- Do not stop the vacuum pump before closing the hand valves of the gauge manifold. This is to prevent air being drawn into system.
- During evacuation the system must be heated that will not only vaporize the moisture, but will drive the moisture out of all the crevices.

SCALE:

MAT:

## VACUUM

RP/3.15.2/17a

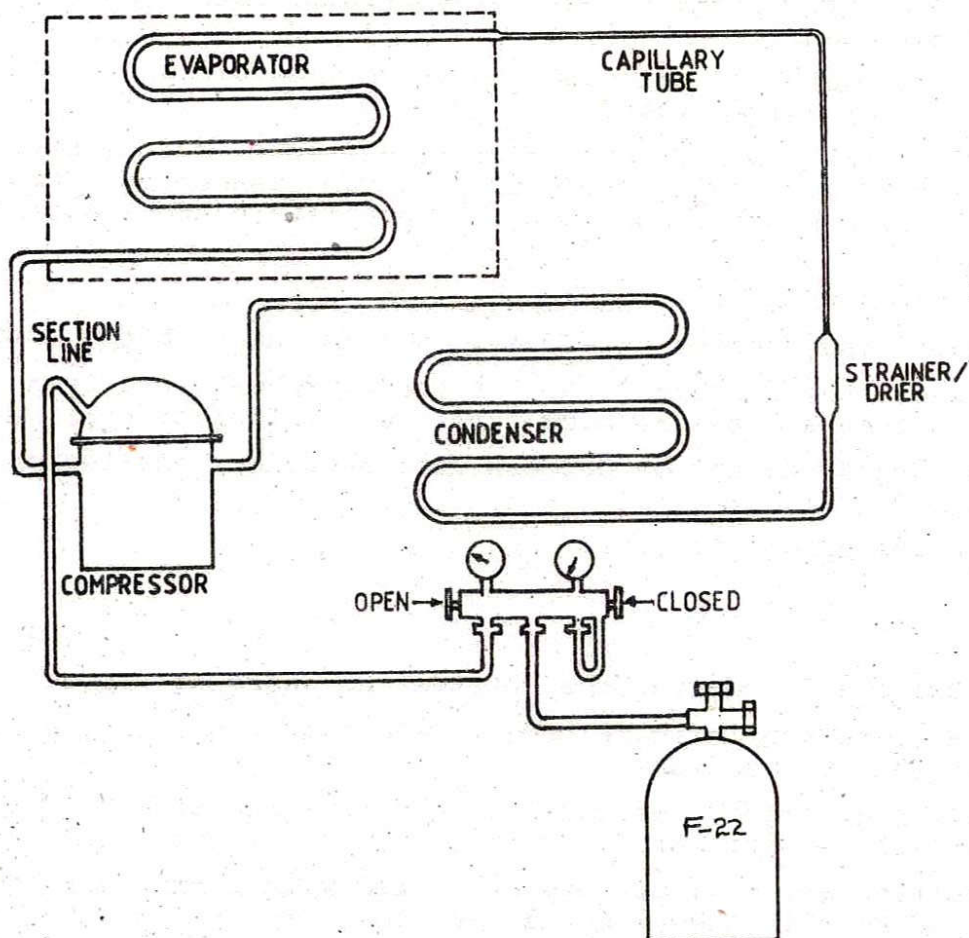
FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refr.  
&  
Air Cond.



#### TOOLS , MATERIAL AND MACHINERY

- Refrigerant F-22
- Clamp-on ammeter.
- Window air conditioner.
- Oxyacetylene welding set.
- Gauge manifold.
- Pinch-off tool.
- Thermometer.

#### SEQUENCE OF OPERATIONS

- Complete the vacuum and disconnect the centre hose of the gauge manifold from the vacuum pump and connect it to a cylinder, containing the refrigerant F-22.
- Open the cylinder valve (vapor) and purge the centre hose, then tight the hose connection.
- Open the low side hand valve of gauge manifold and admit refrigerant (break vacuum) in the system.
- Start the air conditioning system.

SCALE:

MAT:

## CHARGING OF REFRIGERANT

RP/3.15.2/18

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

Refr.  
&  
Air Cond.



- Again open the low side hand valve of the gauge manifold and allow the refrigerant to enter the system, until proper charge has been added.
- Close low side hand valve of the gauge manifold and close the cylinder valve tightly.
- Closely watch the suction (low side) pressure, recommended compressor motor amperage (current), compressor head temperature moist of the system, suction line temperature and evaporator temperature.
- Check the system for proper operation.
- Pinch-off the process tube (charging line) near to the compressor.
- Disconnect the low side hose of the gauge manifold from the process tube, and centre hose from the refrigerant cylinder.
- Silver braze the end of process tube and check for leakproof joint.
- Remove the pinch-off tool.

#### NOTE

- Unit must be run during the refrigerant charging process.
- Unit must be run during pinch-off and silver brazing the end of the process tube.
- Never charge liquid refrigerant into low side of the window air conditioner.
- The refrigerant cylinder may be heated with warm water not over 120 F (49°C) and never use an open flame for heating.
- Pinch-off tool should not be removed, before leakproof joint has been made at the end of the process tube.

SCALE:

MAT:

## CHARGING OF REFRIGERANT

RP/3.15.2/18a

FUNDAMENTALS OF  
AIR CONDITIONING

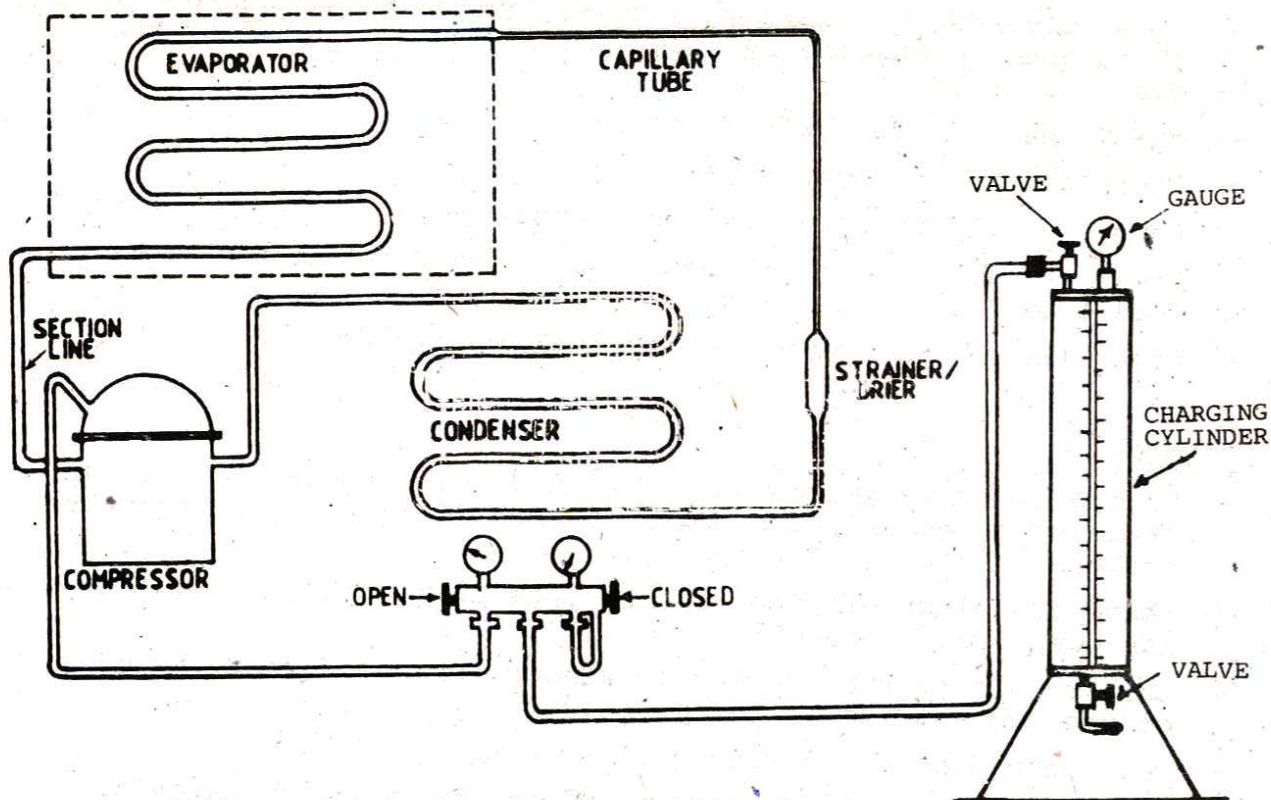


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





#### TOOLS, MATERIAL AND MACHINERY

- Gauge manifold.
- Pinch-off tool.
- Charging cylinder.
- Window air conditioner.
- Thermometer.
- Refrigerant F-22
- Clamp-on ammeter.
- Oxyacetylene welding set.

#### SEQUENCE OF OPERATIONS

- Put the refrigerant (F-22) in the charging cylinder.
- Adjust the dial (scale marked on dial) of the charging cylinder according to the pressure gauge reading (pressure gauge shows the gas pressure in the charging cylinder).
- Evacuate the system.
- Attach a line from the charging cylinder to the centre of the gauge manifold and purge with the fittings loose at the centre part of the gauge manifold.
- Open the gauge manifold valve (low side hand valve of the gauge manifold).
- Crack the charging cylinder valve and allow the refrigerant to enter the system (after breaking vacuum, start compressor).
- Check the amount of refrigerant by reading the scale on the charging cylinder, to put the correct amount of charge (refrigerant) in the system.

SCALE:

MAT:

## CHARGING OF REFRIGERANT

RP/3.15.2/19

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



- After entering the correct amount of refrigerant charged in the system, close the cylinder valve and hand valve of the gauge manifold.
- Check the unit for proper operation.
- Pinch-off the process tube (charging line).
- Remove gauge manifold from the system.
- Braze the end of the process tube and remove the pinch-off tool from the process tube.
- Check the process tube end for leakproof joint.

#### CAUTION

- Before removing gauge manifold, it should be ensure that the charging cylinder valve has been closed and the process tube has been pinched off properly.
- Leave the pinch-off tool on the tube until the process tube end has been brazed properly.
- Unit should be run during brazing/silver soldering the end of the process tube, after pinching.
- Unit should be run during gas charging.
- Measure the amount of refrigerant on the scale by watching the glass tube (liquid level indicator), when charge refrigerant.
- Use the top valve of the charging cylinder during charging of refrigerant in gas position.

SCALE:

MAT:

## CHARGING OF REFRIGERANT

RP/3.15.2/19a

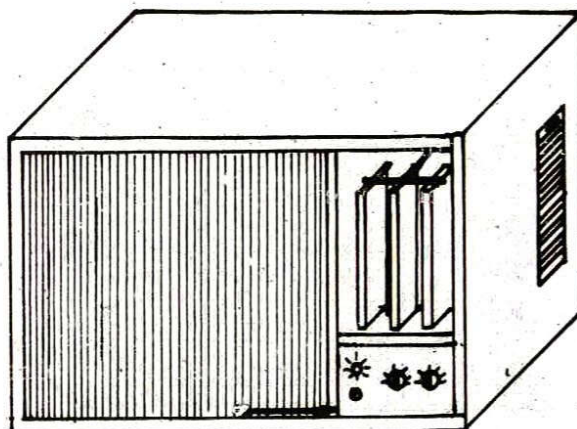
FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refr.  
&  
Air Cond.



WINDOW AIR CONDITIONER

#### TOOLS AND MACHINERY

- Screw driver set.
- Window air conditioner.
- Fin straightener or fins straightener comb.

#### SEQUENCE OF OPERATIONS

- Disconnect the electric supply of window air conditioner.
- Remove front grille and filter, from the air conditioner.
- Remove the air conditioner from its casing.
- Check the number of fins per inch of evaporator and condenser.
- Select the correct comb of fin straightener or fins straightener comb, according to the number of fins per inch.
- Straighten the fins by moving the comb of fin straightener from down to upward direction in the fins.
- Put the air conditioner in its casing
- Make electric supply connections and start air conditioner.
- Check the air velocity, incoming from the evaporator or condenser (which fins are straighten) for proper air circulation.
- Set the filter in front of the evaporator and the adjust the front grille.

#### CAUTION

Never use any sharp edges metal piece for straighting the fins of any type of evaporator or condenser, of refrigeration and air conditioning machinery.

SCALE:

MAT:

## STRAIGHTENING OF FINS

RP/3.15.2/20

FUNDAMENTALS OF  
AIR CONDITIONING

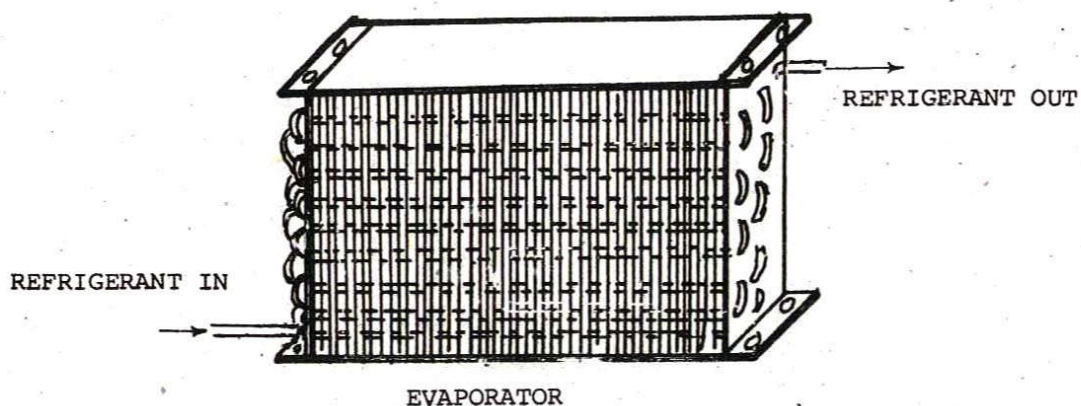


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





#### TOOLS, MATERIAL AND MACHINERY

- Window air conditioner.
- Electric blower (portable).
- Fin straightener.
- Refrigerant F-22.
- Water-soap solution.
- Nitrogen gas.
- Socket wrench set.
- Gauge manifold.
- Vacuum pump.
- Oxyacetylene welding set.

#### SEQUENCE OF OPERATIONS

- Separate the evaporator of the air conditioner by disconnecting the suction line and refrigerant control.
- Clean the evaporator and straighten the fins.
- Close the one end of the evaporator.
- Pressurize the evaporator upto 170 psig. (1277 kPa).
- Detect leakage and mark the point of leakage.
- Repair leakage and pressurize the evaporator again.
- Check for leaks again.
- If no leakage (evaporator is OK), adjust the evaporator in the air conditioner.
- Attach suction line and refrigerant control, with evaporator.
- Pressurize the air conditioning system upto 170 psig. (1277 kPa).
- Check for leaks, if no leakage, evacuate the air conditioning system.
- Charge refrigerant and check it for proper operation.

SCALE:

MAT:

## MAINTENANCE OF EVAPORATOR

RP/3.15.2/21

FUNDAMENTALS OF  
AIR CONDITIONING

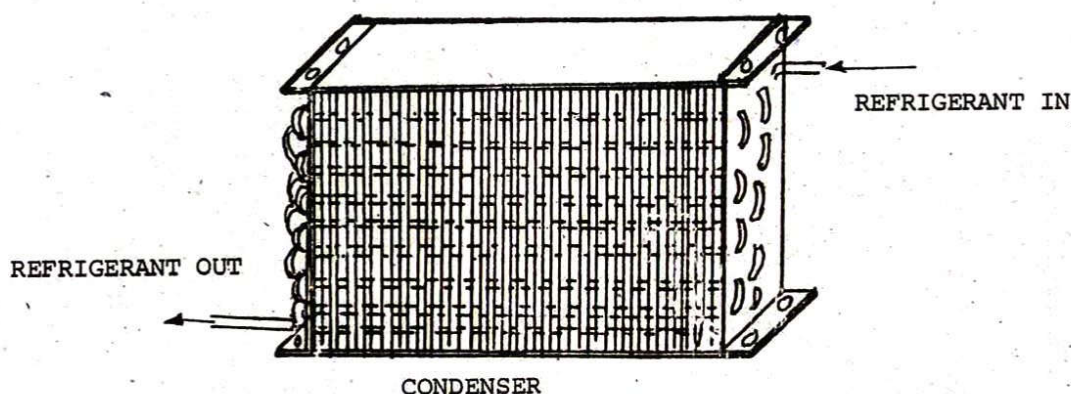


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





#### TOOLS, MATERIAL AND MACHINERY

- Window air conditioner.
- Electric blower (portable).
- Fin straightener.
- Refrigerant F-22.
- Water-soap solution.
- Nitrogen gas.
- Socket wrench set.
- Gauge manifold.
- Vacuum pump.
- Oxyacetylene welding set.

#### SEQUENCE OF OPERATIONS.

- Separate the condenser of the air conditioner by disconnecting the discharge line and liquid line.
- Clean the condenser and straighten the fins.
- Close the one end of the condenser.
- Pressurize the condenser upto 170 psig. (1277 kPa).
- Detect leakage and mark the point of leakage.
- Repair leakage and pressurize the condenser again.
- Check for leaks again.
- If no leakage (condenser is OK), adjust the condenser in the air conditioner.
- Attach the discharge line and liquid line, with condenser.
- Pressurize the air conditioning system upto 170 psig. (1277 kPa).
- Check for leaks, if no leakage, evacuate the air conditioning system.
- Charge refrigerant in the air conditioning system and check it for proper operation.

#### NOTE

- When repair leaks, the pressure in the system should be 0 psig.

SCALE:

MAT:

## MAINTENANCE OF CONDENSER

RP/3.15.2/21a

FUNDAMENTALS OF  
AIR CONDITIONING

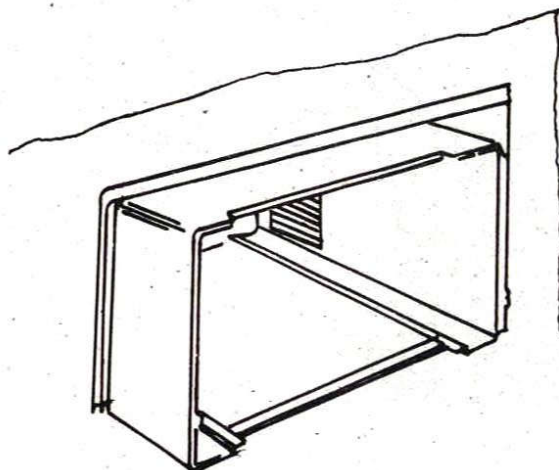


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

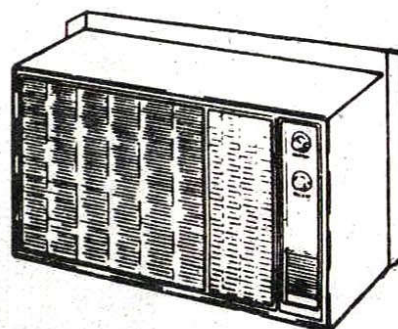
PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.

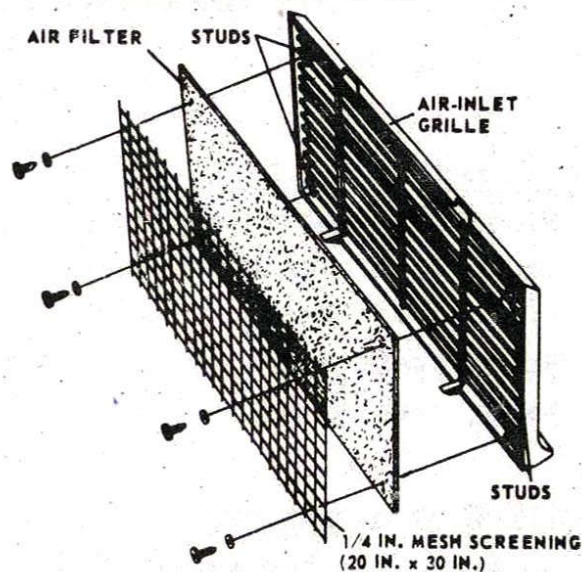




ADJUSTMENT OF CASING



MOUNTING OF AIR CONDITIONER



Typical filter installation for window air conditioner.

#### TOOLS, EQUIPMENT AND MACHINERY

- Window air conditioner.
- Socket wrench set.
- Tool kit.
- Clamp-on ammeter
- Electric drill machine.
- Masonry drills.

#### SEQUENCE OF OPERATIONS

- Make foundation (proper hole) as the size of the air conditioner's casing.
- Mount the casing of the air conditioner in the hole.
- Adjust the casing (housing) in the hole to tilt downward 1/4 inch on the outside.
- Seal the cracks (gap between the casing and wall) with metal plates, rubber gaskets and sealing compounds.
- Check the casing that it is securely tighten in the hole.

SCALE:

MAT:

## INSTALLATION OF WINDOW AIR CONDITIONER

RP/3.15.2/22

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



- Put (mount) the air conditioner in the housing (casing).
- Adjust the filter and grille (first adjust the filter) on the front side of the air conditioner.
- Make electric connections and start the air conditioner.
- Adjust the thermostat at proper temperature and check the air conditioner for proper operation.

#### PRECAUTIONS

- The housing (casing) of the air conditioner must be securely fastened in place to prevent the unit from falling out of the window or hole.
- All the openings should be sealed to minimize air infiltration. (The gap between the unit housing and side of the window are usually sealed with sponge rubber strips or styrofoam).
- The unit housing (casing) should be adjusted to tilt downward about 1/4 inch on the outside (windowsill with leveling bracket and security bracket mounted). This is enough to provide condensate.
- Avoid moving the unit by using the tubing or coil as hand grip because a leak can be formed. Carry the unit by holding into the bottom pan.
- Avoid forcing the unit into the casing.
- Check to be sure that the refrigerant lines and the wiring are free and clear as the unit moves into the casing.
- When making the electrical hookup, use a separate circuit.
- The filter, front grille and control knobs should be easily installed.
- Air conditioning unit should be installed in that wall/window where the sun light does not strike directly.
- The air conditioning unit should be installed where proper air wind touch to the outside (condenser side).

#### NOTE

- When the air conditioner chassis is to be installed, first remove any packing pieces (most likely to be fitted around fans and fan motor) and test the fan for tightness on the shaft and freedom of rotation without making contact with the shroud or condenser fins.

SCALE:

## INSTALLATION OF WINDOW AIR CONDITIONER

RP/3.15.2/22a

MAT:

FUNDAMENTALS OF  
AIR CONDITIONING

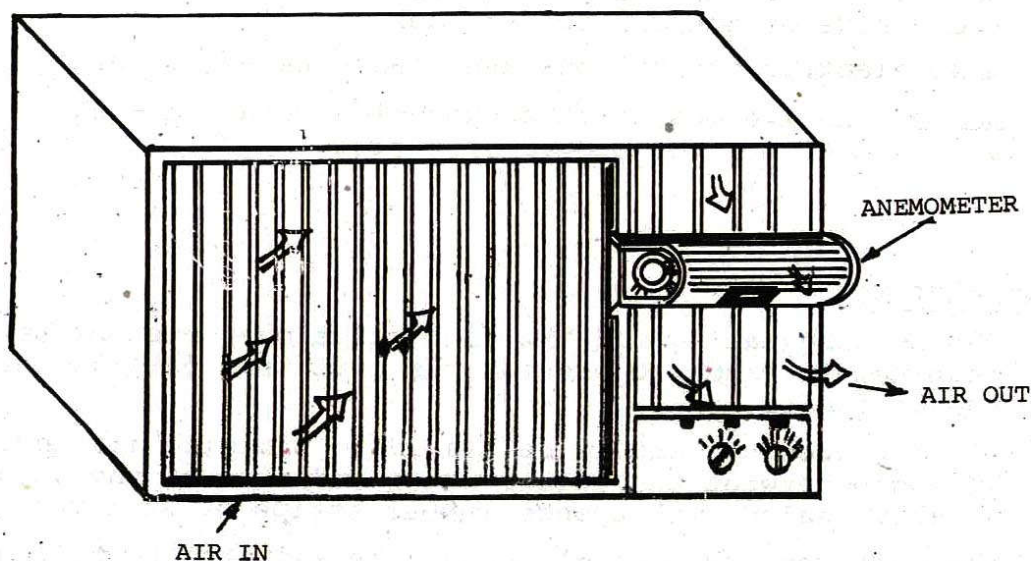


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





#### INSTRUMENT AND MACHINERY

- Anemometer.
- Window air conditioner.


#### SEQUENCE OF OPERATIONS.

- Put the knob at "V" on dial of the anemometer.
- Start air conditioner fan motor.
- Place the anemometer base in front of the grille of air conditioner.
- Turn the knob of anemometer until white vane marker is in the centre of the sight window and then turn knob until red vane is just under centre line.
- Note the reading on marked dial against carat index.
- Note atleast three readings from three different places of the grille and compute the average reading.

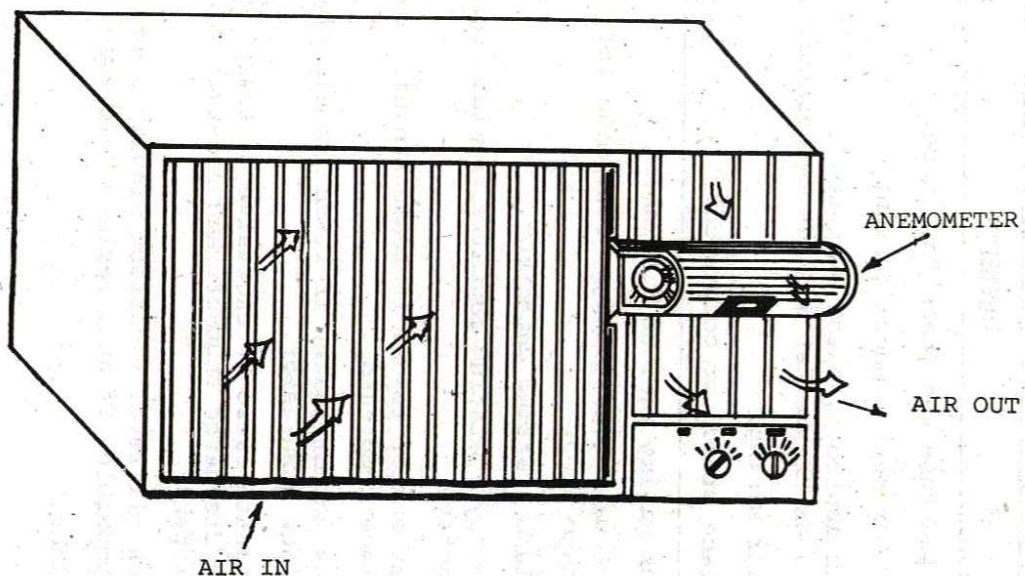
#### NOTE

Take several readings, then compute the average to ensure the greater accuracy.

There are many types of anemometers. If some other type of anemometer is available, the same experiment made accordingly.

SCALE:	MEASURING OF AIR VELOCITY	RP/3.15.2/23
MAT:		FUNDAMENTALS OF AIR CONDITIONING
 DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		Refg. & Air Cond.





#### INSTRUMENT AND MACHINERY

- Anemometer.
- Window air conditioner..

#### SEQUENCE OF OPERATIONS

- Calculate the area of the grille.
- Set the white mark of the knob against calculated area on rotating dial of the anemometer.
- Start the air conditioner fan motor.
- Place the anemometer base against the grille (supply air grille).
- Turn the anemometer knob until white vane marker is in the centre of the sight window and then turn knob until red vane is just under centre line.
- Note the reading (volume of air) on marked dial against carat index.
- Note atleast three readings from three different places of the grille and compute the average reading.

#### NOTE

Take several readings, then compute the average to ensure greater accuracy.

There are many types of anemometers. If some other type of anemometer is available, the same experiment made accordingly.

SCALE:

MAT:

## MEASURING OF AIR VOLUME

RP/3.15.2/24

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



# TROUBLE SHOOTING CHART FOR AIR CONDITIONING UNITS

TROUBLE	COMMON CAUSE	REMEDY
Unit does not run - no hum.	Blown power fuse. Protector open. Control contacts open. (Thermostat not demanding) Faulty wiring. Open circuit in stator.	Replace fuse and check for cause. Wait for rest - check current. Check controls, check pressures. (Turn on thermostat and set temperature). Repair wiring. Replace stator or compressor.
Compressor will not start - hums intermittently (cycling on protector)	Improperly wired. Low line voltage. Open starting capacitor. Relay contacts not closing. Open circuit in starting winding. Stator winding grounded (normally will blow fuse) High discharge pressure. Tight compressor. Weak starting capacitor or one weak capacitor of a set.	Check wiring against diagram. Check main line voltage, determine location of voltage drop. Replace starting capacitor. Check by operating manually, replace relay if defective Check stator leads. If leads are all right, replace compressor. Check stator leads. If leads are all right, replace compressor. Eliminate cause of excessive pressure. Make sure discharge shut-off and receiver valves are open. Check oil level - correct binding condition, if possible. If not, replace compressor. Replace.

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.2/25

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



TROUBLE	COMMON CAUSE	REMEDY
Compressor starts, motor will not get off starting winding.	<p>Low line voltage. Improperly wired. Defective relay. Running capacitor shorted. Starting and running windings shorted. Starting capacitor weak or one of a set open. High discharge pressure. Tight compressor.</p>	<p>Bring up voltage. Check wiring against diagram. Check operation - replace relay if defective. Check by disconnecting running capacitor. Check resistances. Replace compressor if defective.  Check capacitance - replace if defective.  Check discharge shutoff valves. Check pressure. Check oil level. Check binding. Replace compressor if defective.</p>
Compressor starts and runs but cycles on protector.	<p>Low line voltage. Additional current passing through protector. Suction pressure too high. Discharge pressure too high. Protector weak. Running capacitor defective. Stator partially shorted or grounded. Inadequate motor cooling. Compressor tight. Discharge valve leaking or broken.</p>	<p>Bring up voltage. Check for added fan motors and pumps connected to wrong side of protector. Check compressor for proper application. Check ventilation, restrictions and overcharge. Check current - replace protector if defective. Check capacitance - replace if defective. Check resistances; check for ground - replace if defective. Correct motor cooling system. Check oil level. Check for binding condition. Replace valve plate.</p>

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.2/25a

FUNDAMENTALS OF  
AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



TROUBLE	COMMON CAUSE	REMEDY
Starting capacitors burnout.	<p>Short cycling. Relay contacts sticking. Prolonged operation on starting winding.</p> <p>Improper relay or incorrect relay setting. Improper capacitor.</p> <p>Capacitor voltage rating too low. Capacitor terminals shorted by water.</p>	<p>Reduce number of starts to 20 or less per hour. Clean contacts or replace relay.</p> <p>Reduce starting load (install crankcase pressure limit valve), increase voltage if low - replace relay if defective. Replace relay.</p> <p>Check parts list for proper capacitor rating - mfd. and voltage. Install capacitors with recommended voltage rating. Install capacitors so terminals will not be wet.</p>
Running capacitors burnout.	<p>Excessive line voltage. High line voltage and light load. Capacitor voltage rating too low. Capacitor terminals shorted by water.</p>	<p>Reduce line voltage to not over 10 percent above rating of motor. Reduce voltage if over 10 percent excessive. Install capacitors with recommended voltage rating. Install capacitors so terminals will not be wet.</p>
Relays burnout.	<p>Low line voltage. Excessive line voltage. Short cycling. Relay vibrating. Incorrect relay. Incorrect running capacitor.</p>	<p>Increase line voltage to not less than 10 percent under compressor motor rating. Reduce voltage to maximum of 10% above motor rating Reduce number of starts per hour. Mount relay rigidly. Use relay recommended for specific motor compressor Replace running capacitor with correct mfd. capacitance.</p>

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.2/25b

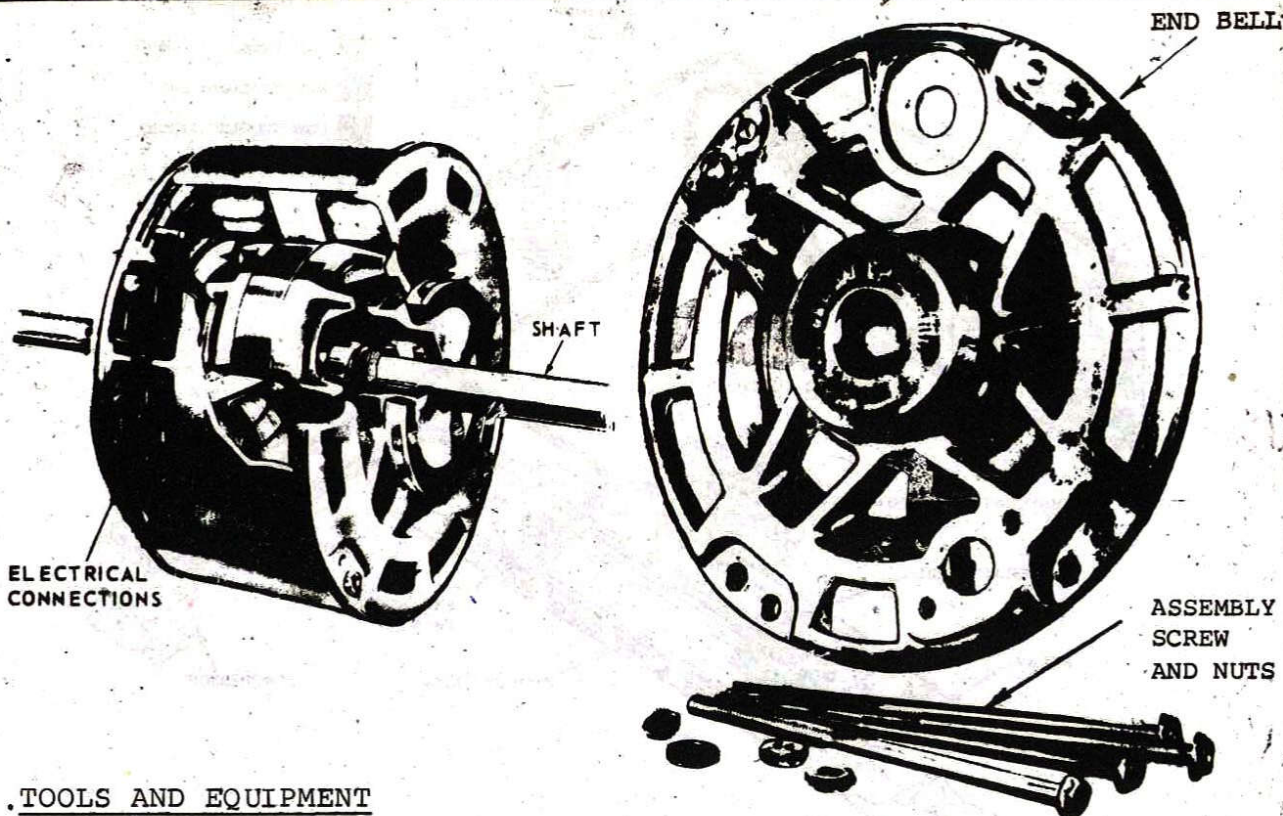
FUNDAMENTALS OF  
AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

 Refg.  
&  
Air Cond.





#### TOOLS AND EQUIPMENT

- Multimeter.
- Adjustable wrench.
- Window air conditioning unit.
- Socket wrench set.
- Allen key set.
- Electric blower (portable).

#### SEQUENCE OF OPERATIONS

- Disconnect the electric supply.
- Disconnect the fan motor from the components (fan capacitor and selector switch).
- Clean fan motor externally.
- Remove the fan and blower from the motor shaft.
- Remove the fan motor from the air conditioner.
- Check the shaft play. Replace bushes or bearings, if necessary.
- Lubricate the bushes or bearings.
- Check for a grounded winding and internal short of the motor.
- Install fan motor in air conditioner.
- Fit the fan and blower on the fan motor shaft tightly.
- Make fan motor connections in air conditioner.
- Make electric supply connections and check for proper operation.

SCALE:

## SERVICING AND MAINTENANCE OF FAN MOTOR

RP/3.15.2/26

MAT:

FUNDAMENTALS OF  
AIR CONDITIONING

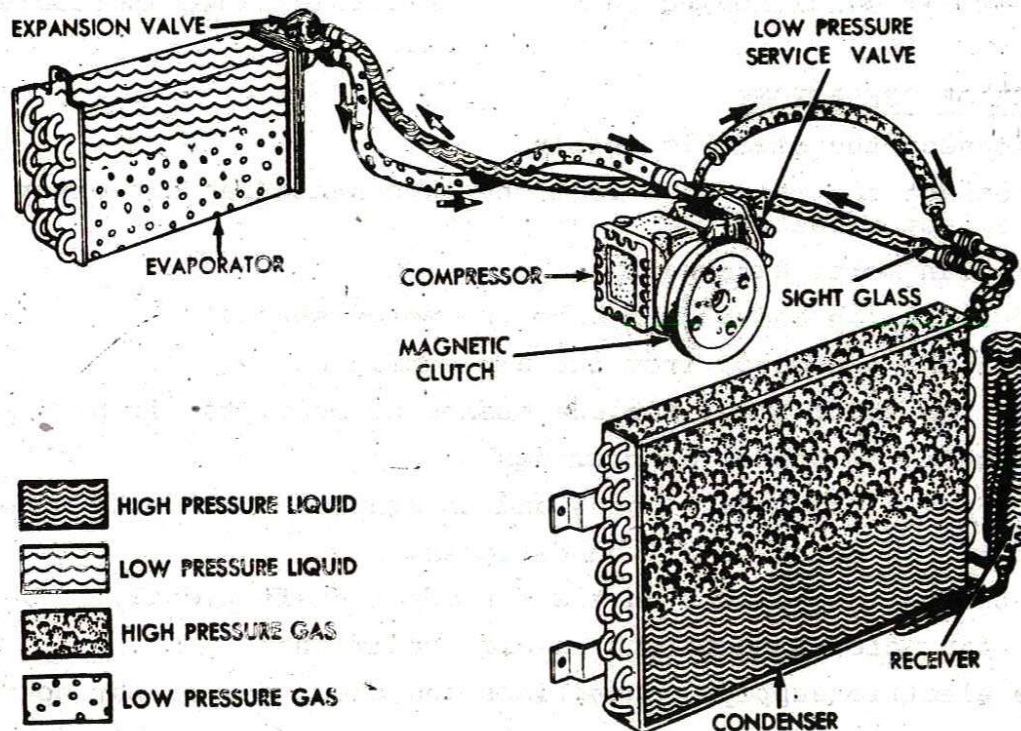
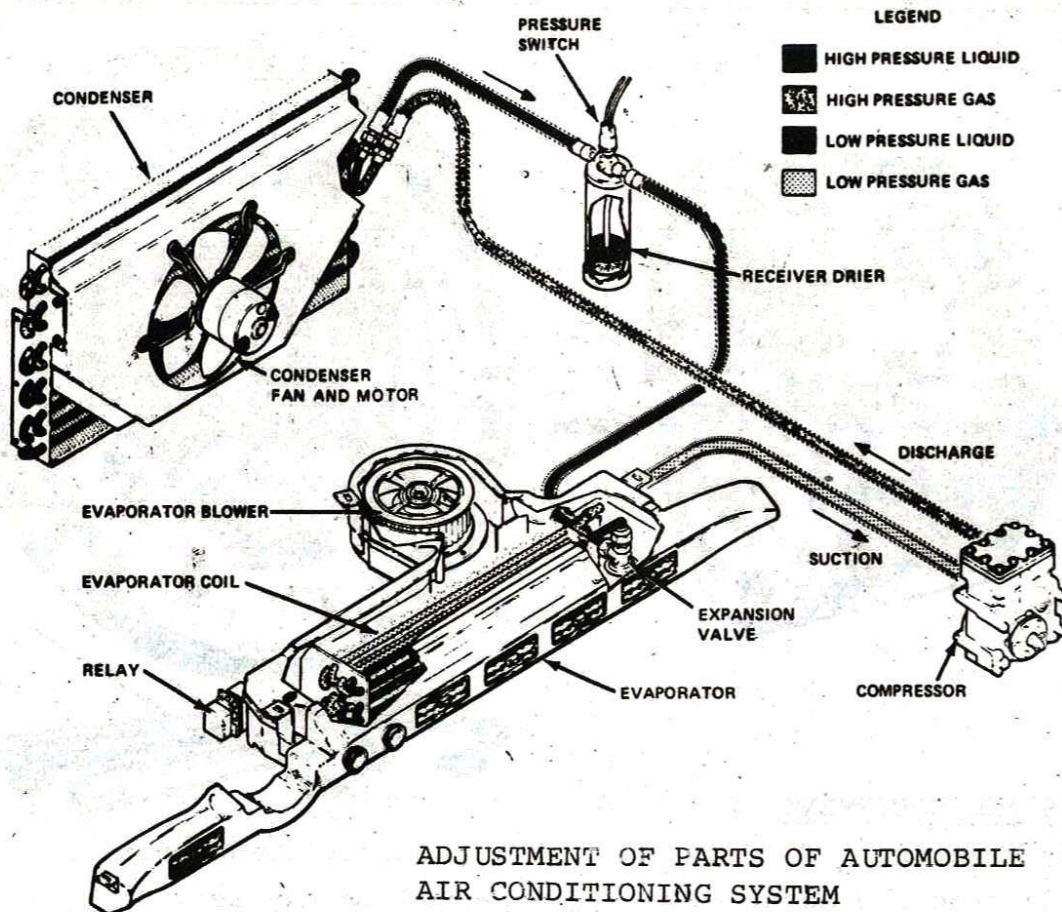


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





OBSERVE THE FUNCTION OF AUTOMOBILE AIR CONDITIONING SYSTEM, REFRIGERANT CONDITION OR STATE IS SHOWING IN EACH PART OF THE SYSTEM.

SCALE:

MAT:

## INFORMATION SHEET

RP/3.15.2/27

FUNDAMENTALS OF  
AIR CONDITIONING

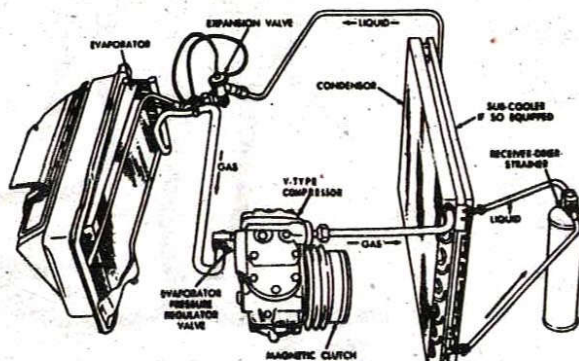


**DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING**

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





### TOOLS, INSTRUMENTS AND MACHINERY

- Automobile Air conditioning unit.
- Refrigeration tool kit .
- Multimeter.

### SEQUENCE OF OPERATIONS.

- Clean the parts of the air conditioning unit from the dust and dirt.
- Clean oil and other deposits from the air conditioning parts.
- Lubricate the fan (evaporator blower motor).
- Check belts and replace if necessary.
- Wash condenser and dry it.
- Clean expansion valve and its thermal bulb.
- Check unit for proper operation.

SCALE:

## SERVICING OF AUTOMOBILE AIR CONDITIONER

RP/3.15.2/28

MAT:

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



# TO CHARGE REFRIGERANT THROUGH COMPRESSOR

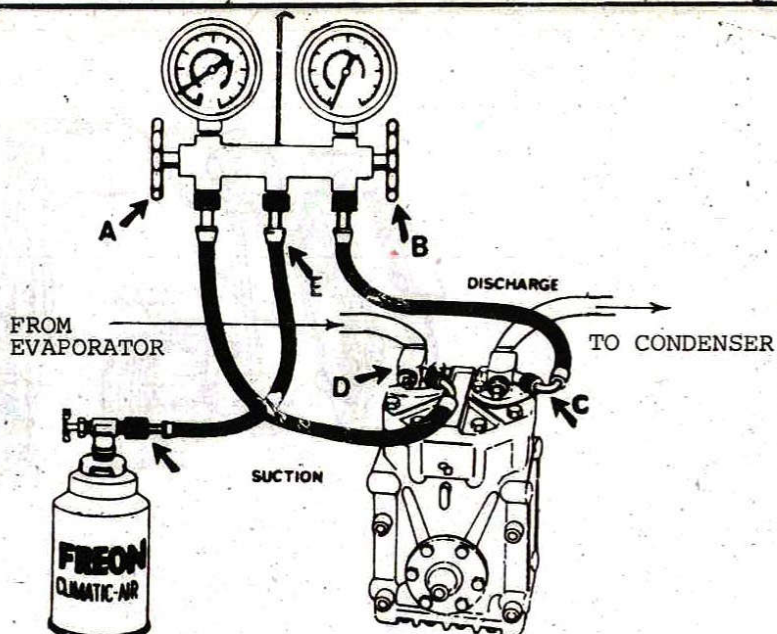
Connect Refrigerant Cylinder to E.

Valve A - Open

Valve B - Closed

Valve C - Back Seat Cracked Open

Valve D - Back Seat Cracked Open



## TOOLS AND MATERIAL

- Vacuum pump
- Refrigerant F-12
- Automobile Air Cond. unit
- Gauge manifold
- Refrigeration tool kit

## SEQUENCE OF OPERATIONS.

- Evacuate the the Air Conditioning unit and close the hand valves of the gauge manifold.
- Remove the vacuum pump and attach the gauge manifold with refrigerant(F-12) cylinder.
- Purge the service lines of the gauge manifold.
- Crack(open)the hand valve "A" of the gauge manifold and charge refrigerant upto 5 psig(140 kPa).
- Start the Air Cond. unit and charge more refrigerant till no bubbles in the sight glass which is located in the liquid line.
- Check for proper cooling and pressures(suction and discharge).
- Check the unit for proper operation.
- Close the hand valve of the gauge manifold.
- Full back the service valves of the compressor and remove gauge manifold from the unit.

## NOTE

Be sure, there should be no bubble in the sight glass, when the system is operating.

An over charged unit may be detected by excessive head pressure, but t is condition will not show in the sight glass. If high pressure is shown on the high side gauge, determine the correct system pressure and purge the excessive refrigerant.

SCALE:

REFRIGERANT CHARGING OF  
AUTOMOBILE AIR CONDITIONER

RP/3.15.2/29

MAT:

FUNDAMENTALS OF  
AIR CONDITIONING

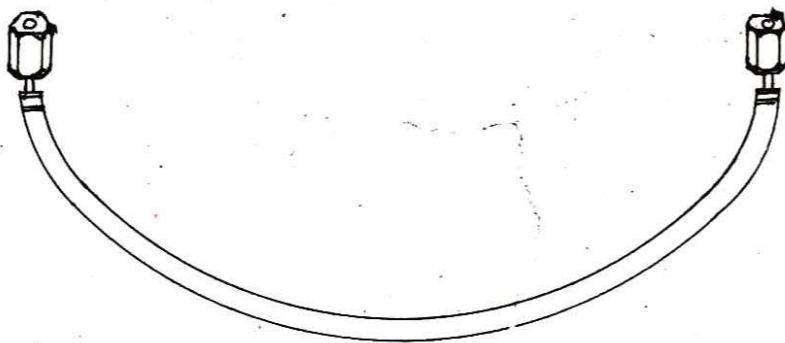


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





RUBBER HOSE

#### TOOLS AND MATERIAL

- Portable charging station.
- Refrigerant leak detector.
- Refrigeration tool kit.
- Refrigerant F-12.
- Rubber hose for automobile Air Conditioning unit of proper size comparative to the Air Conditioning unit.

#### SEQUENCE OF OPERATIONS

- Remove refrigerant from the system or pump down the system, if possible.
- Remove the damaged rubber hose.
- Replace the rubber hose with new one.
- Check system for leaks and repair.
- Evacuate the system.
- Charge refrigerant, if removed.
- Test the unit for proper operation.

#### NOTE

- Check oil in the system (before refrigerant charging) and charge oil if necessary.
- Repair rubber hose by removing damaged portion (make leakproof joints with jobbly clamps).

SCALE:

MAT:

## REPAIRING OF RUBBER HOSE

RP/3.15.2/30

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refr.  
&  
Air Cond.



# TRUBLE SHOOTING CHART FOR AUTO AIR CONDITIONING UNITS

TRUBLE	COMMON CAUSE	REMEDY
Low head pressure.	<p>Leak in system.</p> <p>Defective expansion valve.</p> <p>Suction valve closed.</p> <p>Shortage of refrigerant.</p> <p>Plugged receiver drier.</p> <p>Compressor suction valve leaking.</p> <p>Bad reed valves in compressor.</p>	<p>Repair leak</p> <p>Replace valve (Expansion valve).</p> <p>Open valve.</p> <p>Add refrigerant.</p> <p>Replace receiver drier.</p> <p>Replace valve.</p> <p>Replace reed valve.</p>
High head pressure.	<p>Air in system.</p> <p>Clogged condenser.</p> <p>Discharge valve closed.</p> <p>Overcharged system.</p> <p>Insufficient condenser air.</p> <p>Loose fan belt.</p> <p>Condenser not centred on fan or too close to radiator.</p>	<p>Recharge system.</p> <p>Clean condenser.</p> <p>Open valve.</p> <p>Remove some refrigerant.</p> <p>Install large fan.</p> <p>Tighten fan belt.</p> <p>Centre and check distance from radiator.</p>
Low suction pressure.	<p>Refrigerant shortage.</p> <p>Worn compressor piston.</p> <p>Compressor head gasket leaking.</p> <p>Kinked or flattened hoses.</p> <p>Compressor suction valve leaking.</p> <p>Moisture in system.</p> <p>Trash in expansion valve screen.</p>	<p>Add refrigerant.</p> <p>Replace compressor.</p> <p>Replace head gasket.</p> <p>Replace hose.</p> <p>Change valve plate.</p> <p>Replace drier.</p> <p>Replace drier.</p>

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.2/31

FUNDAMENTALS OF  
AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





TROUBLE	COMMON CAUSE	REMEDY
High suction pressure.	Loose expansion bulb. Overcharged system. Expansion valve stuck open. Bad reed valves in compressor. Leaking head gasket on compressor.	Tighten bulb clamp. Remove some refrigerant. Replace valve. Replace valves in compressor. Replace head gasket.
Compressor not working.	Broken drive belt. Broken clutch wire. Broken compressor piston. Bad thermostat switch. Bad clutch coil.	Replace belt. Repair wire. Replace compressor. Replace thermostat. Replace clutch coil.
Evaporator not cooling.	Frozen coil, switch set too high. Faulty clutch. Drive belt slipping. Hot air leaks into car. Plugged receiver drier. Capillary tube broken. Shortage of refrigerant. High head pressure. Low suction pressure. High suction pressure. Frozen expansion valve. Defective expansion valve.	Defrost coil by turning thermostat down. Check clutch wire and thermostat. Tighten belt. Close heater vents or air vents. Replace receiver drier. Replace expansion valve. Add refrigerant. See trouble "High head pressure". See trouble "Low suction pressure". See trouble "High suction pressure". Replace receiver drier and evacuate the system. Replace valve.
Frozen evaporator coil.	Faulty thermostat. Thermostat not set properly. Insufficient evaporator air.	Replace thermostat. Set to driving conditions. Turn switch to higher setting.

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.2/31a

FUNDAMENTALS OF  
AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.

TROUBLE	COMMON CAUSE	REMEDY
Belt trouble.	<p>Pulleys not in line.</p> <p>Belt too tight or too loose.</p> <p>Wrong belt.</p> <p>Overcharged system or excessive head pressure.</p> <p>Bad bearing in idler pulley.</p>	<p>Align pulleys.</p> <p>Adjust correctly.</p> <p>Replace belt.</p> <p>Discharge some refrigerant.</p> <p>Replace bearing.</p>
Excessive vibration of compressor and mount.	<p>Head pressure too high.</p> <p>Loose or broken bolts in mount.</p> <p>No lock washers on bolts.</p> <p>Crankshaft pulley not on straight and tight.</p> <p>Too much refrigerant.</p> <p>Worn or frozen bearings in idler pulley.</p> <p>Loose or defective belt.</p>	<p>See trouble "High head pressure".</p> <p>Replace or tighten bolts.</p> <p>Install lock washers.</p> <p>Tighten all bolts.</p> <p>Discharge (remove) some refrigerant.</p> <p>Replace bearings.</p> <p>Tighten or replace belt.</p>
Noisy clutch.	<p>Be sure coil properly installed.</p> <p>Be sure pulley is tightly bolted to compressor shaft.</p> <p>Check key on shaft of compressor.</p>	<p>Centre clutch and coil.</p> <p>Tighten bolts.</p> <p>Line key with clutch.</p>
Blower does not work.	<p>Check fuse.</p> <p>Check loose or broken connections.</p> <p>Check control switch.</p> <p>Check fan motor and be sure it is not locked or dragging.</p> <p>Check voltage at motor.</p> <p>Check ground wire.</p>	<p>Replace fuse.</p> <p>Repair connections.</p> <p>Replace if defective.</p> <p>Centre motor and adjust blower clearance.</p> <p>Check wires and replace motor if defective.</p> <p>Correct problem.</p>

SCALE:

MAT:

## TROUBLESHOOTING CHART

RP/3.15.2/31b

FUNDAMENTALS OF  
AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAKISTAN TECHNICAL TRAINING PROGRAMME

 Refg.  
&  
Air Cond.



TROUBLE	COMMON CAUSE	REMEDY
Blower runs too slowly.	Check for loose wires or shorts. Check for binding shaft. Check for burned out resistors in controls. Check allen set screws on blower wheel. Check voltage at motor.	Correct problem. Centre motor and blower. Replace switch. Tighten set screws. Check connections and insulation on wires.
Clutch does not work.	Check fuse. Check for broken or loose wires to clutch. Check for short in clutch coil. Check voltage at clutch. Check thermostat. Check blower switch at all positions. Defective compressor(frozen).	Replace if bad(blown). Replace or repair wires. Replace coil. Check connections and insulation on wires. Replace if bad(faulty). Replace if inner brass race is burned. Replace compressor.

SCALE:

MAT:

## TROUBLESHOOTING CHART

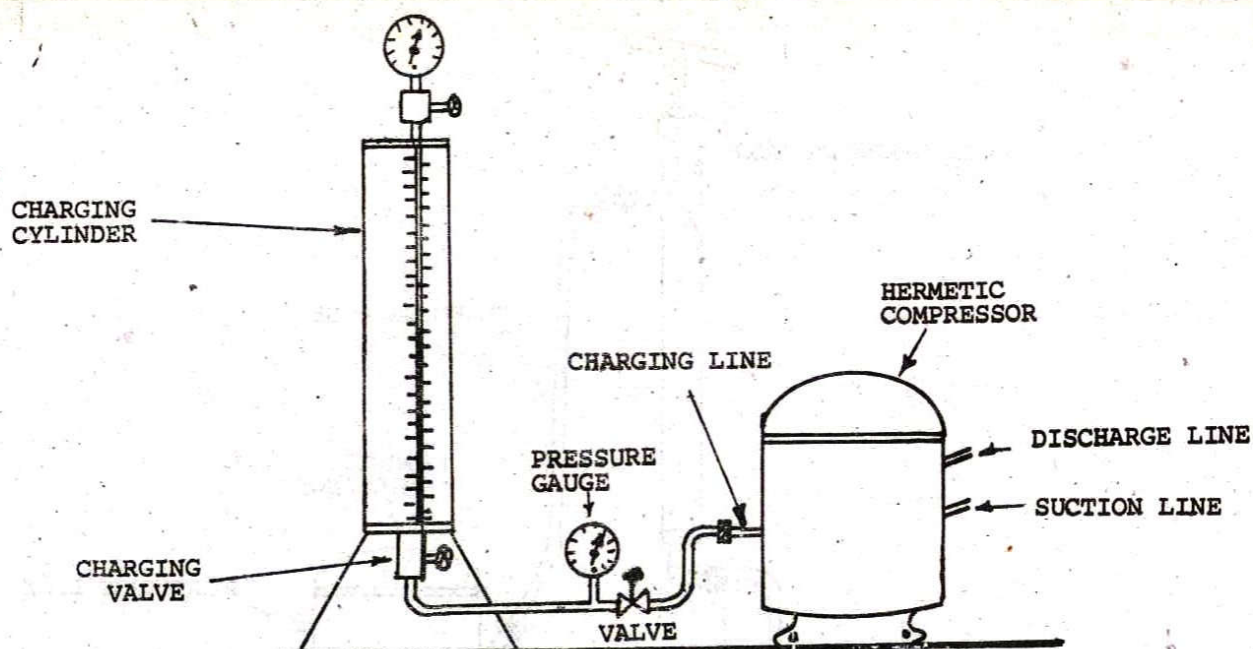
RP/3.15.2/31c

FUNDAMENTALS OF  
AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



#### TOOLS, MATERIAL, EQUIPMENT AND MACHINERY

- Hermetic compressor
- Vessel
- Valve attachment
- Compressor oil
- Charging cylinder.
- Pressure gauge.

#### SEQUENCE OF OPERATIONS

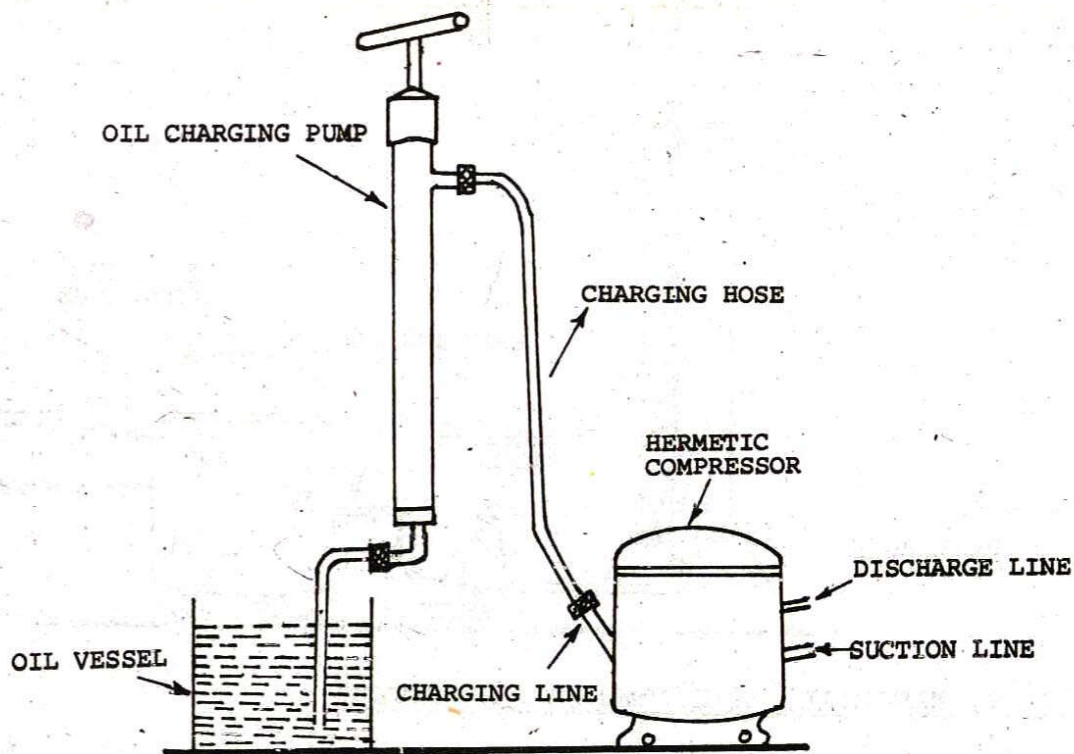
- Drain off all the oil from the compressor.
- Check the quantity and quality of drained oil.
- Place the correct amount of new oil in charging cylinder alongwith small amount of refrigerant to create pressure.
- Attach the charging cylinder with the suction line of the compressor (by using valve attachment).
- Open the bottom valve of the charging cylinder and valve attachment (the oil will be forced into the compressor).
- Close the bottom valve of charging cylinder when the exact amount of oil has to be charged.
- Remove the valve attachment from the compressor.
- Check the compressor for proper operation.

#### NOTE:

- Use compressor oil of standard specification.
- If the compressor is attached with the system, be sure that the cylinder pressure is higher than the system pressure and use the same refrigerant in the charging cylinder for pressure as in the system.

SCALE:	<h2 style="margin: 0;">ADDING OF OIL</h2>	RP/3.15.2/32
MAT:		FUNDAMENTALS OF AIR CONDITIONING
<b>DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING</b> PAK-GERMAN TECHNICAL TRAINING PROGRAMME		<b>Relg. &amp; Air Cond.</b>





#### TOOLS, MATERIAL AND MACHINERY

- Oil charging pump.
- Hermetic compressor.
- Charging hose.
- Vessel.
- Compressor oil.

#### SEQUENCE OF OPERATIONS

- Drain off all the oil from the compressor.
- Check the quantity and quality of drained oil.
- Attach the oil charging pump with suction line of the compressor.
- Put the oil charging pump (suction side) in the vessel of new oil.
- Add same quantity of new oil as drawn from the compressor.
- Remove the oil charging pump from the compressor.
- Check the compressor for proper operation.

#### NOTE.

- During the oil charging process, it is important that the oil pump base (suction side of the oil charging pump), should be dipped in the oil.
- Use compressor oil of standard specifications.
- If necessary, a charging hose can be attached with the suction side of the oil charging pump.

SCALE:

MAT:

### ADDING OF OIL

RP/3.15.2/33

FUNDAMENTALS OF  
AIR CONDITIONING

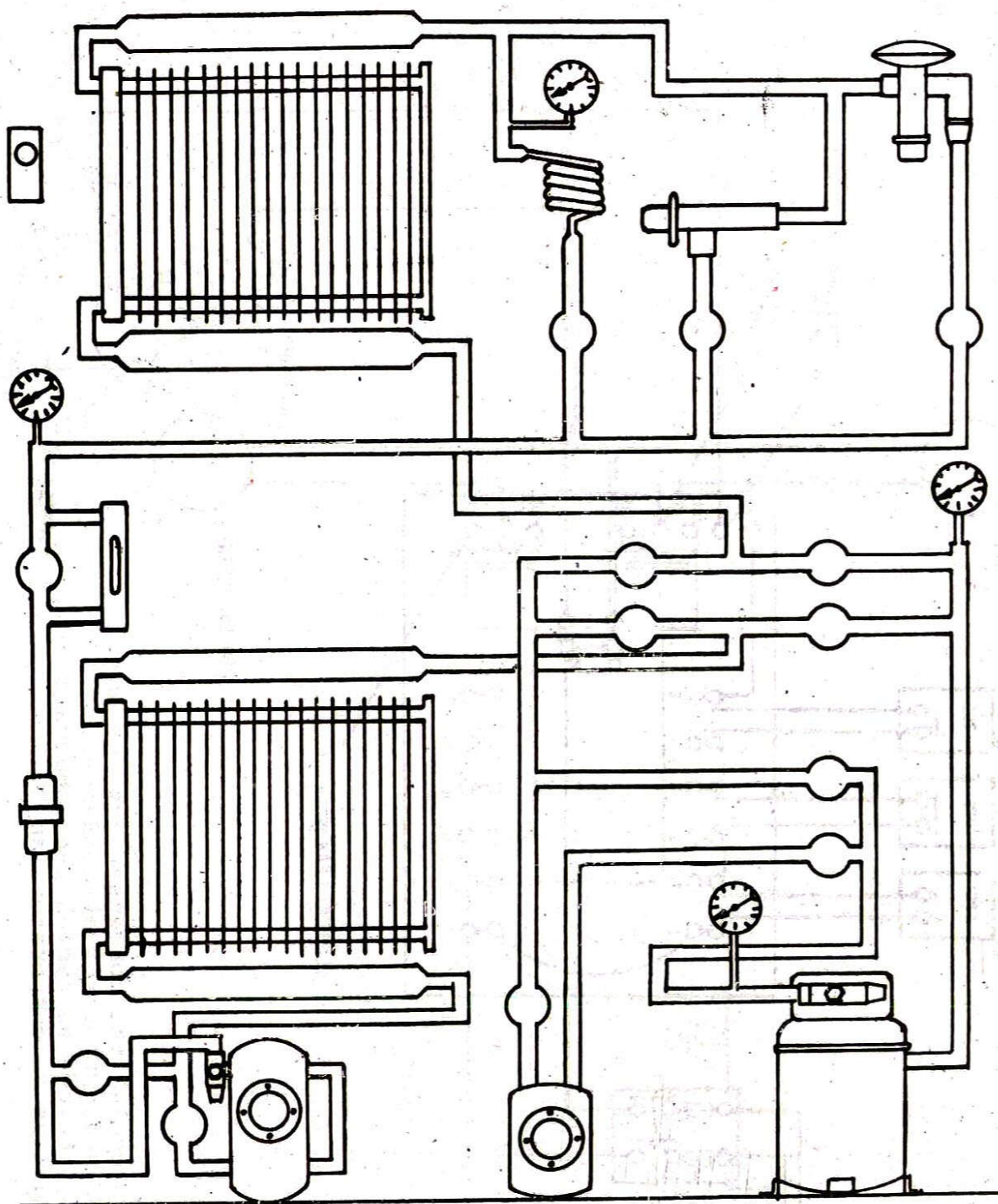


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refig.  
&  
Air Cond.





Make different refrigerant circuits on training model unit with the help of training manual and complete practicals on this unit with the help of training manual of the above trainer.

SCALE:

MAT:

## INFORMATION SHEET

RP/3.15.2/34

FUNDAMENTALS OF  
AIR CONDITIONING

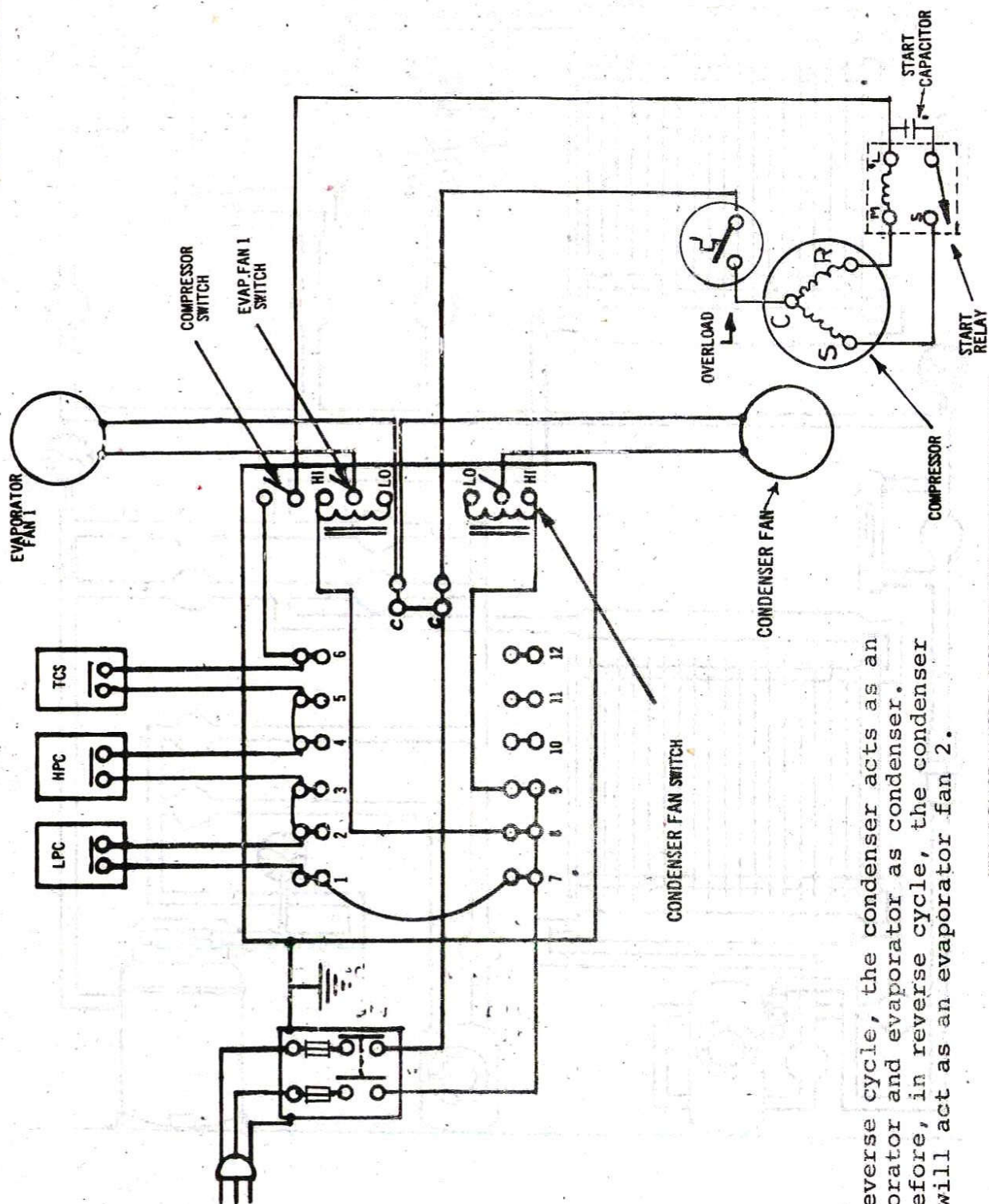


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refr.  
&  
Air Cond.





**NOTE**

In reverse cycle, the condenser acts as an evaporator and evaporator acts as condenser. Therefore, in reverse cycle, the condenser fan will act as an evaporator fan 2.

WIRING DIAGRAM MODEL 9001 REFRIGERATION TRAINING UNIT

COMPLETE THE ELECTRIC CIRCUIT OF THE REFRIGERATION TRAINING UNIT.

SCALE:

MAT:

## INFORMATION SHEET

RP/3.15.2/34a

FUNDAMENTALS OF  
AIR CONDITIONING

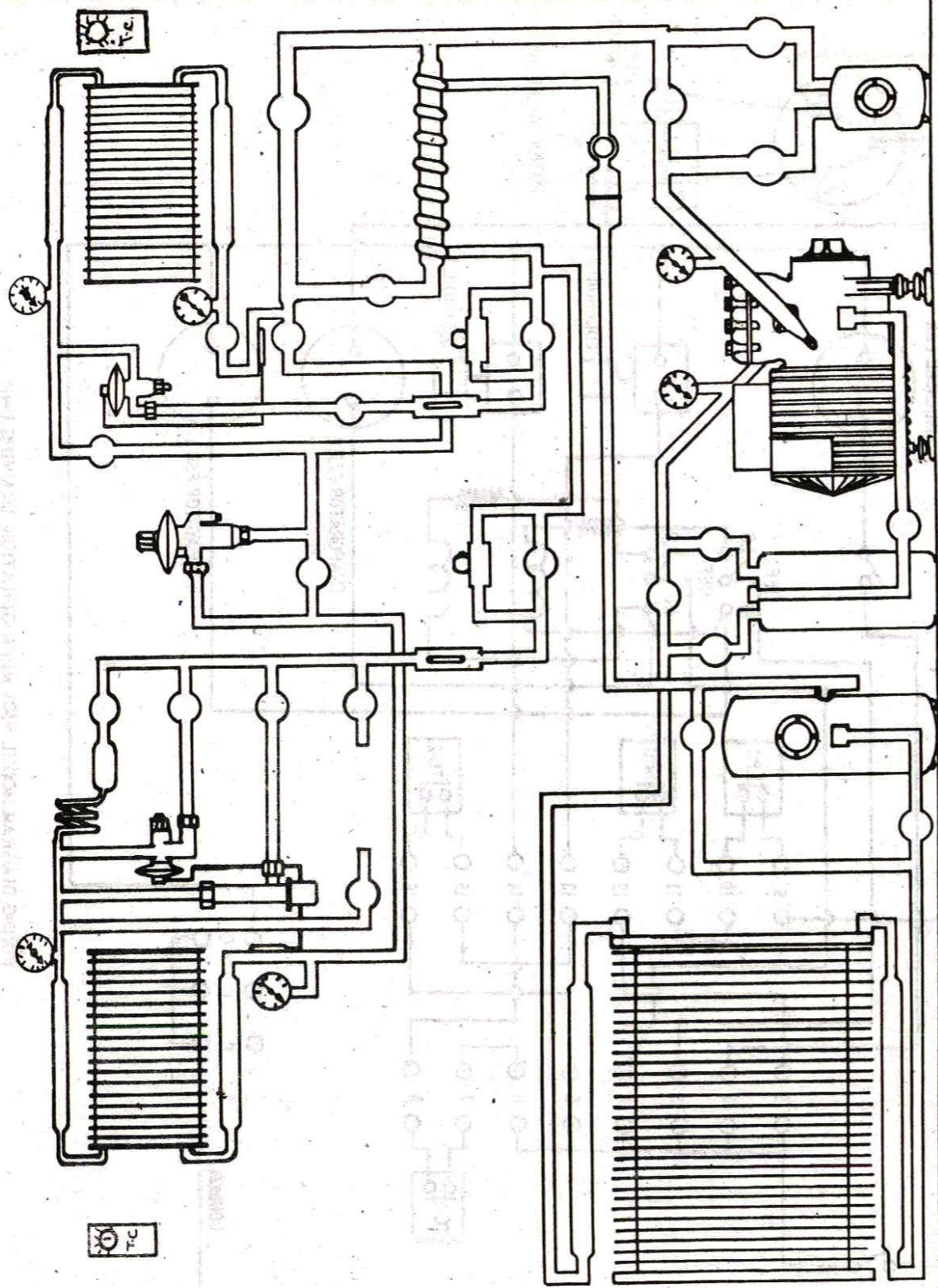


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





Make different refrigerant circuits on training model unit with the help of training manual and complete the practicals on this unit with the help of training manual of the above trainer.

SCALE:

MAT:

## INFORMATION SHEET

RP/3.15.2/35

FUNDAMENTALS OF  
AIR CONDITIONING

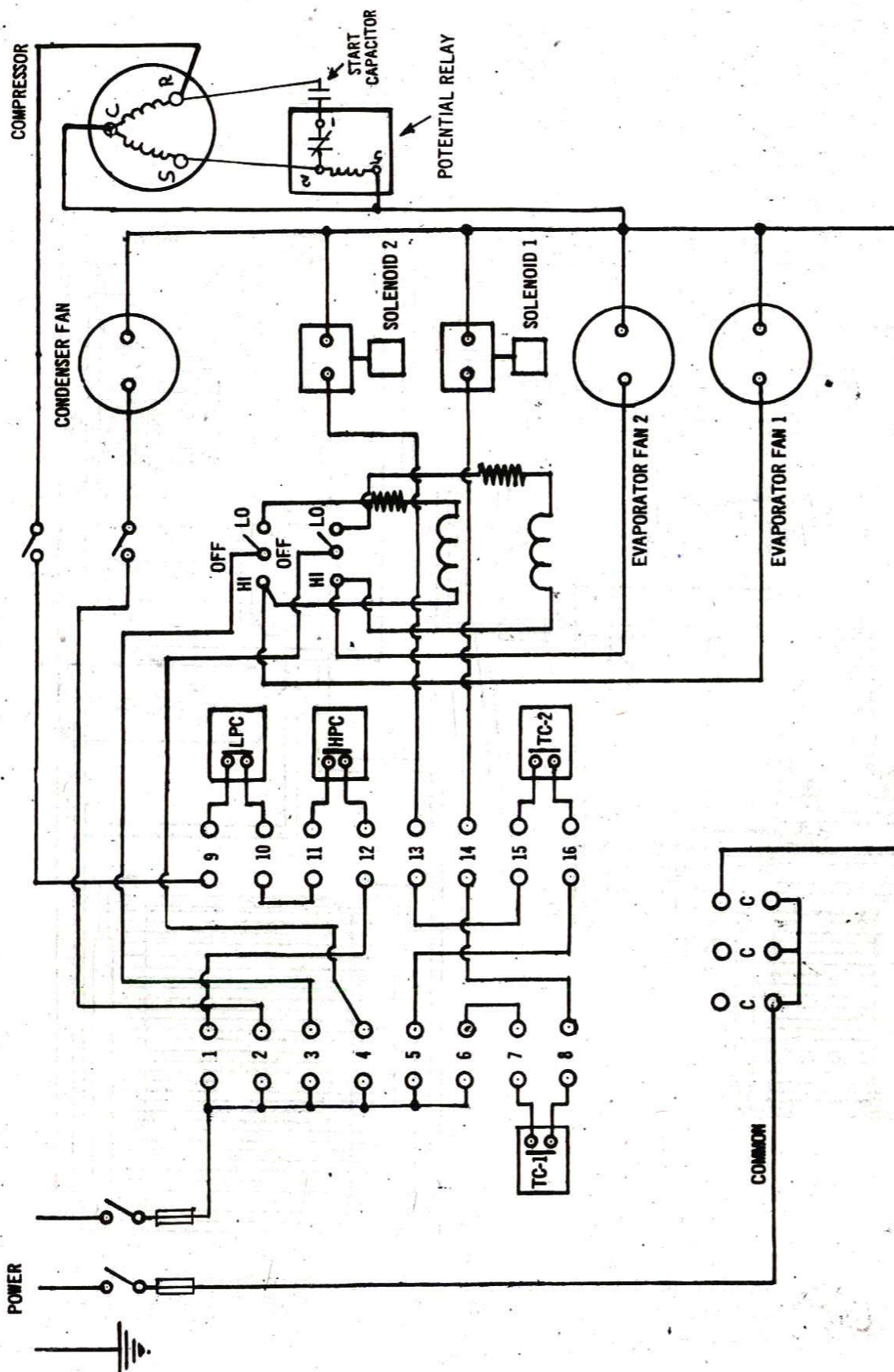


DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.





WIRING DIAGRAM MODEL 9501 REFRIGERATION TRAINING UNIT

COMPLETE THE ELECTRIC CIRCUIT OF REFRIGERATION TRAINING UNIT.

SCALE:

MAT:

## INFORMATION SHEET

RP/3.15.2/35a

FUNDAMENTALS OF  
AIR CONDITIONING



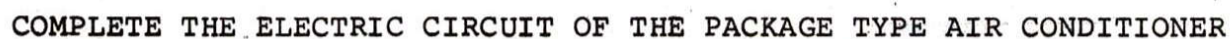
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAX-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.

### DIAGRAM

220V





# LEGEND

C	Contactor.	CCB	Cooling (compressor) circuit breaker.
Cap	Capacitor.	CCSV	Capacity control solenoid valve.
CH	Crankcase Heater.	CCW	Counter clock wire.
Compr	Compressor.	CW	Clock wire.
CR	Control relay/cooling relay/ Compressor relay.	DM	Demper motor.
HPS	High pressure switch.	DR	Demper relay.
HR	Holding relay (base unit lables) Heating relay (Heating lables).	FCB	Fan circuit breaker.
IFC	Indoor fan contactor.	FCPS	Fan cycling pressure switch.
IFM	Indoor fan motor.	FL	Feasible link.
IFR	Indoor fan relay.	H	Heater.
IP	Internal protector.	HA	Heating anticipator.
LPS	Low pressure switch.	HC	Heater contractor.
OFM	Out door fan motor.	HCB	Heater circuit breaker.
OFR	Out door fan relay.	HPCT	Head pressure control thermostat.
OL	Over load.	HTR	Heater relay (Base unit lables).
TC	Thermostat (cooling).	LOR	Lock out relay.
TH	Thermostat heating.	LS	Limit switch.
TM	Timer motor.	MAT	Mixed air thermostat.
TR	Timer relay.	RB	Reset botton.
TRAN	Transformer.	TB	Terminal block.
---	Factory installed options.		
---	Field wiring.		
—	To indicate common potential, not to represent while.		
—	Factory wiring.		
⬡	Component connections, marked.		
○	Component connections unmarked.		
□	Terminal board connections.		
▢	Splice.		
AHA	Adjustable heat anticipator.		
APS	Air pressure switch (field supplied).		
CB	Circuit breaker.		
CC	Cooling compensator.		

SCALE:

## INFORMATION SHEET

RP/3.15.2/36a

MAT:

FUNDAMENTALS OF  
AIR CONDITIONING



DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK-GERMAN TECHNICAL TRAINING PROGRAMME

Refg.  
&  
Air Cond.



