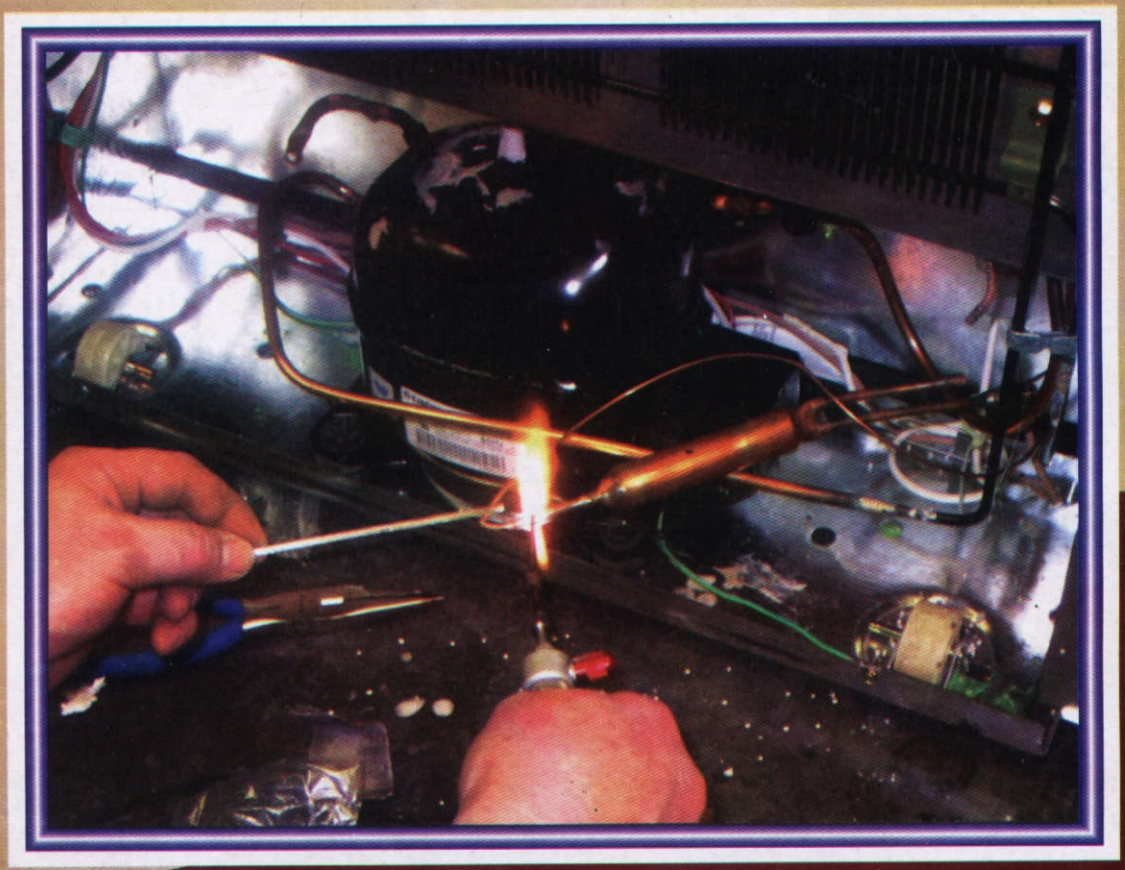
TRADE TRAINING-III

TTC PROGRAMME

REFRIGERATOR AND AIR CONDITIONING



TEVTA

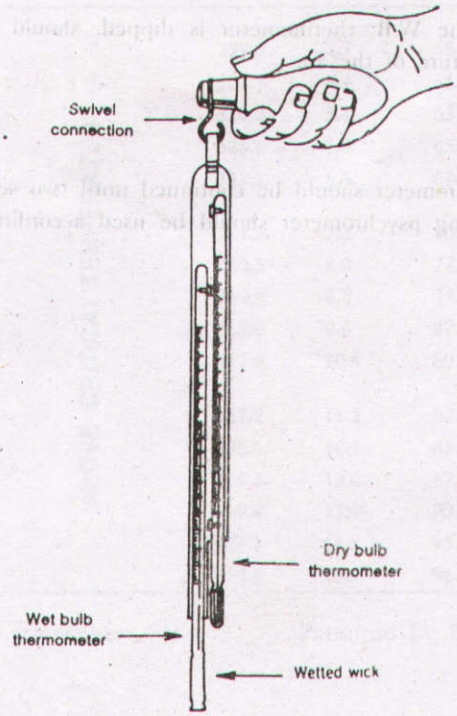
GOVERNMENT OF THE PUNJAB

TECHNICAL EDUCATION & VOCATIONAL TRAINING AUTHORITY

TRADE TESTING BOARD

DEVELOPMENT CELL LAHORE

T.T.P. Series No. 95 Price Rs. 75/-



Sling psychrometer

TOOLS AND MATERIAL

- Sling psychrometer.
- Wetted cloth sac or wet wick.

SEQUENCE OF OPERATIONS:

- Wet the wick of the wet bulb (W.B) thermometer of the sling psychrometer.
- Whirle the sling psychrometer rapidly through the air at a speed of 1000 to 2000 fpm for about a half minute.
- Read both thermometers (W.B and D.B) of the sling psychrometer.
- Whirle the sling psychrometer again for another half minute and read both thermometers (wet bulb and dry bulb) again.

RESULT:

- Thermometer which bulb is not enclosed in a wetted cloth sac or wet wick, that thermometer shows dry bulb (D.B) temperature.
- Thermometer which bulb is enclosed in a wetted cloth sac or wet wick, that thermometer shows wet bulb (W.B) temperature.

CAUTION:

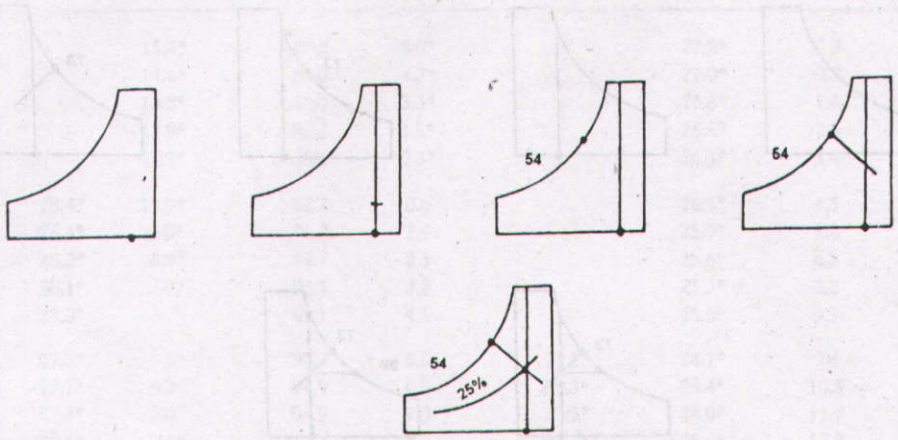
- If the wick partially dry, it may be necessary to dip into water again and then start the reading over.
- To obtain accurate reading with W.B thermomter, the air must move (pass) the wet bulb of thermometer at a brick velocity.

SCALE	USE OF SLING PSYCHROMETER	RP/4.15.1/01
MAT		AIR CONDITIONING

- To obtain accurate reading, the wick must be clean and free from soap and sizing.
- The water in which the W.B. thermometer is dipped, should preferably be at a temperature equal the W.B temperature of the air.

NOTE:

- Whirlling of sling psychrometer should be continued until two sets of reading agreed.
- Some other type of sling psychrometer should be used according to their operating instructions and specifications.



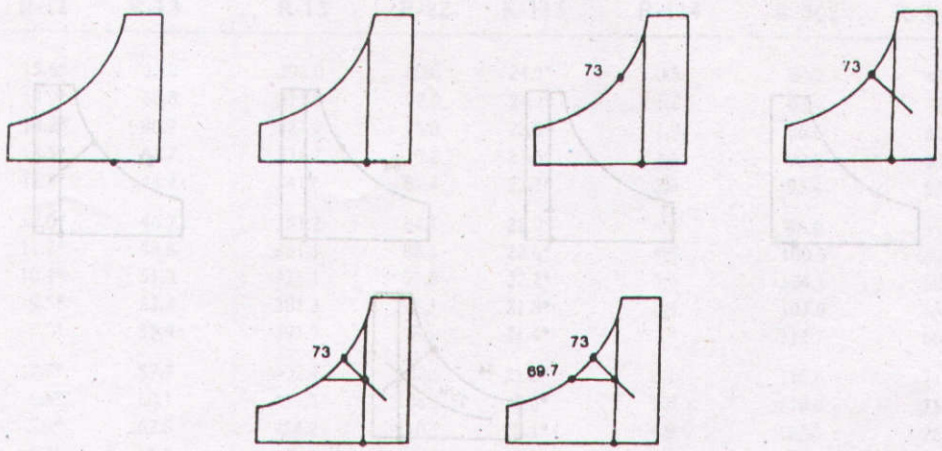
Finding relative humidity.

TOOLS AND MATERIAL:

- Sling psychrometer.
- Psychrometric chart.

SEQUENCE OF OPERATIONS

- Measure the W.B. temperature and D.B. temperature of the air with sling psyhrometer
- Locate temperature on D.B scale of the psychrometric chart.
- Draw a line vertically upward to the instep of the chart.
- Locate the temperature on the W.B. scale of the psychrometric chart.
- Draw a line digonally downward until the D.B temperature line is crossed.
- Read the relative humidity at this point (where lines are crossed.)



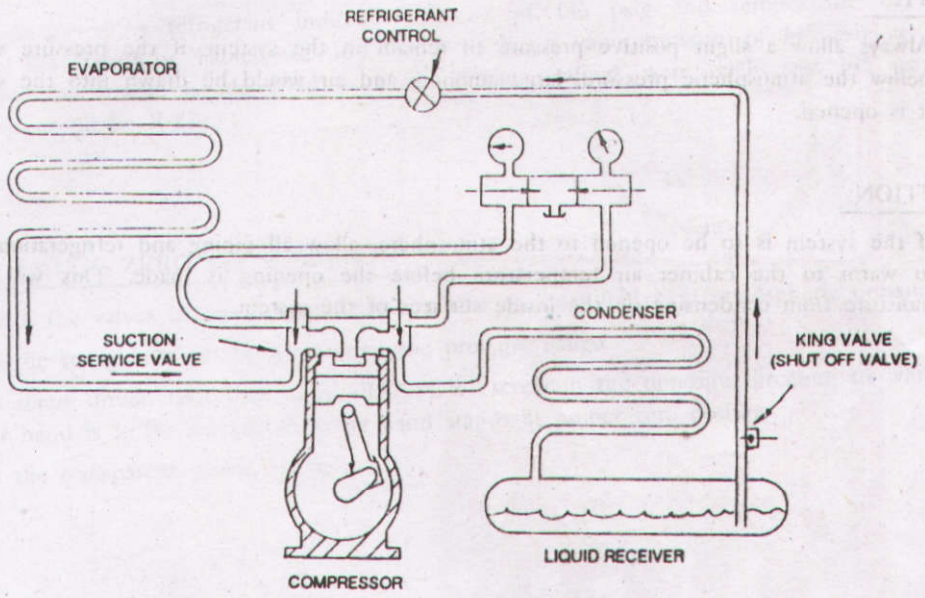
Finding dew point temperature.

TOOLS AND MATERIAL:

- Sling psychrometer.
- Psychrometric chart.

SEQUENCE OF OPERATIONS

- Measure the W.B. temperature and D.B. temperature of the air with sling psychrometer.
- Locate temperature on the dry bulb scale of psychrometric chart.
- Draw a line vertically upward to the instep of the chart.
- Locate temperature on the W.B. scale of the psychrometric chart.
- Extend this point dignonally downward until the D.B line is crossed.
- Extend this point (where lines are crossed) horizontally to the left to the instep.
- Read the dew point temperature.



TOOLS, EQUIPMENT AND MACHINERY:

- Refrigeration system.
- Refrigeration service valve wrench.
- Open end spanner set.
- Gauge manifold.
- Adjustable wrench.

SEQUENCE OF OPERATIONS:

- Connect the gauge manifold to the service valves (suction and discharge) of the compressor and crack the service valves to the gauge port position (mid position).
- Close off the liquid receiver outlet valve (King valve)/liquid line shut off valve.
- Install a jumper wire across the terminals of the low pressure (L.P) control switch (if L.P switch is used.)
- Start the system.
- Watch the suction pressure gauge and allow the system to function until the pressure reading is reduced to 2psig.
- Stop the compressor.
- Full front seat the compressor suction and discharge service valves.
- Remove the jumper wire from the low pressure control switch (if L.P switch is used).
- Remove the gauge manifold (if necessary) and close off the gauge ports of the service valves with dead caps.

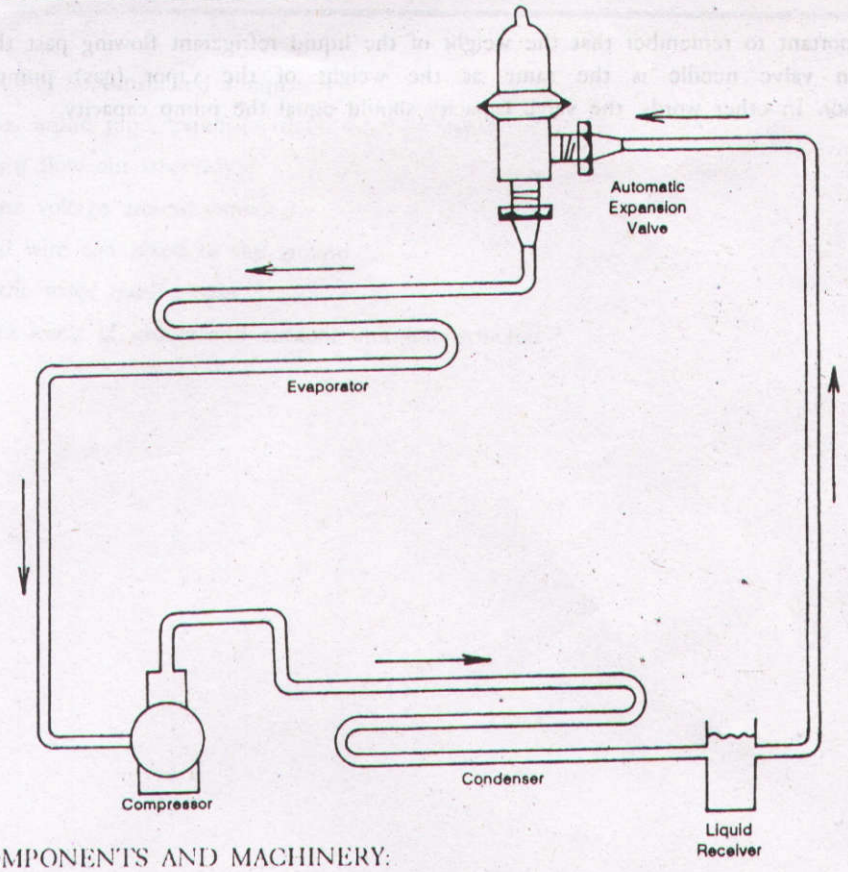
SCALE	PUMP DOWN	RP/4.15.1/04
MAT		AIR CONDITIONING

NOTE:

- Always allow a slight positive pressure to remain in the system, if the pressure were reduced below the atmospheric pressure, large amounts and air would be drawn into the system, when it is opened.

CAUTION:

- If the system is to be opened to the atmosphere, allow all piping and refrigeration components to warm to the cabinet air temperature before the opening is made. This will prevent the moisture from condensing on the inside surfaces of the system.



TOOLS, COMPONENTS AND MACHINERY:

- Automatic Expansion Valve.
- Refrigeration service valve wrench.
- Open end spanner set.
- Gauge manifold.
- Adjustable wrench.
- Screw driver set.

SEQUENCE OF OPERATIONS:

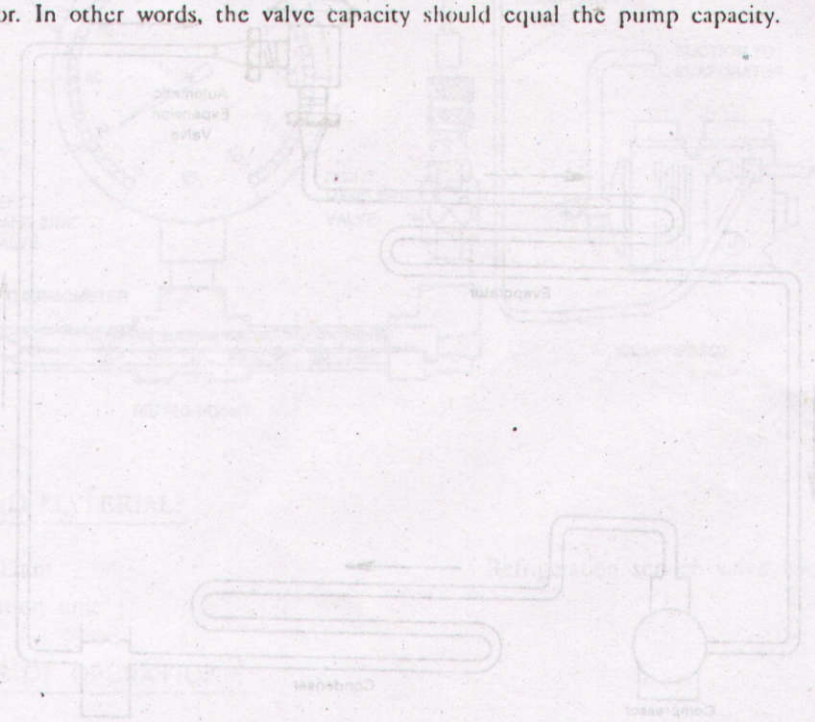
- Select the automatic expansion valve (A.E.V) according to the unit capacity.
- Connect the suction side of the A.E.V with the end of the liquid line by making a leakproof connection.
- Connect the discharge side of the A.E.V with the inlet of the evaporator by making a leakproof connection.
- Check the connection of the A.E.V with the end of the liquid line and inlet of the evaporator for leaks.

NOTE:

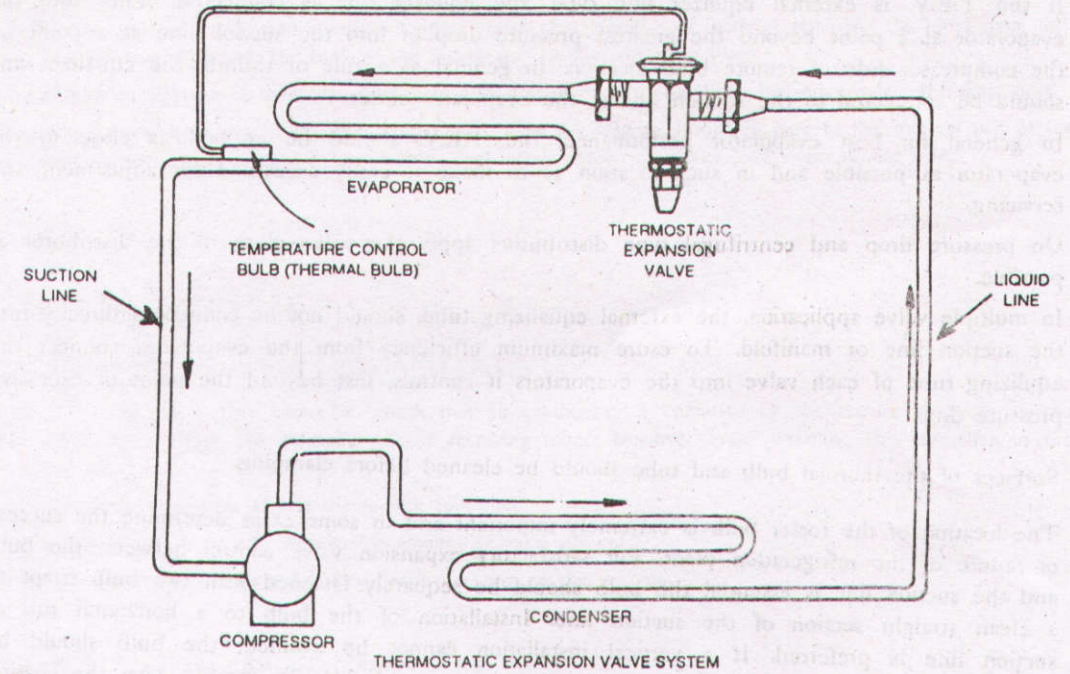
- Automatic expansion valve feature a manual adjustment. The adjusting screw increases or decreases the tension of the control spring above the diaphram changing the valve opening point. The valve can be adjusted to open at a predetermined pressure within the range of the control spring. A change in valve inlet pressure of 1 psi (6.87Kpa) will move the valve stem approximately 0.001 in (0.0025 cm.)

SCALE	INSTALLATION OF AUTOMATIC EXPANSION VALVE	RP/4.15.1/05
MAT		AIR CONDITIONING

It is important to remember that the weight of the liquid refrigerant flowing past the automatic expansion valve needle is the same as the weight of the vapor (gas) pumped by the compressor. In other words, the valve capacity should equal the pump capacity.



SCALE :	INSTALLATION OF AUTOMATIC EXPANSION VALVE	RP/4.15.1/05a
MAT :		AIR CONDITIONING



THERMOSTATIC EXPANSION VALVE SYSTEM

TOOLS AND MATERIAL:

- Thermostatic expansion Valve
- Adjustable wrench.
- Gauge manifold.
- Refrigeration system.
- Refrigeration Service Valve Wrench.
- Open end spanner set.
- Nitrogen gas.

SEQUENCE OF OPERATIONS:

- Select the Thermostatic Expansion Valve (T.E.V) according to the unit capacity.
- Connect the suction side of the valve (T.E.V) with the end of the liquic line by making a leakproof connection.
- Connect the discharge side of the valve (T.E.V) with the inlet of the evaporator by making a leakproof connection.
- Connect the thermal bulb of the T.E.V at the end of the evaporator coil firmly.
- Check the connections of the T.E.V with the end of the liquid line and inlet of the evaporator for leaks.

NOTE:

- All the connections of the Thermostatic Expansion Valve must be leakproof.
- Thermal bulb should be upward of the tube.

SCALE :	INSTALLATION OF THERMOSTATIC EXPANSION VALVE	RP/4.15.1/06
MAT		AIR CONDITIONING

- If the T.E.V. is external equlizer line type, the equlizer line is connected either into the evaporator at a point beyond the greatest pressure drop or into the suction line at a point on the compressor side of remote bulb location. In general as a rule of thumb, the equalizer line should be connected to the suction line at the evaporator outlet.
- In general for best evaporator performance, the T.E.V. should be applied as close to the evaporator as possible and in such location as to make it easily accessible for adjustment and servicing.
- On pressure drop and centrifugal type distributors apply the valve close to the distributor as possible.
- In multiple valve application, the external equalizing tube, should not be connected directly into the suction line or manifold. To esure maximum efficiency from the evaporator, connect the equlizing tube of each valve into the evaporators it controls, just beyond the point of excessive pressure drop.
- Surfaces of the thermal bulb and tube should be cleaned before clamping.
- The location of the feeler bulb is extremely important and in some cases determine the success or failure of the refrigeration plant. For satisfactory expansion valve control between the bulb and the suction line is essential the bulb should be sequarely fastened with two bulb straps to a clean straight section of the suction line. Installation of the bulb to a horizontal run of suction line is preferred. If a vertical installation cannot be avoided, the bulb should be mounted so that capillary tubing comes from the top (see Fig.1). To install, clean the suction line thoroughly before clamping the remote bulb in place. When a steel suction line is used, it is advisable to paint the line with aluminium paint to minimize future corrosion and to eliminate faulty remote bulb contact with the line. On lines under 7/8 in. (22.225mm) OD (outside diameter), the remote bulb may be installed on top of the line. On 7/8 in. OD and larger, the remote bulb should be installed at about 4 or 8 o'clock position (see Fig.2). If it is necessary to protect the remote bulb from the effects of the air stream after it is clamped to the line, use a material such as sponge rubber that will not absorb water when the evaporator temperatures are above 32°F (0°C). Below 32°F, cork or similar material sealed against moisture is suggested to prevent ice collecting at the remote bulb location.

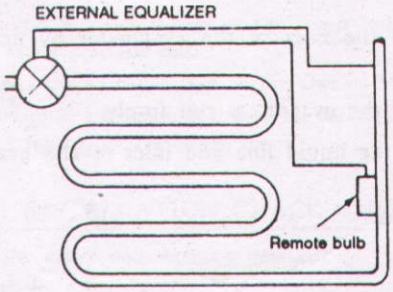


Figure 1 Remote bulb installation on vertical tubing.

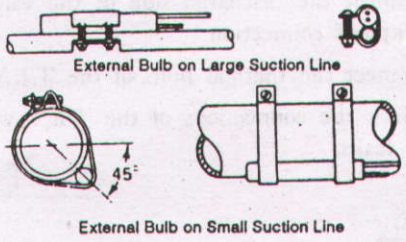


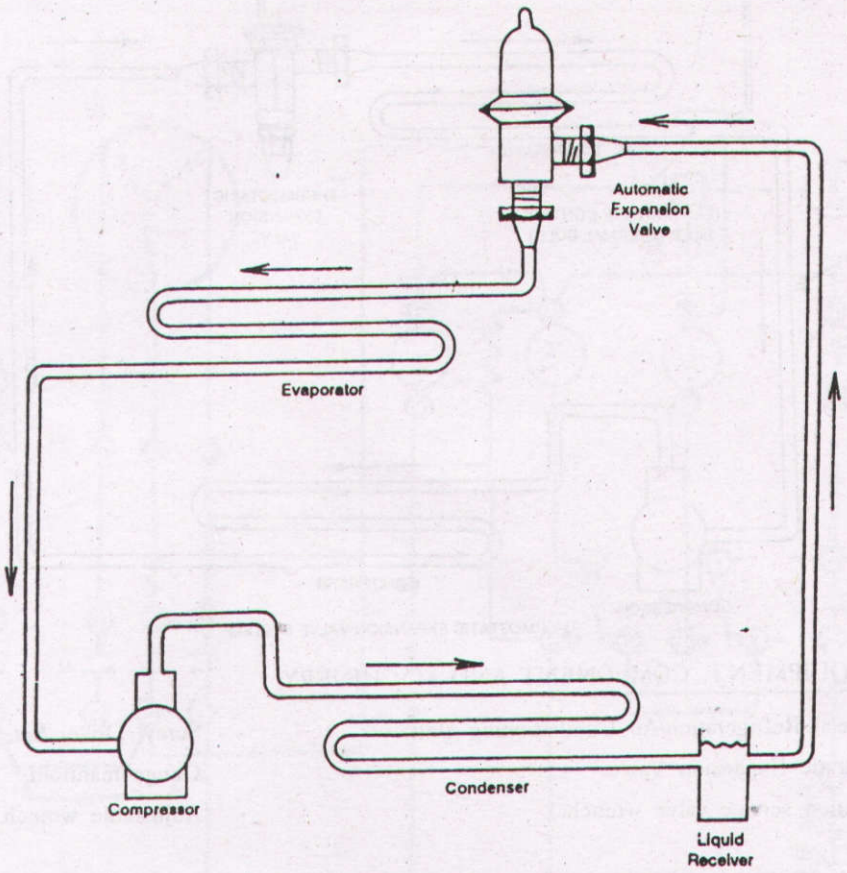
Figure 2 Remote bulb installation on horizontal tubing.

SCALE :	INSTALLATION OF THERMOSTATIC EXPANSION VALVE	RP/4.15.1/06a
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.



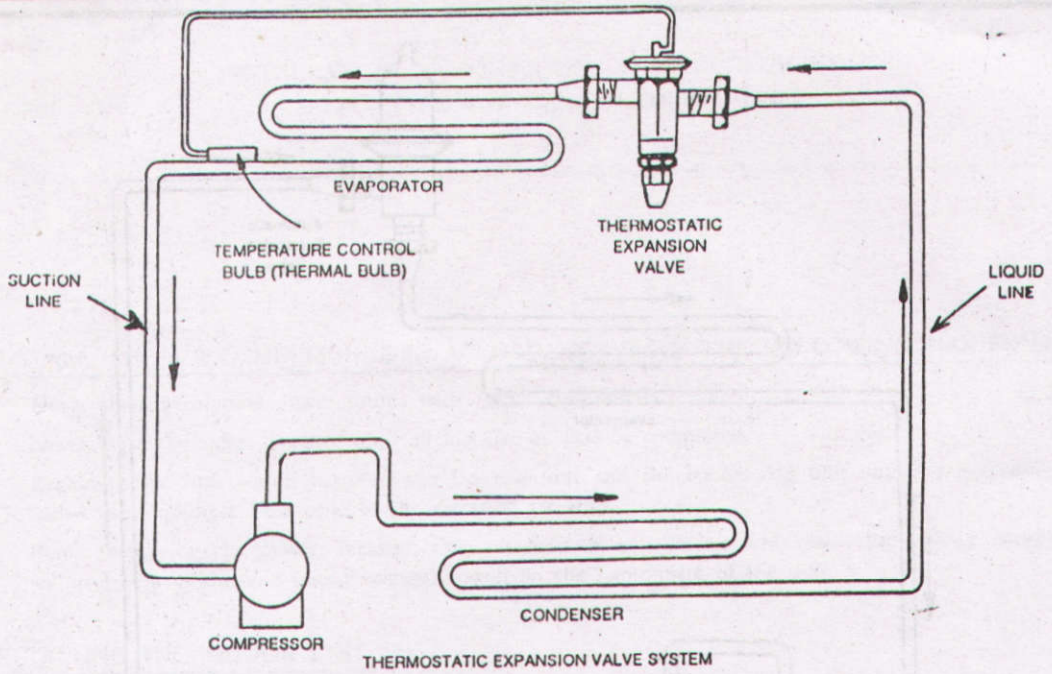
TOOLS, EQUIPMENT AND MACHINERY:

- Air conditioning unit.
- Refrigeration service valve wrench.
- Adjustable wrench.
- Open end spanner set.
- Automatic Expansion valve. (A.E.V).
- Gauge manifold.
- Screw driver set.

SEQUENCE OF OPERATIONS:

- Select the automatic expansion valve according to that automatic expansion valve which will be replaced.
- Pump down the system.
- Dismount the automatic expansion valve.
- Mount (install) the automatic expansion valve according to the procedure of exercise No.RP/4.15.1/05
- Evacuate the suction and discharge sides of the automatic expansion valve.
- Put the system in normal position. (In working position).
- Check the system for proper function.

SCALE :	REPLACING OF AUTOMATIC EXPANSION VALVE	RP/4.15.1/07
MAT		AIR CONDITIONING



THERMOSTATIC EXPANSION VALVE SYSTEM

TOOLS, EQUIPMENT, COMPONENT AND MACHINERY:

- Commercial Refrigeration/Air Condiationing Unit.
- Thermostatic Expansion Valve.
- Refrigeration service valve wrench.
- Screw Driver Set.
- Gauge manifold.
- Adjustable wrench.

SEQUENCE OF OPERATIONS:

- Select the thermostatic expansion valve according to that thermostatic expansion valve which will be replaced.
- Pump down the system.
- Dismount the thermostatic expansion valve.
- Mount/install the the thermostatic expansion valve according to the procedure of exercise No.RP/4.15.1/06.
- Evacuate the suction and discharge sides of the thermostatic expansion valve.
- Open the liquid receiver outlet valve (king valve)/shut off valve (put the system in normal position/in working condition).
- Start compressor and observe the operation of replaced thermostatic expansion valve in the system.

NOTE:

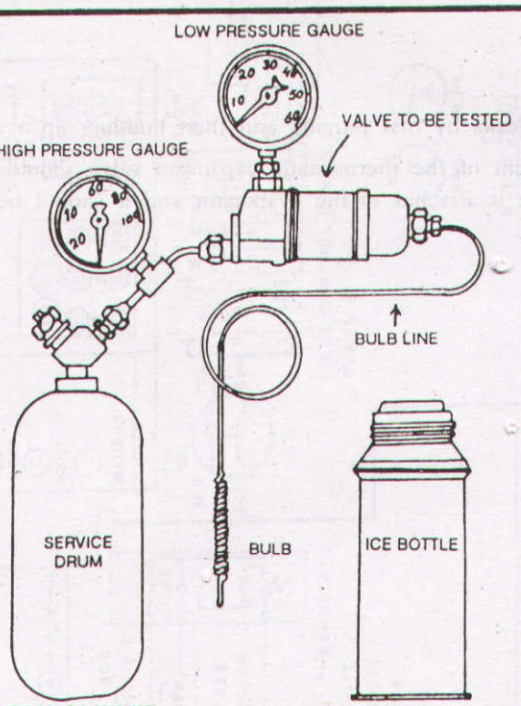
- Carefully test for leaks by first purging and then building up a refrigernat vapor pressure.
- The sensing element of the thermostatic expansion valve should be clamped to the suction line at the point where it attaches to the evaporator and it should be upward of the tube.

SCALE	REPLACING OF THERMOSTATIC EXPANSION VALVE	RP/4.15.1/08
MAT		AIR CONDITIONING

NOTE:

- Carefully test for leaks by first purging and then building up a refrigernat vapor pressure.
- The sensing element of the thermostatic expansion valve should be clamped to the suction line at the point where it attaches to the evaporator and it should be upward of the tube.

SCALE :	REPLACING OF THERMOSTATIC EXPANSION VALVE	RP/4.15.1/08a
MAT		AIR CONDITIONING
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK - GERMAN TECHNICAL TRAINING PROGRAMME		Refg. & Air Cond.



TOOLS, MATERIAL AND COMPONENT:

- Thermostatic expansion valve.
- Low pressure gauge.
- Ice bottle.
- Shut off valve.
- Screw driver set.
- High pressure gauge.
- Service drum (cylinder) R-12

SEQUENCE OF OPERATIONS:

- Connect the valve with low pressure gauge screwed loosly into the adapter on the expansion valve outlet. The gauge is screwed up loosely so as to provide a small amount of leakage through threads.
- Insert the bulb in the crushed ice.
- Open the valve on the service drum and be sure that the drum is warm enough to build up a pressure of atleast 70 pounds on the high pressure gauge connected in the line to the valve inlet.
- The expansion valve can now be adjusted. The pressure on the outlet gause should be different for various refrigerants, as follows:

Freon---------- 22 pounds.
Methyl chloride ---------- 15 pounds.
Sulfur dioxide----------3 pounds.

NOTE:

- Be sure to have a small amount of leakage through the gauge connection while making this adjustment.
- Tap the body of the valve tightly with a small wrench in order to determine if the valve is smooth in operation. The needle of the gauge should not jump more than on pound.
- Screw the gauge up tight so as to stop the leakage through the threads and determine if the expansion valve closes off tightly. With a good valve, the pressure will increase a few pounds

SCALE	TESTING OF THERMOSTATIC EXPANSION VALVE	RP/4.15.1/09
MAT		AIR CONDITIONING

and then either stop or build up very slowly. With a leaking valve, the pressure will build up rapidly until it equals the inlet pressure.

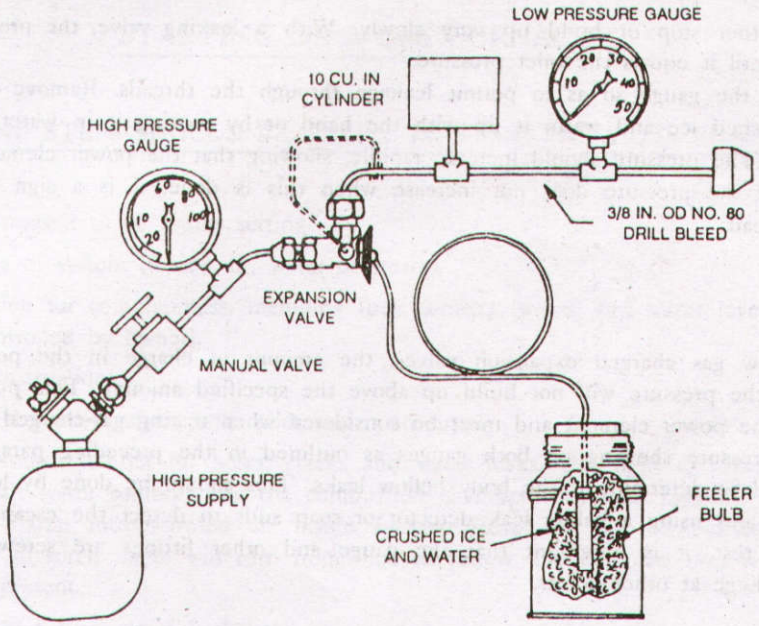
- Again loosen the gauge so as to permit leakage through the threads. Ramove the feeler bulb from the crushed ice and warm it up with the hand or by putting it in water at about room temperature. The pressure should increase rapidly, showing that the power element has not lost its charge. If the pressure does not increase when this is done, it is a sign that the power element is dead.

NOTE:

- With the new gas charged expansion valves, the amount of charge in the power element is limited and the pressure will not build up above the specified amount. This pressure is always marked on the power element and must be considered when testing gas-charged valves.
- With high pressure showing on both gauges as outlined in the preceding paragraph the valve can be tested to determine if the body bellow leaks. This should be done by loosening up the packing nut and using a halide leak detector or soap suds to detect the escape of gas. When making this test, it is important that the gauge and other fittings are screwed up tight to eliminate leakage at other points.

PRECAUTION:

- Be sure that the service drum has liquid in it and is warm enough to build up sufficient pressure. Use of a high pressure gauge as shown in above fig, will often save a lot of trouble because it will show when too little pressure is present on the inlet side of the valve. During the winter time especially, the service drum may become cold and develop insufficient pressure to make a satisfactory test.
- Be sure that the thermos bottle or other container is full of finely-crushed ice and does not have merely a little ice floating on top of the water.



TOOLS, MATERIAL AND COMPONENT:

- Thermostatic expansion valve.
- Screw driver set.
- High pressure gauge.
- Service cylinder (gas cylinder)
- Crushed ice and water bottle.
- Shut off valve.
- Low pressure gauge.
- 10-cu. in. cylinder.

SEQUENCE OF OPERATIONS:

- Connect the valve as shown in the above fig. the adaptor on the expansion valve outlet provides a small amount of leakage through the No. 80 drill orifice opening. A 10-cu. in. tank (cylinder) is used to reduce pressure fluctuations.
- Insert the bulb in the crushed ice and allow it to cool.
- Open the valve on the service cylinder and be sure that the cylinder is warm enough to build up a pressure of at least 70 psi. On the high pressure gauge connected in the line to the valve inlet.
- Now expansion valve can be adjusted. The pressure in the outlet should equal the pressure of the refrigerant at 22F. The water and ice mixture is 32F. If the super heat is to be 10F; then the temperature of the refrigerant will be 22F. The pressure on the outlet gauge should be different from various refrigerants as follows.

Refrigerant R-12	22Psi.
Refrigerant R-22	45Psi.
Refrigerant R-500	29Psi.
Refrigerant R-502	55Psi.

SCALE :	ADJUSTMENT OF THERMOSTATIC EXPANSION VALVE	RP/4.15.1/10
MAT :		AIR CONDITIONING

- When making the adjustment, be sure there is a small amount of leakage through the low pressure orifice.
- Tap the body of the valve lightly in order to determine if the valve is smooth in operation. The needle of the low pressure gauge should not jump more than one pound.
- To test the needle for leaks, close the orifice to stop the leakage and determine if the expansion valve closes off tightly.
- If the valve is in good condition and not leaking, the pressure will increase a few pounds and then either stop or build up very slow.
- With a defective, leaking valve, the pressure will build up repaidly until it equals the inlet pressure.
- To test the power element, remove the power element bulb from the crushed ice and warm it up with the hand or by putting it in water at about room temperature. The pressure increases rapidly, if the power element is operating.

SCALE	ADJUSTMENT OF THERMOSTATIC EXPANSION VALVE	RP/4.15.1/10a
MAT		AIR CONDITIONING

TROUBLE SHOOTING CHART OF THERMOSTATIC EXPANSION VALVE

TROBULE	CAUSE / SYMPTOM	REMEDY
High discharge pressure.	Insufficient cooling water due to inadequate supply or faulty water valve. Condenser or liquid receiver too small. Cooling water above designed temperature. Air or noncondensable gases in condenser. Overcharge of refrigerant. Condenser dirty. Insufficient cooling air circulation over air cooled condenser.	Start pump and open water valves. Adjust, repair or replace any defective equipment. Replace with correct size condenser or liquid received. Increase supply of water by adjusting water valve, replacing with a large valve. Puge and recharge the system. Bleed to proper charge. Clean condenser. Properly locate condenser to freely dispel hot discharged air. Tight or replace slipping belts or pulleys and be sure blower motor is of proper size.
Low suction pressure . . . High superheat.	A. Expansion valve limiting flow Inlet pressure too low from excessive vertical lift, undersize liquid line or excessive low condensing temperature. Resulting pressure difference across valve too small. Gas in liquid line . . .due to pressure drop in the line or insufficient refrigerant charge. If there is no sight glass in the liquid line, a charactristic whistling noise will be heard at the expansion valve. Valve restricted by pressure drop through evaporator. External equalizer line plugged, or external equalizer connection capped without providing a new vlave cage or body with internal equlizer.	Increase head pressure. If liquid line is too small, replace with proper size. Locate cause of liquid line flash gas and correct by use of any or all of the following methods. 1. Add charge. 2. Clean strainers, replace filter driers. 3. Check for proper line size. 4. Increase head pressure or decrease temperature to ensure solid liquid refrigerant at valve inlet. Change to an expansion valve having an external equalizer. If external equalizer is plugged, repair or replace. Otherwise, replace with valve having correct equalizer.

TROBULE	CAUSE / SYMPTOM	REMEDY
	Moisture, wax, oil or dirt plugging valve orifice. Ice formation or wax at valve seat may be indicated by sudden rise in suction pressure after shutdown and system has warmed up.	Wax and oil indicate wrong type of oil is being used. Purge and recharge system, using proper oil. Install a filter-drier to prevent moisture and dirt from plugging valve orifice.
	Valve orifice too small.	Replace with proper valve.
	Superheat adjustment too high.	Adjust correct superheat.
	Power assembly failure or partial loss of a charge.	Replace power assembly (if possible) or replace valve.
	Gas charged remote bulb of valve has lost control due to remote bulb tubing or power head being colder than the remote bulb.	Replace with ``W`` cross-ambient power assembly. See ``Remot bulb and power assembly charge.``
	Filter screen clogged.	Clean all filter screens.
	Wrong type oil.	Purge and reacharge system and used proper oil.
	B. Restriction in system other than expansion valve.	
	Strainer clogged or too small.	Remove and clean strainers. Check manufacturer's catalog to make sure that correct strainer was installed. Add a filter-drier to system.
	A solenoid valve not eperating properly or is undersized.	If valve is undersized, check manufacturer's catalog for proper size and condition that would cause malfunction.
	King valve at liquid receiver too small or not fully opened.	Repair or replace faulty valve if it can not be fully opened.
	Hand valve stem failure or valve too small or not fully opened.	Replace any undersized valve with one of correct size.
	Discharge or suction service valve on compressor restricted or not fully opened.	
	Plugged lines.	Clean, repair, or replace lines.
	Liquid line too small.	Install proper size liquid line.
	Suction line too small.	Install proper size suction line.
	Wrong type oil in system, blocking refrigerant flow.	Purge and recharge system and use proper oil.

SCALE :

MAT :

TROUBLE SHOOTING CHART

RP/4.15.1/11a

AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

SCALE

MAT

TROUBLE SHOOTING CHART

RP/4 15 1/11b

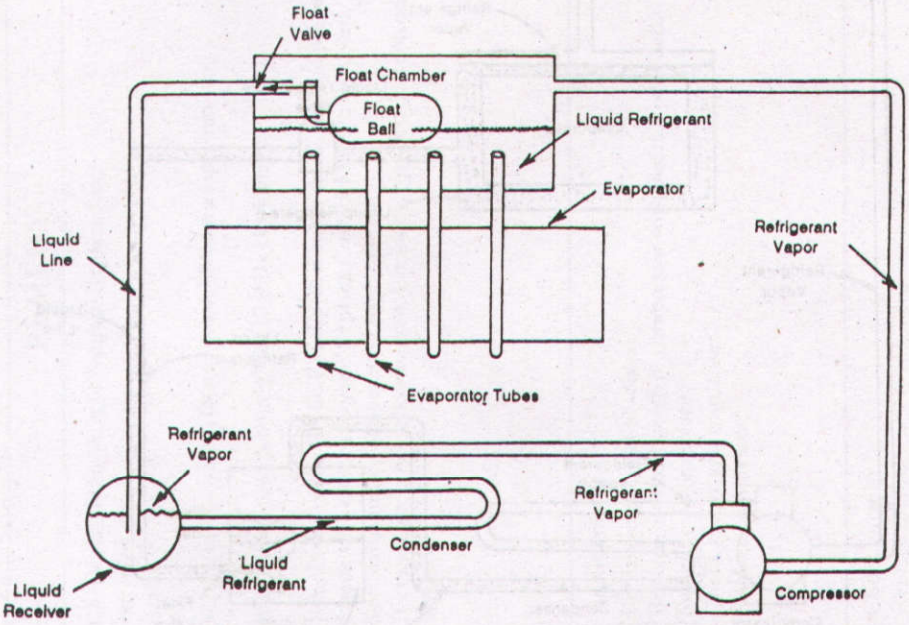
AIR CONDITIONING

Refg. & Air Cond.

TROBULE	CAUSE / SYMPTOM	REMEDY
Low suction pressure .... Low superheat.	Poor distirbution in evaporator, causing liquid to short circuit through favoured passes and throttling valve before all passes receive sufficent refrigerant. Compressor oversize or running too fast due to wrong size pulley. Uneven or inadequate evaporator loading due to poor air distribution or brine flow. Evaporator too small . . . . .often indicated by excessive ice formation. Excessive accumulation of oil in evaporator.	Clamp power assembly remote bulb to free draining suction line. Clean suction line throughly before clamping bulb in place. Install a refrigerant distributor. Balance evaporator load distribution. Reduce speed of compressor by installing proper size pulley or provide compressor capacity control. Balance evaporator load distribution by providing correct air or brine distribution. Replace with proper size evaporator. Alter suction piping to provide proper oil return or install oil separator, if required.
High suction pressure . . . High superheat	Unbalanced system having an over-sized evaporator, and undersized compressor and a high load on the evaporator. Load in excess of design conditions. Compressor undersized. Evaporator too large. Compressor discharge vlave leaking.	Balance system components for load requirements. Replace with proper size compressor. Replace with proper size evaporator. Replace or repair valve.
High suction pressure . . . low superheat.	Compressor undersized. Valve superheat setting too low. Gas in liquid line with oversized expansion valve. Compressor discharge valve leaking. Pin and seat of expansion valve wire down, eroded, or help open by foreign material, resulting in liquid flood back. Ruptured diaphram or bellows in a constant pressure (automatic) expansion valve, resulting in liquid floodback.	Replace with proper size compressor. See ``measuring and adjusting operating superheat``. Replace with proper size expansion valve. Correct cause of flash gas. Repair or replace discharge valves. Clean or replace damaged parts or replace valve. Install a filter-drier to remove foreign material from system. Replace valve power assembly.

TROBULE	CAUSE / SYMPTOM	REMEDY
	External equalizer line plugged, or external equalizer connection capped without providing a new vlave cage or body with internal equlizer. Moiture freezing valve in open position.	If external equalizer is plugged, repair or replace Otherwise, replace with valve having correct equalizer. Apply hot rags to valve to melt ice. Install a filter drier to ensure a moisture-free system.
Fluctuating suction pressure.	Incorrect superheat adjustment. Trapped suction line. Improper remote bulb location or installation. Floodback of liquid refrigerant caused by poorly designed liquid distribution device or uneven evaporator loading. Improperly mounted evaporator. External equalizer lines trapped at a common point although there is more than one expansion valve on same system. Faulty condensing water regulator, causing change in pressure drop across the valve. Evaporative condenser cycling, causing radical change in pressure difference across expansion vlave. Cycling of blowers or brine pumps. Restricted external equlizer line.	Correct superheat adjustment. Install ``P`` trap to provide a free draining suction line. Clamp remote bulb to free draining suction line. Clean suction line throughly before clamping bulb in place. Replace faulty distributor with a refrigerant distributor. If evaporator loading is uneven, install proper load distributor devices to balance air velocity evenly over evaporator coils. Remount evaporator loading is uneven, install proper load distributor devices to balance air velocity evenly over evaporator coils. Remount evaporator lines to provide proper angle. Each valve must have its own separate equalizer line going directly to an appropriate location on evaporator outlet to ensure proper operational reasons of each individual valve. Replace condensing water regulator. Cheek spray nozzles, coil surface, control circuits, thermostat, overloads, etc. Repair or replace any defective equipment. Clean clogged nozzles, coil surface, etc. Repair or replace with correct size.

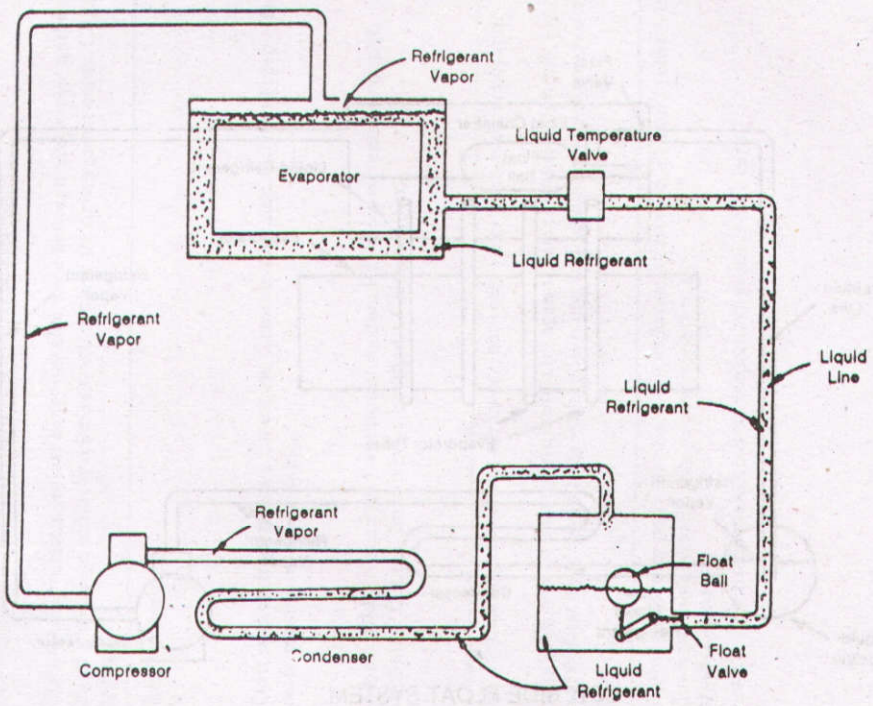
TROBULE	CAUSE / SYMPTOM	REMEDY
Fluctuating discharge pressure.	Faulty condensing water requlating valve.	Replace condensing water regulating vlave.
	Insufficient charge..... usually accompanied by corresponding fluctuation in suction pressure.	Add charge to othe system.
	Cycling of evaporative condenser.	Check spray nozzles, coil surface, control circuits, thermostat, overloads, etc. Repair or replace any defective equipment. Clean clogged nozzles, coil surface, etc.
	Inadequate and fluctuating supply of cooling water to condenser.	Check water regulating valve and repair or replace if defective. Check water circuit for restriction.
	Cooling fan for condenser cycling.	Determine cause for cycling fan, and correct.
	Fluctuating discharge pressure controls on low ambient air-cooled condenser.	Adjust, repair, or replace controls.



LOW SIDE FLOAT SYSTEM.

LOW SIDE FLOAT VALVE:

Low side float valve is an efficient refrigerant control. It maintains a constant liquid level of refrigerant in the evaporator. The float itself may be a sealed ball, a cylinder or an open pan. It is connected by lever to a needle which closes an orifice, when the liquid, level reaches the correct height and opens it when some of the refrigerant evaporates and the liquid level drops. Low side float valve may be connected either to a needle or a ball valve. It is callibrated so that the valve will close when the float is at the proper level. This is, when there is a certain level of liquid refrigerant in the evaporator, the suction tube on these evaporators extend into a float chamber and with pan type float, extends to the bottom of the pan. Low side float control has the possible disadvantage of the ''oil Binding".



HIGH SIDE FLOAT SYSTEM

HIGH SIDE FLOAT VALVE:

High side float refrigerant control is like as the low side float mechanism. It is located on the high pressure side. Condensed refrigerant from the condenser flows directly to the high side float chamber. No liquid receiver is used in the system. As the liquid refrigerant level rises, the float inside the chamber opens a valve allowing the liquid refrigerant to flow into the evaporator. In this type of refrigerant control, the liquid refrigerant is stored in the evaporator. As the liquid level falls into the float chamber, the float will move down and close the valve opening into the evaporator. In this way the pressure difference between the high side and low side is maintained. This float maintains a constant level of liquid refrigerant on the high pressure side.

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

SCALE :

MAT

TROUBLE SHOOTING CHART

RP/4.15 1/14

AIR CONDITIONING

TROUBLESHOOTING CHART OF PACKAGE TYPE AIR CONDITIONING UNIT

TROBULE	CAUSE / SYMPTOM	REMEDY
Compressor does not run.	Power line open. Safety thermostat tripped. Tripped circuit breaker. Contactor stuck open. Loose terminal connections. Improperly wired controls. Low line voltage. Compressor motor defective. Seized compressor.	Reset circuit breaker. Reset thermostat. Check controller. Find cause of trip and reset breaker. Replace contactor. Check connections and tight. Check wiring and rewire. Check line voltage. Determine location of voltage drop and remedy difficiency. Check motor winding for open or short. Replace compressor, if necessary. Replace compressor.
Compressor stop on low pressure control.	Low pressure control erratic in action. Compressor suction valve leaking. Compressor suction shut off valve partially closed. Low refrigerant charge. Plugged compressor suction strainer	Raise differential setting. Check capillary for pinches. replace control. Replace valve plate. Open valve- Add refrigerant. Clean strainer.
Compressor cycles on high ressure control.	High pressure control erratic in action. Compr discharge valve partially closed. Air in system. Condenser fan (s) not operating.	Check capillary tube for pinches, set control as required. Open valve or replace if defective. purge. Check motor and wiring, repair or replace if defective.

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

SCALE

MAT

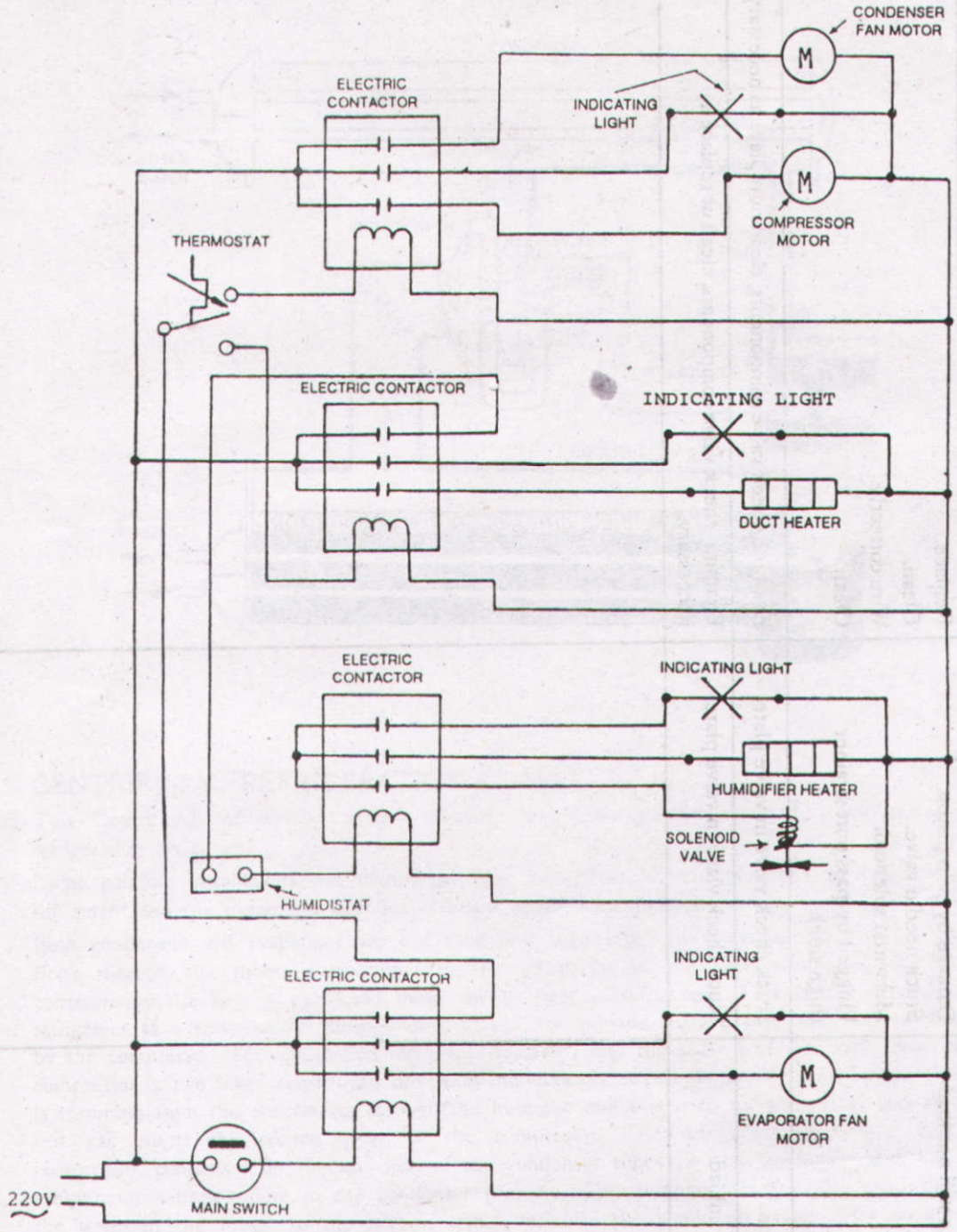
TROUBLE SHOOTING CHART

AIR CONDITIONING

RP/4 15 1/14a

TROBULE	CAUSE / SYMPTOM	REMEDY
Unit operates long or continuously.	Low refrigerant charge. Control contacts fused. Air in system. Partially plugged or plugged expansion valve or strainer. Defective insulation. Service load. Inefficient compressor.	Add refrigerant. Replace control. Purge. Clean or replace. Replace or repair. Keep doors and windows close. Check vlaves and replace if necessary.
System noiser.	Piping vibration. Expansion valve hussing. Compressor noisy.	Support piping as required. Check or loose pipe conections. Add refrigerant, check for plugged liquid line strainer. Check valve plates for valve noise, replace compressor (worn bearings). Check for loose compressor hold down bolts.
Compressor looses oil	Leak in system. Plugged or stuck compressor snifter valve. Check case heaters, no energised during shut-down.	Repair leak. Repair or replace. Replace heaters, check wiring.
Frosting or sweating on suction line.	Expansion valve admitting excess refrigerant.	Adjust expansion vlave.
Hot liquid line.	Shortage of refrigerant due to leak.	Remove leak and recharge.
Frosted liquid line.	Restricted filter drier.	Remove restriction or replace filter drier.
Compressor will not unload.	Burned-out coil. Leaking bypass piston. Stuck needle valve. Mis-wired solenoid. Plugged by-pass port (low side). Weak by-pass piston spring.	Replace coil. Clean or replace. Clean. Wire correctly. Clean. Replace.

TROBULE	CAUSE / SYMPTOM	REMEDY
Compressor will not load.	Damage by-pass piston. Stuck needle valve. Mis wired solenoid. Plugged by-pass port strainer (high side).	Replace. Clean. Wire correctly. Clean.
High suction.	Stuck check valve in valve plate.	Examine check valve components, clean or replace as necessary.
Chattering unload.	Stuck check vlave in valve plate.	Examine check valve components, clean or replace as neccessary.



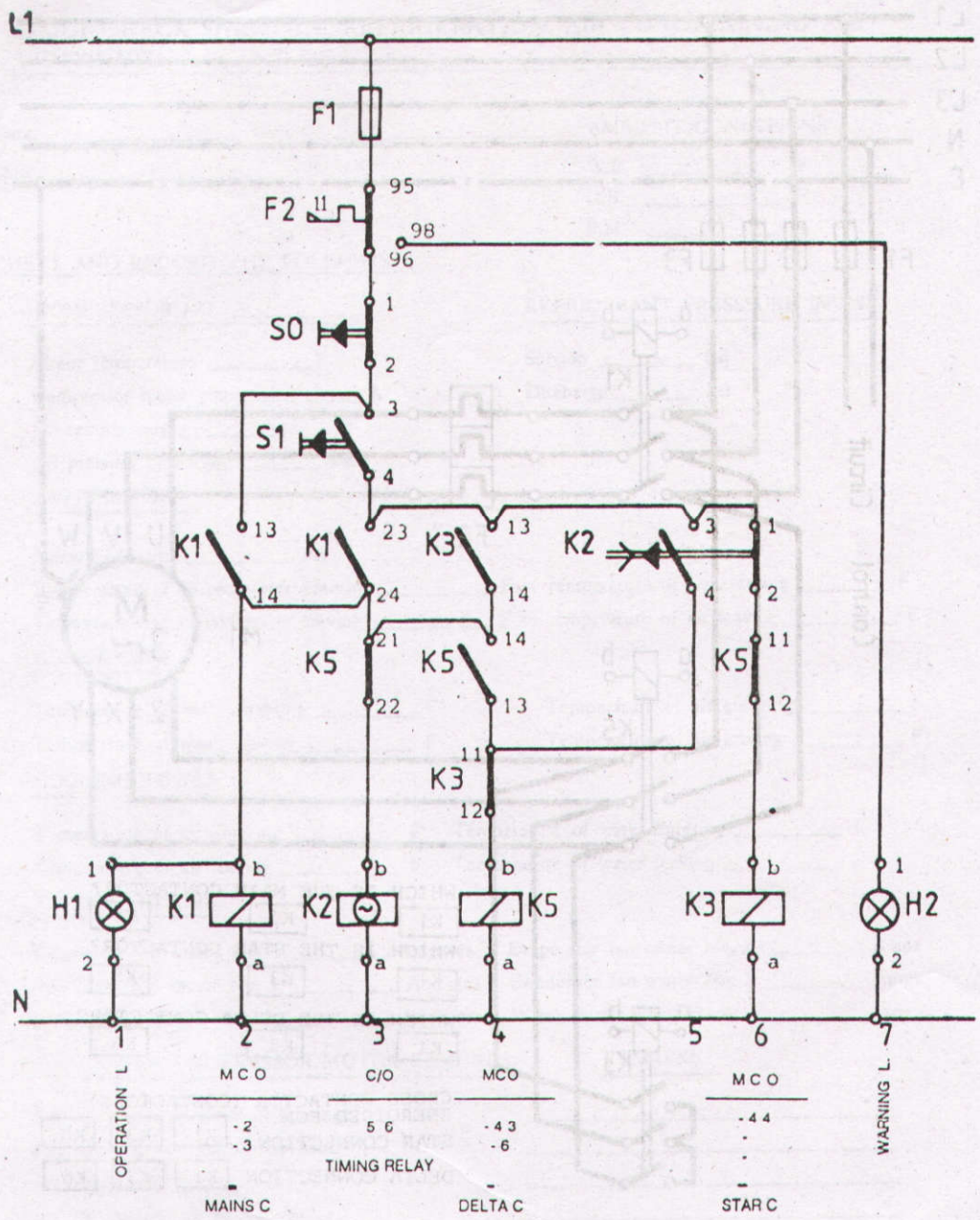
NOTE:-
TAKE SUITABLE MATERIAL AND DO YOUR PRACTICAL JOB.
CONNECT SUPPLY IN PREENCE OF YOUR INSTRUCTOR

SCALE	ELECTRIC CIRCUIT OF AIR HEATING AND HUMIDIFYING SYSTEM	RP/4 15.1/15
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.



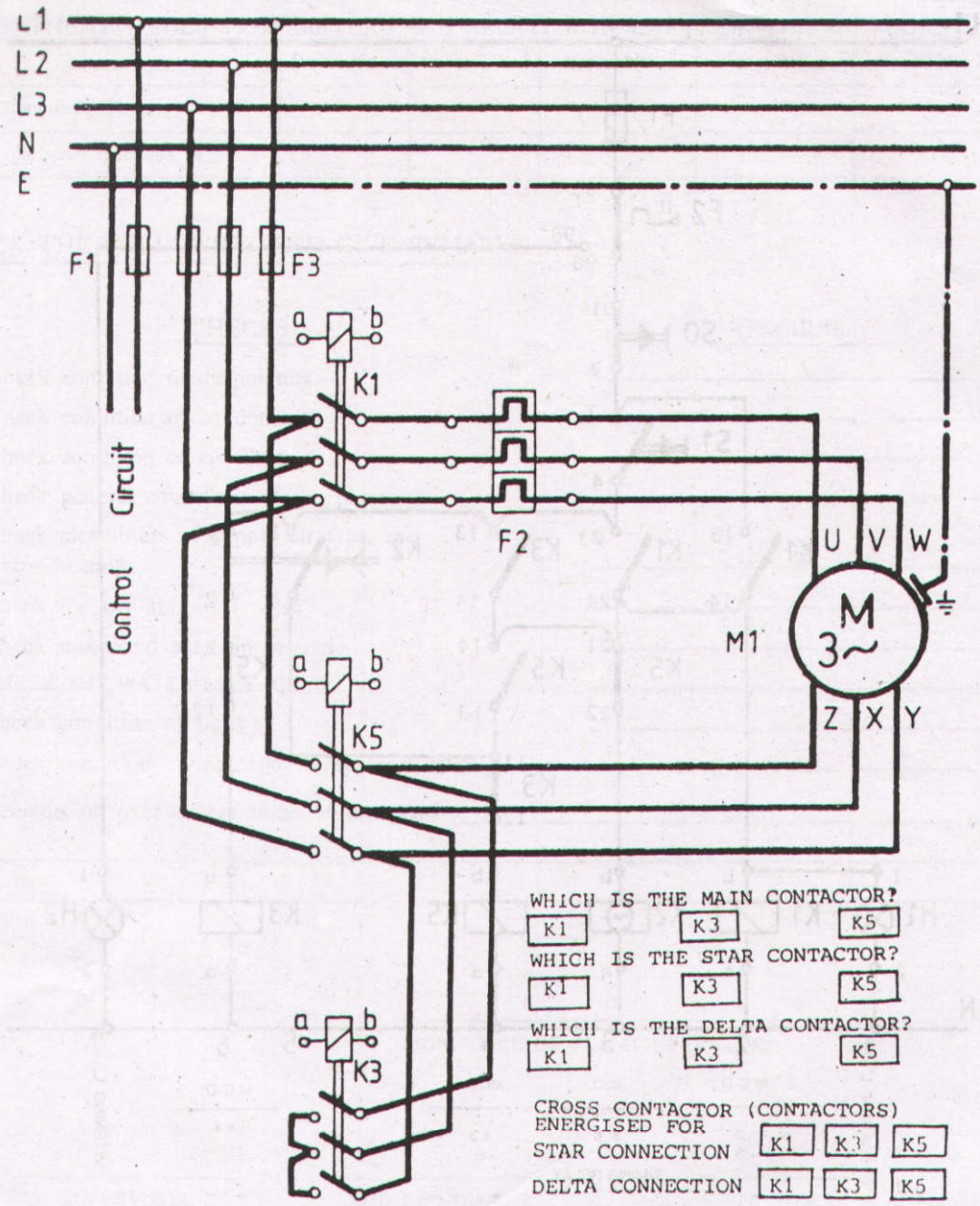
- TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB.
- ACCORDING TO INSTRUCTOR'S DECISION USE PLUG OR DOOR INSTALLATION.
- CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.
- CONTROL CIRCUIT

SCALE	MOTOR CONNECTION, 3~ STAR DELTA	RP/4.15.1/16
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.



WHICH IS THE MAIN CONTACTOR?

K1 K3 K5

WHICH IS THE STAR CONTACTOR?

K1 K3 K5

WHICH IS THE DELTA CONTACTOR?

K1 K3 K5

CROSS CONTACTOR (CONTACTORS) ENERGISED FOR

STAR CONNECTION K1 K3 K5

DELTA CONNECTION K1 K3 K5

TAKE SUITABLE MATERIAL (MOTOR) AND DO YOUR PRACTICAL JOB:

ACCORDING TO INSTRUCTOR'S DECISION USE PLUG WIRING OR BOARD INSTALLATION:

CONNECT SUPPLY IN PRESENCE OF YOUR INSTRUCTOR.

POWER CIRCUIT

SCALE	MOTOR CONNECTION, 3~ STAR DELTA	RP/4.15.1/16a
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

COLLING LOAD ESTIMATE

Name _____ Address _____ Date _____

Job Location _____ Space used for _____

Floor area _____ Sq.ft. Ceiling height _____ ft. Volme _____ Cu. ft.

DESIGNING CONDITIONS

ITEM	UT SIDE	IN SIDE	DIFFERENCE
DB			
WB			
%RH			
Gr/Lb			

OUT SIDE WALLS

	GROSS WALL	GLASS	NET WALL
N			
E			
S			
W			

VENTILATION AND INFILTRATION

VENTILATION = Peoples X CFM Per person

Infiltration = Volume X 60

COOLING LOAD BTU/HR

ITEM	Sensible	Latent	SUB Total (Lantent, Sensible)
SENSIBLE HEAT GAIN THROUGH GLASSES			
Sq. ft. X = -			
North X = -			
East X = -			
South X = -			
Total sensible heat gain through glasses			
HEAT TRANSMISSION GAIN			
Wall Sq. ft. X Factor X DB Temp. Difference			
North X X = -			
East X X = -			
South X X = -			
West X X = -			
Partitions X X = -			
Roof X X = -			
Cei ling X X = -			
Total Transmission Gain			
INTERIOR HEAT GAIN, PEOPLES AND LIGHTS			
Number X Sensible Factor X Latent Factor			
Peoples X X = -			
Peoples X X = -			
Watts X 3.4 BTU			
Lights X = -			
Motors X = -			
Appliances X = -			
VENTILATION AND INFILTRATION			
Cu. Ft. per minute X DB Temp. Diff. X x 1.0 = -			
Cu. Ft. per minute X Specific Humidity gr/lb Diff. X x 0.67 = -			

TOTAL LOAD BTU/HR

10% SAFETY _____ BTU/HR

GROSS TOTAL LOAD BTU/HR

TONS OF REFRIGRATION = $\frac{\text{Gross Total Load}}{12000}$ = $\frac{\quad}{12000}$ = Tons.

SCALE	INFORMATION SHEET	RP/4.15.1/17
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

UNIT AIR CONDITIONER HEAT LOAD CALCULATION

Name _____ Address _____

Space used for _____

INTERIOR ROOM DIMENSIONS:

Length _____ Width _____ Height _____

WINDOWS:

No._____ Facing _____ Size _____ x _____

No._____ Facing _____ Size _____ x _____

No._____ Facing _____ Size _____ x _____

WINDOWS LOAD:

1. Sun exposed (Interior shades only)

West side _____ Sq. ft. x 60 = _____ Btu/hr. _____ Watts.

2 Sun exposed (interior shades)

South side _____ Sq. ft. x 40 = _____ Btu/hr. _____ Watts.

3 Sun exposed (awnings)

_____ Sq. ft. x 35 = _____ Btu/hr. _____ Watts.

4 East exposute, north exposure or

shaded _____ Sq. ft. x 15 = _____ Btu/hr. _____ Watts.

WALL LOAD

1 Sun exposed, south and west walls

_____ Sq. ft. x 8 = _____ Btu/hr. _____ Watts.

2 East or north exposure

_____ Sq. ft. x 5 = _____ Btu/hr. _____ Watts.

3 All exposures, thin walls

_____ Sq. ft. x 10 = _____ Btu/hr. _____ Watts.

4 Interior walls

_____ Sq. ft. x 4 = _____ Btu/hr. _____ Watts.

FLOOR LOAD

_____ Sq. ft. x 3 = _____ Btu/hr. _____ Watts.

CEILING LOAD

1. Occupied above

_____ Sq. ft. x 3 = _____ Btu/hr. _____ Watts.

2 Insulated roof

_____ Sq. ft. x 8 = _____ Btu/hr. _____ Watts.

3 Uninsulated roof Sq. ft. x

_____ Sq. ft. x 20 = _____ Btu/hr. _____ Watts.

VENTILATION LOAD

_____ Cu. ft. x 4 = _____ Btu/hr. _____ Watts.

OCCUPANCY LOAD

No. of people _____ x 400 = _____ Btu/hr. _____ Watts.

MISCELLANEOUS LOAD

Electrical watts _____ x 3.4 = _____ Btu/hr. _____ Watts.

other x = Btu/hr. _____ Watts.

TOTAL BTU PER HOUR = _____ Btu/hr. _____ Watts.

Calculate the cooling load capacity in Btu/hr. by using the process as shown in exercise No Rp/4.15.1/17 and also calculate the tonnage capacity by the following formula.

UNIT CAPACITY IN TONS OF REFRIGERATION $= \frac{\text{Total cooling load in Btu/hr.}}{12000} =$ _____ Tons.

$\frac{\qquad\qquad}{12000} =$ _____ Tons.

SCALE :	INFORMATION SHEET	RP/4.15.1/17a
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

HEAT LOAD CALCULATION FOR UNIT OF COLD STORAGE

SEQUENCE OF OPERATION:

- Measure the dimensions inside and outside of the cold storage.
- Measure the outside temperature of the cold storage.
- Select the required (inside) temperature of the cold storage.
- Measure the thickness of insulation of the walls of the cold storage.
- Find the product which will be stored.
- Find the temperature of the product which will be stored.
- Find the heat load of the cold storage by the following table:----------

WALL GAIN LOAD:

Out side wall surface area	x U factor	x Temperature difference	x 24 = BTU/24 Hrs.
North wall _____	x _____	x _____	x 24 = _____
South wall _____	x _____	x _____	x 24 = _____
East wall _____	x _____	x _____	x 24 = _____
West wall _____	x _____	x _____	x 24 = _____
Ceiling _____	x _____	x _____	x 24 = _____
Floor _____	x _____	x _____	x 24 = _____

Total wall gain load = _____

AIR CHANG LOAD

Inside volume x Air changes x Air change factor x Btu/24 hrs.

x x x Btu/24 hrs.

PRODUCT LOAD = $\frac{\text{Mass of product x temperature difference}}{\text{Chilling rate factor}}$ = _____ Btu/24hrs.

= _____ x _____ = _____ Btu/24 Hrs.

RESPIRATION HEAT LOAD = Mas of product x Reaction heat x 24hrs. = _____ B\tu/24hrs.

_____ x _____ x 24hrs. = _____ Btu/24hrs.

SUMMATION LOAD = Wall gain load + Air change load + product load + Respiration load = _____ Btu/24hrs.

= _____ + _____ + _____ + _____ = _____

= _____ Btu/24 hrs.

SUMMATION load = _____ Btu/24 hrs.

10% Safety factor of the summation load = _____ Btu/24 hrs.

TOTAL COOLING LOAD = Summation load + 10 percent safety factor of summation load .....

_____ = _____ + _____

= _____ Btu/24hrs.

AVERAGE HOURLY LOAD = $\frac{\text{Total Cooling Load}}{\text{Desired operating time.}}$ = ... Btu/24hrs.

= $\frac{\text{----------}}{\text{----------}}$ = ... Btu/24hrs

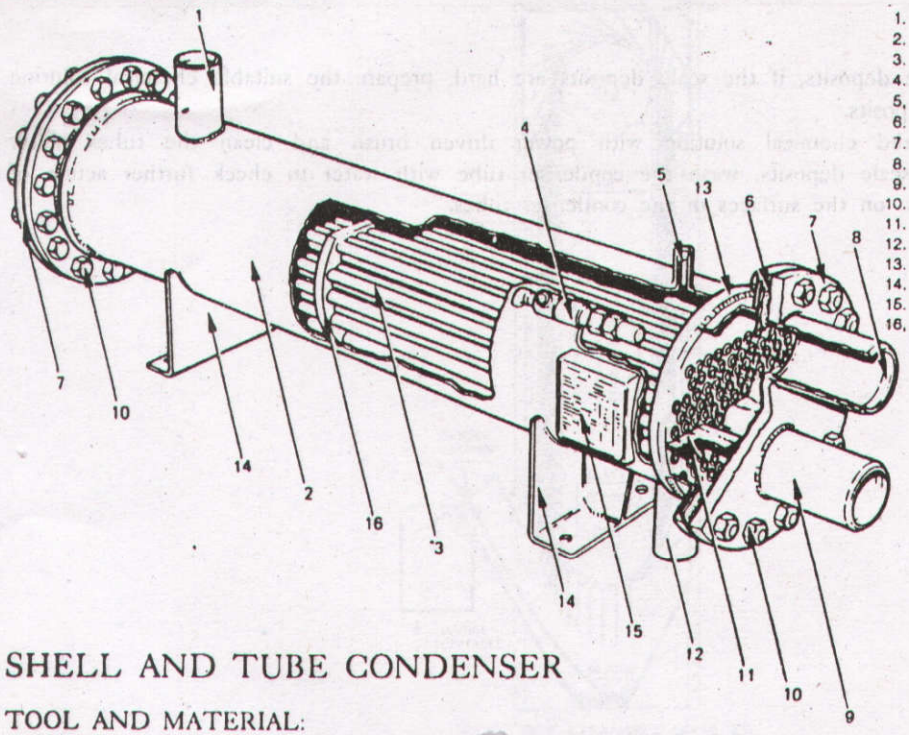
- Use tables for wall gain factor, air change factor, specific heat of products and reaction heat for reaction heat for respiration heat load.
- Calculate the desired operating time of the unit according to use.

SCALE	INFORMATION SHEET	RP/4.15.1/18
MAT		AIR CONDITIONING

SEQUENCE OF OPERATIONS:

- Calculate total heating and cooling load in Btu/Hr. of the given building with the help of Exercise No. RP/4.15.1/17 and find out the total unit capacity in Tons of Refrigeration with the help of following formula:-------

$$\text{TONS OF REFRIGERATION} = \frac{\text{Total Heat Load in Btu/Hr.}}{12000}$$



1. Refrigerant gas inlet
2. Condenser shell
3. Tube nest
4. Relief valve
5. Vent connection
6. Gasket
7. End cover
8. Cooling water outlet
9. Cooling water inlet
10. End cover retaining bolts
11. Corrugated partition baffle
12. Liquid refrigerant outlet
13. Tubeplate
14. Mounting feet
15. Design data plate
16. Tube support plate

SHELL AND TUBE CONDENSER

TOOL AND MATERIAL:

- Shell and tube type condenser.
- Power driven brush.

Open end spanner set.

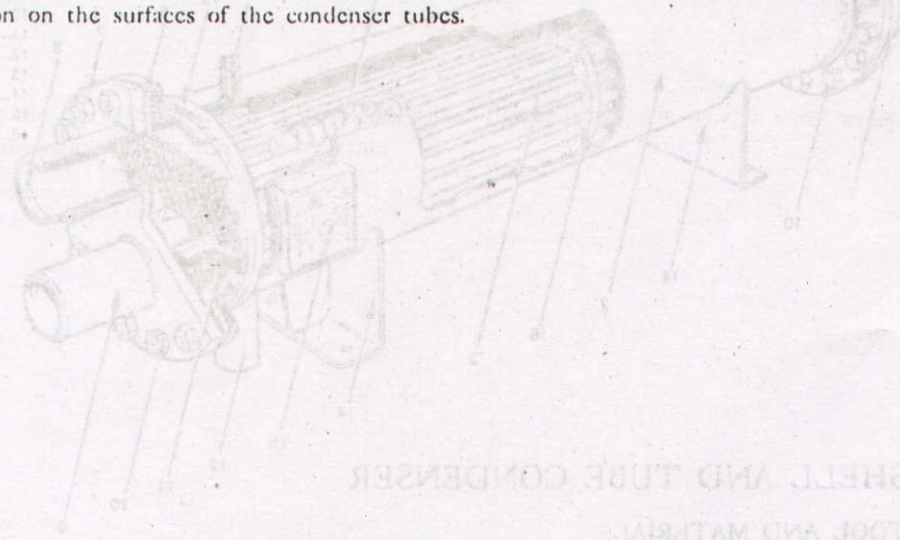
SEQUENCE OF OPERATIONS:

- Check the water and refrigerant temperature of condenser inlet and outlet.
- Shut down the unit.
- Close the water circuit to the condenser.
- Drain off the water from the condenser.
- Open the end covers of the condenser.
- Put out the partition baffles from the condenser water jackets.
- Check the scale deposits (soft or hard) inside the water tubes of the condenser.
- Use the power driven brush (For soft deposits) with clean water and clean the condenser tubes and then check the cleanliness of the condenser water tubes.
- Adjust partition in water jackets of the condenser.
- Adjust the end cover of the condenser by using new gaskets and tight the end covers by making leakproof joints.
- Check the joints of the end cover with condenser for leakproof connections.
- Open the water curcuit to the condenser.
- Start the unit and check it for proper function.

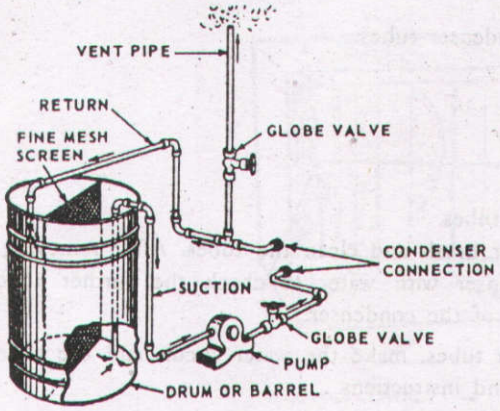
SCALE :	DESCALING AND SERVICING OF SHELL AND TUBE TYPE CONDENSER	RP/4.15.1/19
MAT		AIR CONDITIONING

NOTE:

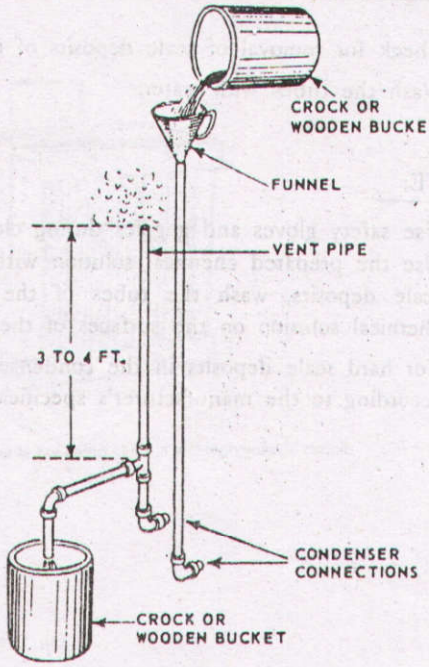
- Check the scale deposits, if the scale deposits are hard, prepare the suitable chemical solution for removing deposits.
- Use the prepared chemical solution with power driven brush and clean the tubes. After removing hard scale deposits, wash the condenser tube with water to check further action of chemical solution on the surfaces of the condenser tubes.



SCALE	DESCALING AND SERVICING OF SHELL AND TUBE TYPE CONDENSER	RP/4.15.1/19a
MAT		AIR CONDITIONING



Condenser water tube cleaning using a forced circulation system for acid solution. Note screen in drum to keep scale from entering pump. Drum must be acid proof. Use ceramic, crock, glass or glass lined tank.



Cleaning water-cooled condenser water tubes. Using dilute hydrochloride acid solution, connect vent pipe to upper condenser connector as shown.

TOOLS, EQUIPMENT AND MATERIAL:

- Shell and tube type condenser.
- Power driven brush.
- Open end spanner set.
- Hydrochloric Acid solution.

SEQUENCE OF OPERATIONS:

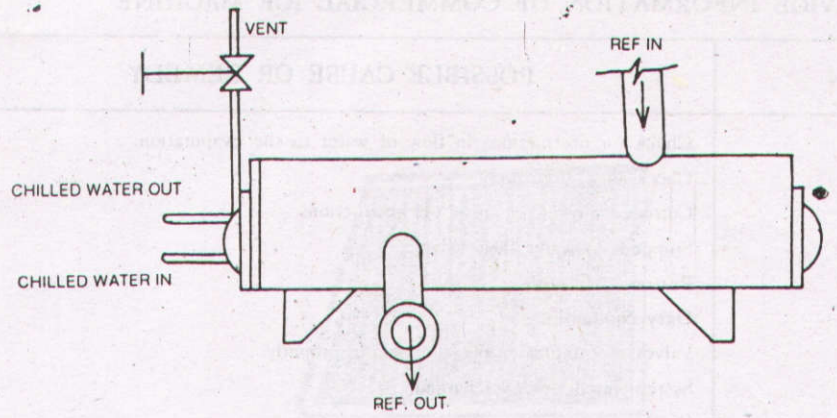
- Check the temperature difference of water and refrigerant entering and leaving the condenser (water temperature difference and refrigerant temperature difference is lower than normal).
- Shut down the unit.
- Close the water circuit to and from the condenser.
- Remove the side plates of the condenser and remove the partition plates from the water jackets of the condenser.
- Check the scale deposits (Soft or Hard), scale deposits are hard.
- Select the prepared chemical of a good company according to the condenser manufactures's specifications.
- Make the arrangement (Piping Circuit) for forced circulation of chemical in the condenser water tubes according to the above shown piping circuit diagram and make connection with the condenser.
- Circulate the chemical solution in the condenser tubes by operating the circulating pumps.

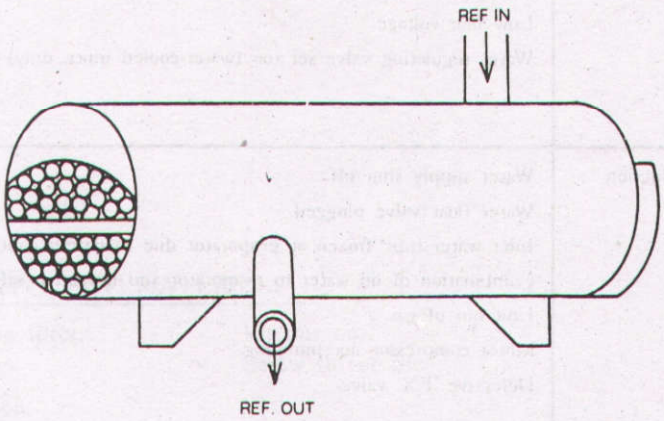
SCALE	DESCALING AND SERVICING OF SHELL AND TUBE TYPE CONDENSER	RP/4.15.1/20
MAT		AIR CONDITIONING

- Check for removal of scale deposits of the condenser tubes.
- Wash the tubes with water.

NOTE:

- Use safety gloves and goggles during cleaning tubes.
- Use the prepared chemical solution with power brush and clean the tubes. After removing hard scale deposits, wash the tubes of the condenser with water to check the further action of chemical solution on the surfaces of the tubes of the condenser.
- For hard scale deposits in the condenser water tubes, make the water circuit and use chemicals according to the manufacturer's specifications and instructions.





TOOLS AND MATERIAL:

- Shell and tube type condenser
- Power driven brush
- Open end spanner set

SEQUENCE OF OPERATIONS:

- Use the sequence of operations (working procedure) as shown in exercise No. RP/4.15.1/19

SCALE :	DESCALING AND SERVICING OF SHELL AND TUBE TYPE EVAPORATOR	RP/4.15.1/21
MAP		AIR CONDITIONING

SERVICE INFORMATION OF COMMERCIAL ICE MACHINE

CONDITION	POSSIBLE CAUSE OR REMEDY
Low ice production	Check for obstructions in flow of water to the evaporation. Check float adjustment. Corroded auyger, clean as per instructions. Stopped up water float valve. Restricted filter-drier. Dirty condenser. Valves in compressor not functioning properly. System uneder-or overcharged. Condenser fan not working. Low line voltage. Water regulating valve set too (water-cooled units. only)
Unit runs, but no ice production	Water supply shut off. Water float valve plugged. Inlet water tube frozen at evaporator due to dafcty control set too cold. Combination of no water to evaporator and defective safety control. Unit out of gas. Motor compressor not pumping. Defective T.X. valve.
Vibration in water reservior assembly.	Too high water pressure or defective water pressure regulator. Partially stopped up float valve.
Excessive noise in compressor.	Auger needs cleaning. Defective bearing.
Low suction pressure.	Water restriction to evaporator. Restricted liquid flow through filter-drier. System low on refrigerant. Moisture in refrigeration system.
Water leaking at bottom of evaporator assembly.	Retaining nut loose on lower housing essembly. Lower water seal leaking.
Wet ice (water being carried out with ice).	Water level set too high.
Wet ice (soft).	System low on refrigerant. Back pressure set too high.

SCALE	TROUBLE SHOOTING CHART	RP/4.15.1/22
MAT		AIR CONDITIONING

CONDITOIN	POSSIBLE CAUSE OR REMEDY
Wet ice (soft).	System low on refrigerant. Back presure set too high. Valve in compressor not pumping properly or reeds in compressor coked (burnt deposits)
Noisy motor compressor.	High head pressure. Defective compressor. Compressor low on oil.
Compressor cuts out on overload.	High head pressure. Low line viltage (it should be within ,10% of reted voltage) Defective empressor unit, starting capacitor, relay, or Over load device. Loose electrical connection, probably in compressor junction box.
High head pressure.	Dirty condenser. System overcharged. Moisture in refrigeration system.
Machne frozen up.	Dirty auger. Defective bearing. Loose V-belt or pulley. Defective auger motor.
Brass in ice.	Defective bearing.
Gear reducer input shaft turns, but out put shaft does not	Gear slipped..
Motor-compresor and auger motor will not run	Check 115 to 230 V supply. Check on/off swithch. Active bin control by placing hand on bulb for 15 seconds. Resdjust if necessary. Check safety control. Check for loose connections. Defective auger motor. Defective wiring harness.
Auger motor runs, but motor compressor does not,	Loose connections at compressor junction box. Defective wiring harness. Defective overload, relay, starting capacitor, or motor compressor. Low voltage causing motor compressor to star circuit on overload.

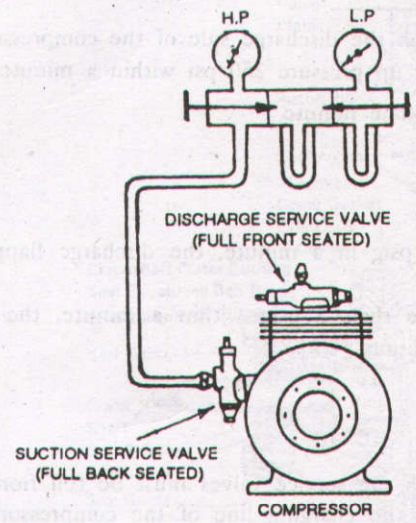
CONDITION	POSSIBLE CAUSE OR REMEDY
Motor-compressor rund, but condenser fan does not.	Loose electrical connections. Fan blade cannot turn due to obstruction. Fan motor burned out.
Auger motor does auger motor	Loose connection. Defective auger motor.
No voltage at auger motor or compressor junction box.	Check voltage at on/off switch Check bin control and/or safety control by placing a jumpr across their two terminals.
Machine fails to shut off when fails to shut off when bin is full.	Bin control out of adjustment or it is defective.

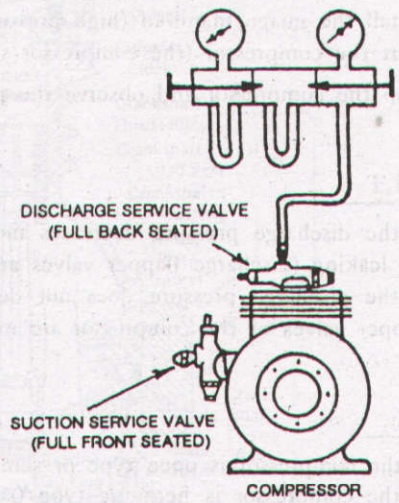
SCALE	TROUBLE SHOOTING CHART	RP/4.15.1/22b
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.





TOOLS, EQUIPMENT AND MACHINERY:

- Compressor.
- Refrigeration service valve wrench
- Gauge manifold.
- Adjustable wrench.

SEQUENCE OF OPERATIONS:

Checking of efficiency of suction side of compressor:

- Seat the suction and discharge service valve in full front position of the compressor (if the compressor is open type or semisealed).
- Install the gauge manifold (low pressure gague or compound gauge) on the suction side of the compressor.
- Start the compressor.
- Observe the suction pressure (the suction pressure should be 26 in. of Hg. vacuum [13.74kpa] or lower within a minute).
- Stop the compressor and observe the compound gauge of the manifold for one minute.

RESULT:

- If the compound gauge of the gauge manifold does not indicate an increase in pressure (vacum stands) for one minute, the suction flapper valves of the compressor are in good condition.
- If the compound gauge of the gauge manifold indicates an increase in pressure (vacum breaks) with in a minute, the suction flapper valves of the compressor are faulty.

SCALE :	CHECKING OF COMPRESSOR EFFICIENCY	RP/4.15.1/23
MAT :		AIR CONDITIONING

Checking of efficiency of discharge side of the compressor:

- Install the guage manifold (high pressure guage) on the discharge side of the compressor.
- Start the compressor (the compressor should build up pressure 250 psi within a minute.)
- Stop the compressor and observe the pressure for one minute.

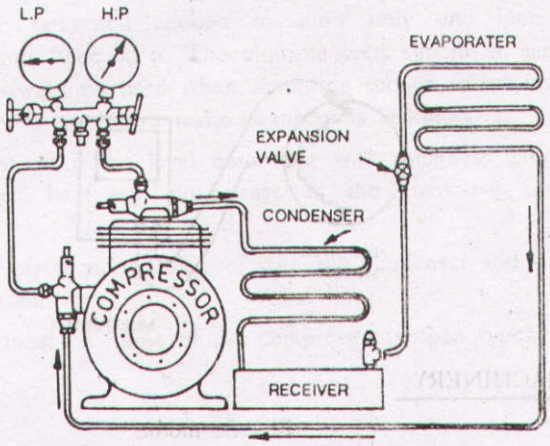
RESULT:

- If the discharge pressure decreases more than 5 psig in a minute, the discharge flapper valves are leaking (discharge flapper valves are faulty.)
- If the discharge pressure does not decrease more than 5 psig within a minute, the discharge flapper valves of the compressor are in good condition.

NOTE:

- If the compressor is open type or semisealed, both the service valves must be full front seated.
- If the compressor is hermetic type (sealed type), the charging line of the compressor must be sealed properly.
- If the compressor is open type, both the flapper valves or one of the flapper valve is faulty, replace the flapper valves and valve plate.
- If the hermetic compressor (Sealed type compressor) has both the flapper valves or one of the flapper valve is faulty, replace the complete compressor.

SCALE	CHECKING OF COMPRESSOR EFFICIENCY	RP/4.15.1/23a
MAT		AIR CONDITIONING



TOOLS, EQUIPMENT AND MACHINERY:

- Compressor.
- Gauge manifold
- Refrigeration service valve wrench.
- Adjusatble wrench.

SEQUENCE OF OPERATIONS:

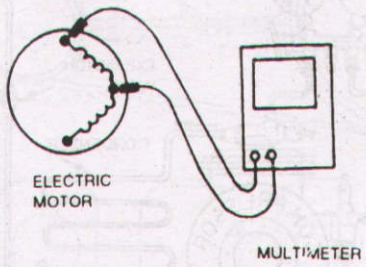
- Install the compound gauge of the gauge manifold on the suction side of the compressor.
- Start the compressor.
- Measure the absolute pressure of the system and stop the compressor.
- Remove the gauge manifold from the suction side of the compressor.
- Connect the high pressure gauge of the gauge manifold with the discharge side of the compressor.
- Start the compressor.
- Measure absolute discharge pressure of the system.
- Stop the compressor.
- Calculate the compression ratio with the help of following formula.

- Compression ratio = $\frac{\text{Absolute head (discharge) pressure.}}{\text{Absolute suction pressure}}$

NOTE:

- For sound refrigeration system design, the ratio between the absolute head pressure and absolute suction pressure should be 10 : 1 within the accepted industry bonds.

SCALE :	CHECKING OF COMPRESSION RATIO	RP/4.15.1/24
MAT :		AIR CONDITIONING



INSTRUMENT AND MACHINERY:

- Multimeter.
- Screw driver set.
- Electric motor.

SEQUENCE OF OPERATIONS:

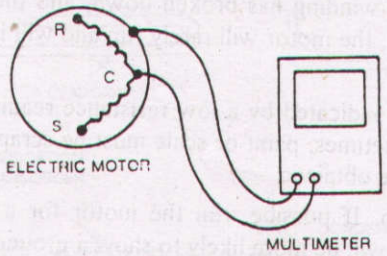
- Remove all the external wiring from the motor terminals.
- Prepare the Multimeter (put the selector switch of the multimeter on ohms scale R x 1).
- Adjust the ohmmeter to zero setting.
- Clean the electric motor terminals.
- Connect one lead of the ohmmeter to one terminal and alternately touch to the other terminals one by one.
- Check the continuity from one terminal to other terminal of the motor.

RESULT:

- If the ohmmeter does not indicate continuity (infinity resistance), the motor winding has seperated (open winding).
- If the ohmmeter shows resistance according to the manufacturer's specifications, motor winding is good.
- If the ohmmeter shows the resistance less than normal, the motor winding is shorted (there should be no continuity from the terminal to the motor case).

NOTE:

- The meter should be zeroed before attempting to make this check (internal short).
- If the motor winding shows continuity, the winding insulation has brokendown and motor winding is shorted.
- Any reading different from the manufacturer's specification, indicates a bad motor winding.
- If the ohmmeter shows resistance lower than normal on shorted winding, to test for this condition, the R x 1 scale should be used.
- Be sure the meter should be zeroed.



INSTRUMENT AND MACHINERY:

- Multimeter.
- Electric motor.

SEQUENCE OF OPERATIONS:

- Remove the external wiring from the motor terminals.
- Set the ohmmeter knob at the highest resistance scale R x 1K, if possible.
- Clean the motor terminals.
- Adjust the ohmmeter to zero setting.
- Attach one lead of the meter firmly to the motor housing (case) and touch the other lead of the meter with the motor terminals one by one and measure the resistance for each terminal.

RESULT:

- If the meter shows any resistance or continuity between the motor terminals and the motor housing, the motor winding is grounded.
- If the meter does not indicate any resistance or continuity, the motor is good.

SCALE	CHECK FOR MOTOR GROUND	RP/4.15.1/26
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

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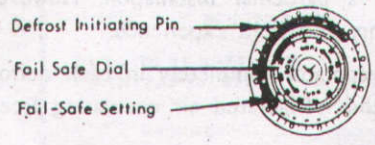
Refg. & Air Cond.

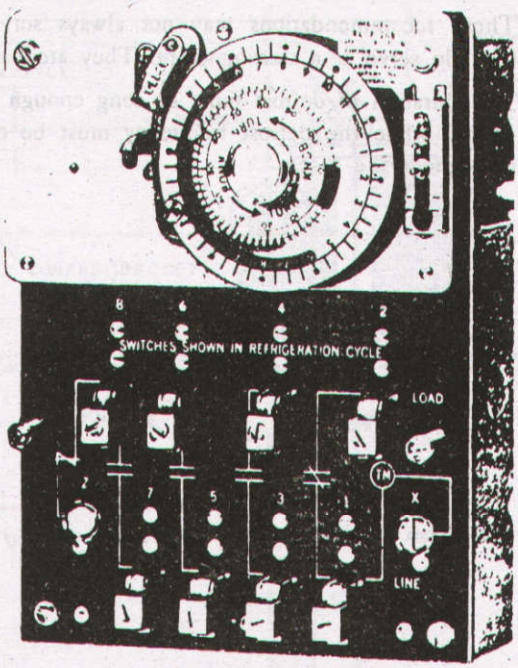
CAUTION:

- Any hermetic motor of one H.P or less should have atleast one million ohms between motor winding and motor housing, unless the manufacturer's specifications indicate, otherwise, motors larger than one H.P should have a minimum resistance of 1000 Ω /V.
- When the insulation on the winding has broken down, and the winding touches the compressor housing or some other metal, the motor will rarely run and will immediately trip the circuit breaker or blow the fuse.
- A grounded winding will be indicated by a low resistance reading between one or more terminals and the motor housing. Sometimes, paint or scale must be scraped off the motor housing so that a more accurate reading can be obtained.
- The motor should be warm. If possibe, run the motor for a few minutes before checking the resistance. A warm winding will be more likely to show a ground than a cold winding.

SCALE	CHECK FOR MOTOR GROUND	RP/4 15 1/26a
MAT		AIR CONDITIONING



Defrost clock dial



Solenoid defrost control

COMPONENT AND MACHINERY:

- Defrosting timer.
- Refrigeration system

SEQUENCE OF OPERATIONS:

- Set the length of defrost period on the inner dial (failsafe dial) by failsafe setting pins.
- Set the number of defrost periods with defrost initiating pin on the main dial.
- Adjust the time of starting of the defrosting timer by putting the main dial time " time marked" (day and night) defrosting.

NOTE:

- Defrost periods up to maximum six can be scheduled per 24 hours with defrost initiating pins.
- Setting the timed defrost control, involves setting the length of time in minutes of each defrost period. (most manufacturers publish thier recommendations as follows)
  - (1) On a case setting lable inside each case.
  - (2) In a case setting card packed with the condensing unit.
  - (3) In the instructions applicable to the case.

SCALE :	ADJUSTMENT OF DEFROSTING TIMER	RP/4.15 1/27
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

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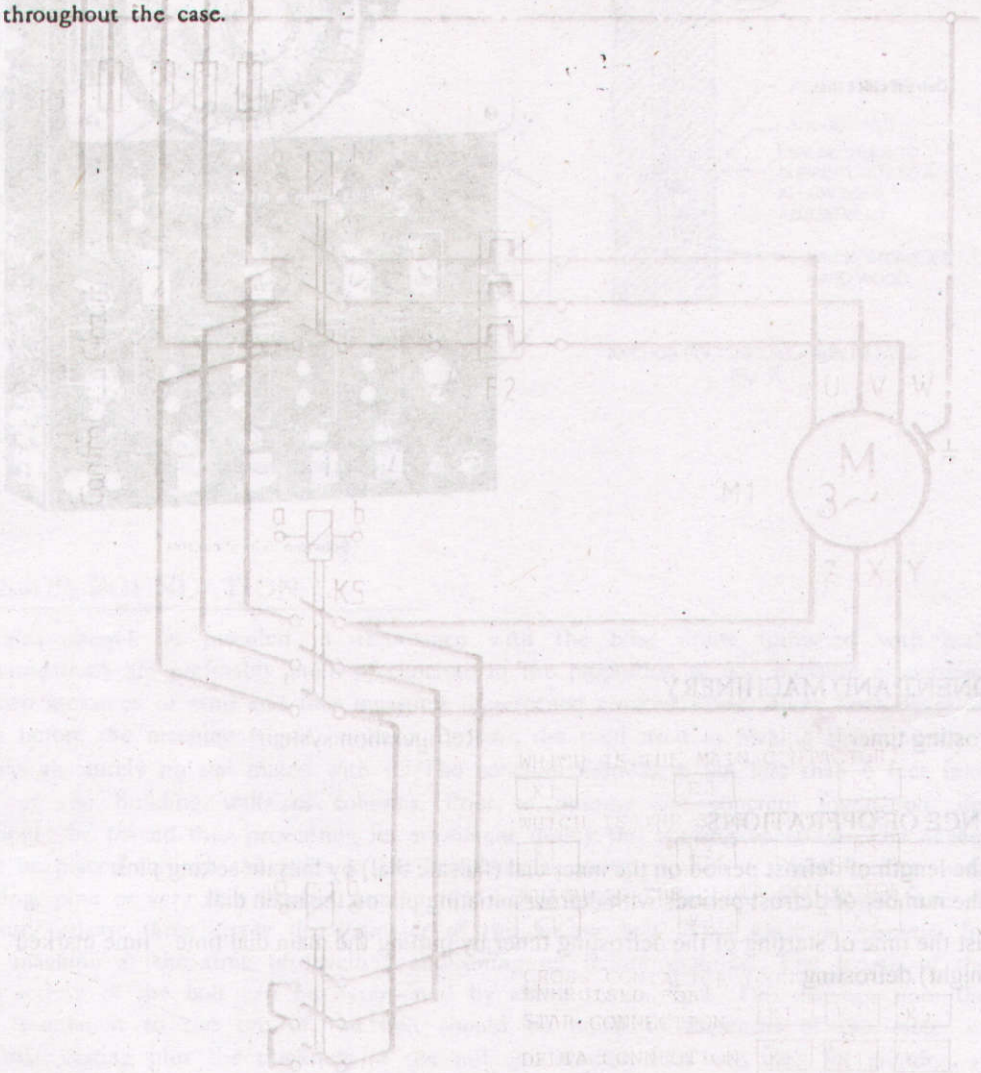
Refg. & Air Cond.

These recommendations may not always serve the need of a particular installation. However, they do serve at a starting point. They are based on laboratory and field experience.

The duration of defrost must be long enough to clear the evaporator completely in each defrost period, while the defrost frequency must be often to keep the refrigerated air circulating freely throughout the case.



SCALE	ADJUSTMENT OF DEFROSTING TIMER	RP/4.15.1/27a
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

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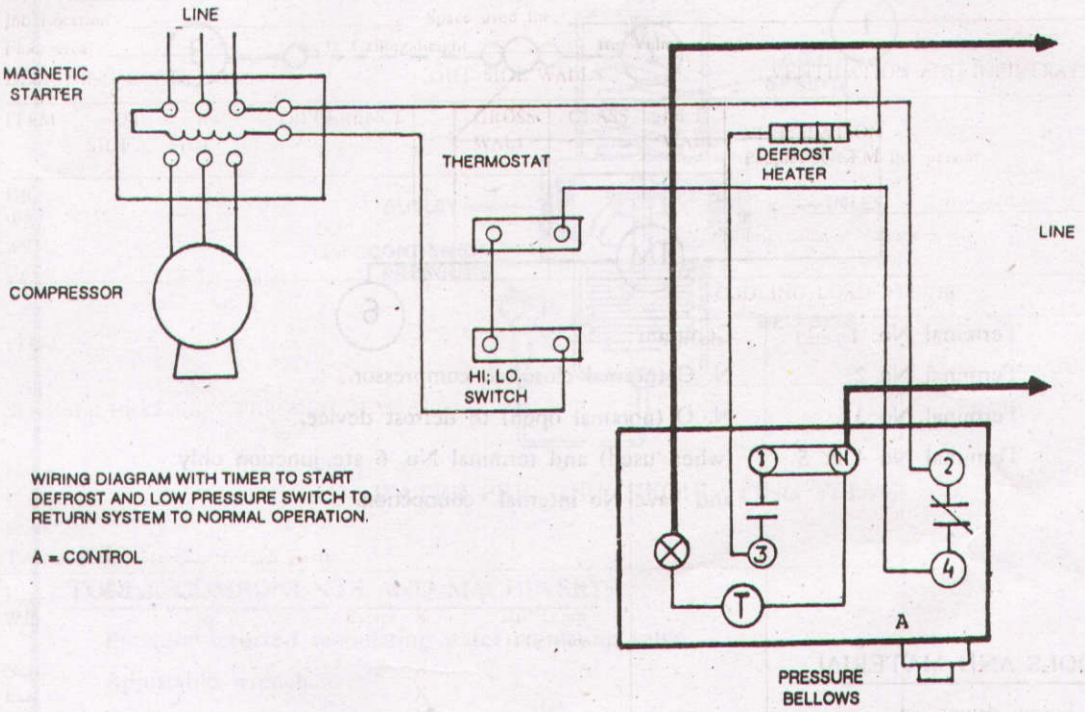

WIRING DIAGRAM WITH TIMER TO START DEFROST AND LOW PRESSURE SWITCH TO RETURN SYSTEM TO NORMAL OPERATION.

A = CONTROL

COMPONENT AND MACHINERY:

- Defrosting timer.
- Refrigeration unit.

SEQUENCE OF OPERATIONS.:

- Connect the low pressure side of the unit with the defrost timer.
- Make the electric wiring circuit as shown in the above figure.
- Set the length of defrost period on the inner dial (failsafe dial) by failsafe setting pins.
- Set the number of defrost periods with defrost initating pins on the main dial.
- Adjust the time of defrosting timer by putting the main dial time at ''time" marked (day & night) defrosting.

SCALE	ADJUSTMENT OF DEFROSTING TIMER WITH PRESSURE CUT OUT SWITCH	RP/4.15.1/28
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

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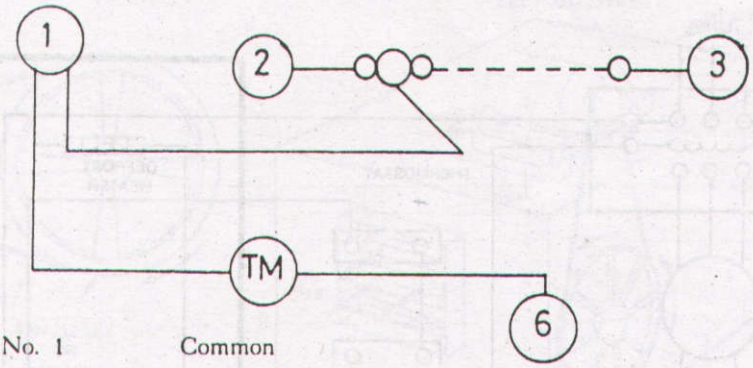


Terminal No. 1	Common
Terminal No 2	N. C (normal close) to compressor.
Terminal No 3	N. O (noramal open) to defrost device.
Terminal No 4 & 5	(when used) and terminal No. 6 are junction only and have No internal connection.

TOOLS AND MATERIAL:

- Screw driver set.
- Defrosting timer.

SEQUENCE OF OPERATIONS:

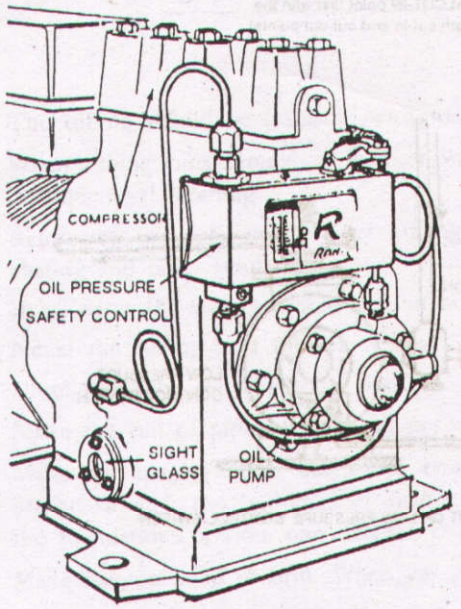
- Connect the electric power of the defrost timer motor on defrosting timer's terminal No. 1 & 6.
- Connect the terminal No. 2 of the defrosting timer to the compressor.
- Connect the terminal No. 3 of the defrosting timer to the defrost device.

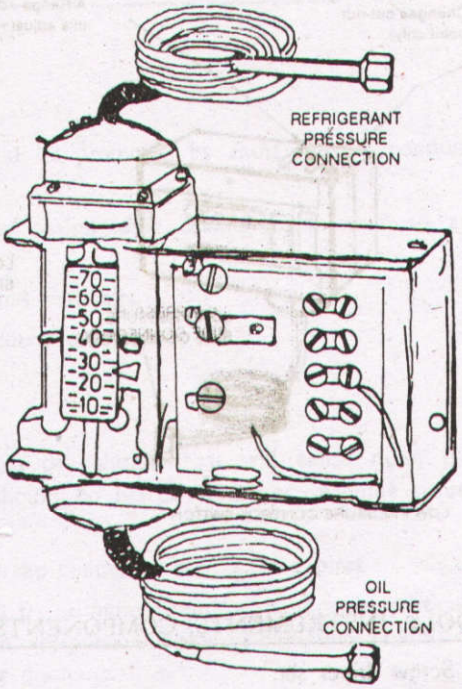
NOTE:

In operation

- Electric power is made to the compressor from terminal No. 1 to terminal No. 2 in above shown fig. When the timer motor has run the required amount of time, the switch changes to teminal No. 2 to terminal No. 3.
- Staying the compressor and energizing the defrosting device, is known as defrost period. After predetermined period of time has lapsed, the switch returns to terminal No. 2. The defrost device either an electric heater or hot gas solenoid is removed from the circuit and the compressor is again energized and produces refrigaration.

SCALE :	ELECTRIC CONNECTION OF DEFROSTING TIMER	RP/4.15.1/29
MAT		AIR CONDITIONING





A solid state oil pressure safety control connected to a serviceable hermetic compressor.

TOOLS, COMPONENT AND MACHINERY:

- Adjustable wrench.
- Refrigeration system.
- Oil pressure safety control switch.
- Screw driver set.
- Flaring set.

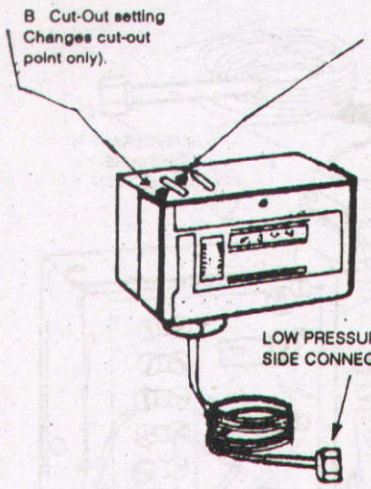
SEQUENCE OF OPERATIONS:

- Set the refrigerant pressure.
- Connection at low side of the unit (crankcase).
- Set oil pressure connection at oil pump discharge line.
- Set the differentila at scale cut-out which is the difference between refrigerant and oil pressure by turning the screw clockwise or anticlockwise direction.

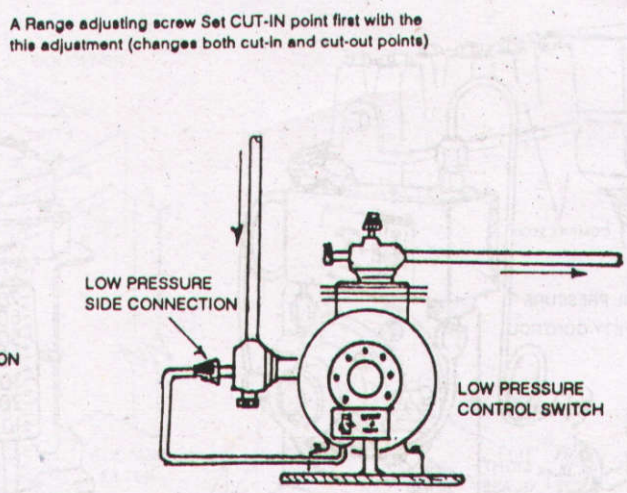
NOTE:

- This control is usually set to cut-out about 20 percent above normal head pressure. In R-12 systems, the control is set about 150 to 160 psi; R-22, 260 to 270 psi, R-502, 280 to 290 psi and R-500, 190 to 200 psi.
- The oil pressure safety cut-out will shut off the electrical power if the oil pressure fails or drops below normal.

SCALE	INSTALLATION OF OIL PRESSURE SAFETY CONTROL SWITCH	RP/4.15 1/30
MAT		AIR CONDITIONING



LOW PRESSURE CONTROL SWITCH



ADJUSTMENT OF LOW PRESSURE CONTROL SWITCH

TOOLS, INSTRUMENTS, COMPONENTS AND MACHINERY:

- Screw driver set.
- Pressure cut-out switch. (dual)
- Refrigeration system

SEQUENCE OF OPERATIONS:

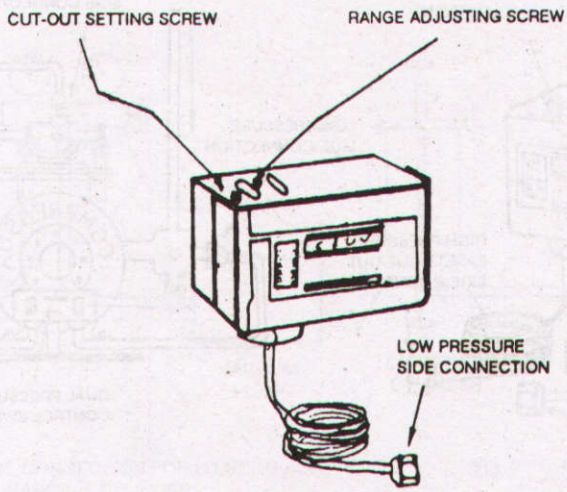
- Set the high pressure cut-out switch at scale cut-out by turning the screw clockwise or anticlockwise direction.
- Set for compressor start at cut-in pressure scale by turning the screw clockwise or anticlockwise direction.
- Set the differential scale for the number of pounds of pressure that the compressor suction will pull the system down to before stopping.

NOTE:

The cut-out value determined by substracting the differential setting from the cut-in setting.

- Do not confuse this cut-out setting with the high pressure cut-out setting.
- Set the low side cut-out scale by difference between the cut-in pressure and differential pressure.
- One setting is the high pressure cut-out, a safety device which is set according to the type of the refrigerant used and manufacturer's recommendations. The other two setting are the cut-in pressure (the pressure at which the compressor starts) and differential (the number of periods of pressure that the compressor suction will pull the system down to before stopping).

SCALE	ADJUSTMENT & INSTALLATION OF LOW PRESSURE CONTROL SWITCH	RP/4.15.1/31
MAT		AIR CONDITIONING



TOOLS AND EQUIPMENT/COMPONENT:

- Low ptessure control switch.
- Refrigeration service valve wrench.

SEQUENC OF OPERATIONS:

- Install the compound gauge on the compressor suction service valve.
- Crack the service valve, off the beak seat.
- With compressor running, seat the suction service valve at front position and observe the pressure on the compound gauge, when the pressure control stops the compressor.

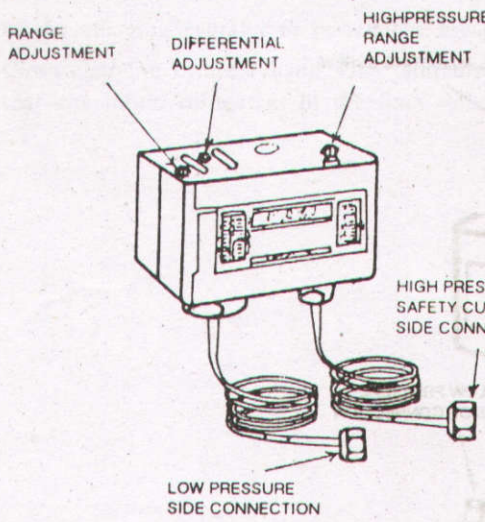
NOTE:

- If the actual pressure does not correspound with the desired control setting, adjust the control, seat the suction service valve at back position and repeat the above procedure until the desired cut-out and cut-in points are obtained.
- Rarely do these controls need replacement, except in the case of refrigerant leakage, in which case, replacement is preferred' to repair.

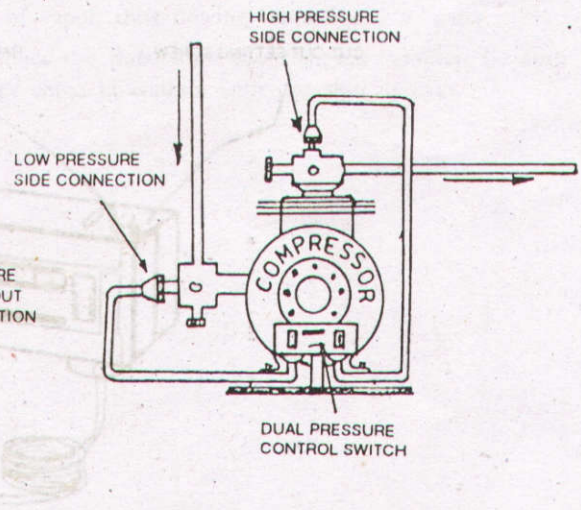
CAUTION:

- Do not disconnect the low pressure control or cause it to become inoperative.

SCALE :	CHECKING OF LOW PRESSURE CONTROL SWITCH	RP/4.15.1/32
MAT		AIR CONDITIONING



DUAL PRESSURE CONTROL SWITCH



ADJUSTMENT OF DUAL PRESSURE CONTROL

SEQUENCE OF OPERATIONS:

- Set the high pressure cut-out switch at scale cut-out by turning the screw clockwise or anticlockwise directions.
- Set for compressor start at cut-in pressure scale by turning the screw clockwise or anticlockwise direction.
- Set the differential scale for the number of pounds of pressure that the compressor suction will pull the system down to before stopping.

NOTE

The cut-out value determined by substracting the differential setting from the cut-in setting.

- Do not confuse this cut-out setting with the high pressure cut-out setting.
- Set the low side cut-out scale by difference between the cut-in pressure and differential pressure.
- one setting is the high pressure cut-out, a safety device which is set according to the type of the refrigerant used and manufacturer's recommendations. The other two setting are the cut-in pressure (the pressure at which the compressor starts) and differential (the number of periods of pressure that the compressor suction will pull the system down to before stopping).

SCALE	ADJUSTMENT OF DUAL PRESSURE CONTROL SWITCH	RP/4.15.1/33
MAT		AIR CONDITIONING

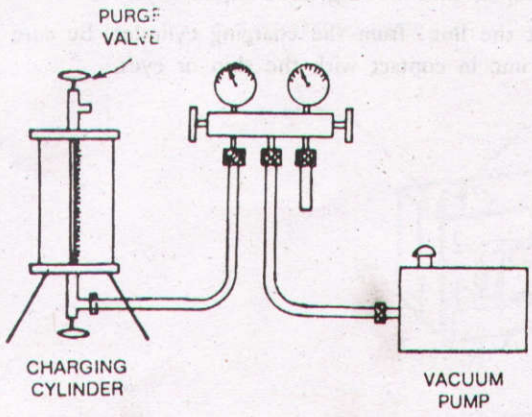


Fig. 1 LINE CONNECTION FOR LOADING A CHARGING CYLINDER

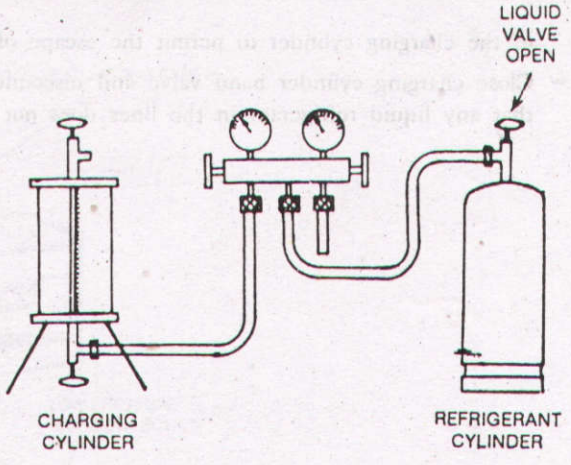


Fig. 2 CONECTION FOR EVACUATING A CHARGING CYLINDER

TOOLS AND MATERIAL:

- Refrigerant.
- Gauge manifold
- Charging cylinder.
- Vacum pump.

SEQUENCE OF OPERATIONS:

- Connect the low pressure gauge of the gauge manifold to the charging cylinder (see Fig.1)
- Open the hand valve on the charging cylinder.
- Open the low side hand valve on the gauge mainfold and purge all pressure from the charging cylinder.
- Cannect the centre charging line of the gauge mainfold to the vacuum pump.
- Start the vacuum pump and draw as deep a vacuum as possible with the vacuum pump.
- Close the low side hand valve on the gauge manifold.
- Remove the centre charging line from the vacuum pump and connect it to the valve on a cylinder of the proper type of refrigerant. If there is a liquid valve, connect the line to it (See Figure2).
- Open the refrigerant cylinder valve and loosen the centre charging line connections at the gauge manifold. Allow the refrigerant to escape for a few seconds, then tighten the connection.
- Invert the refrigerant cylinder, open the liquid valve, so that liquid refrigerant will enter the charging line. If the line is connected to a cylinder valve (liquid), the cylinder is not to be inverted.
- Open the low side hand valve on the gauge manifold and allow liquid refrigerant to be drawn into the charging cylinder.
- When the corrected amount of refrigerant has been drawn into the charging cylinder, close the refrigerant cylinder valve. If the refrigerant stops flowing before the desired amount is in the charging cylinder, open the vent valve on top.

SCALE	LOADING A CHARGING CYLINDER	RP/4.15.1/34
MAT		AIR CONDITIONING

of the charging cylinder to permit the escape of vapor, thus flowing more liquid to enter.

- Close charging cylinder hand valve and disconnect the line. from the charging cylinder. Be sure that any liquid refrigerant in the lines does not come in contact with the skin or eyes.

SCALE :	LOADING A CHARGING CYLINDER	RP/4.15.1/34a
MAT :		AIR CONDITIONING

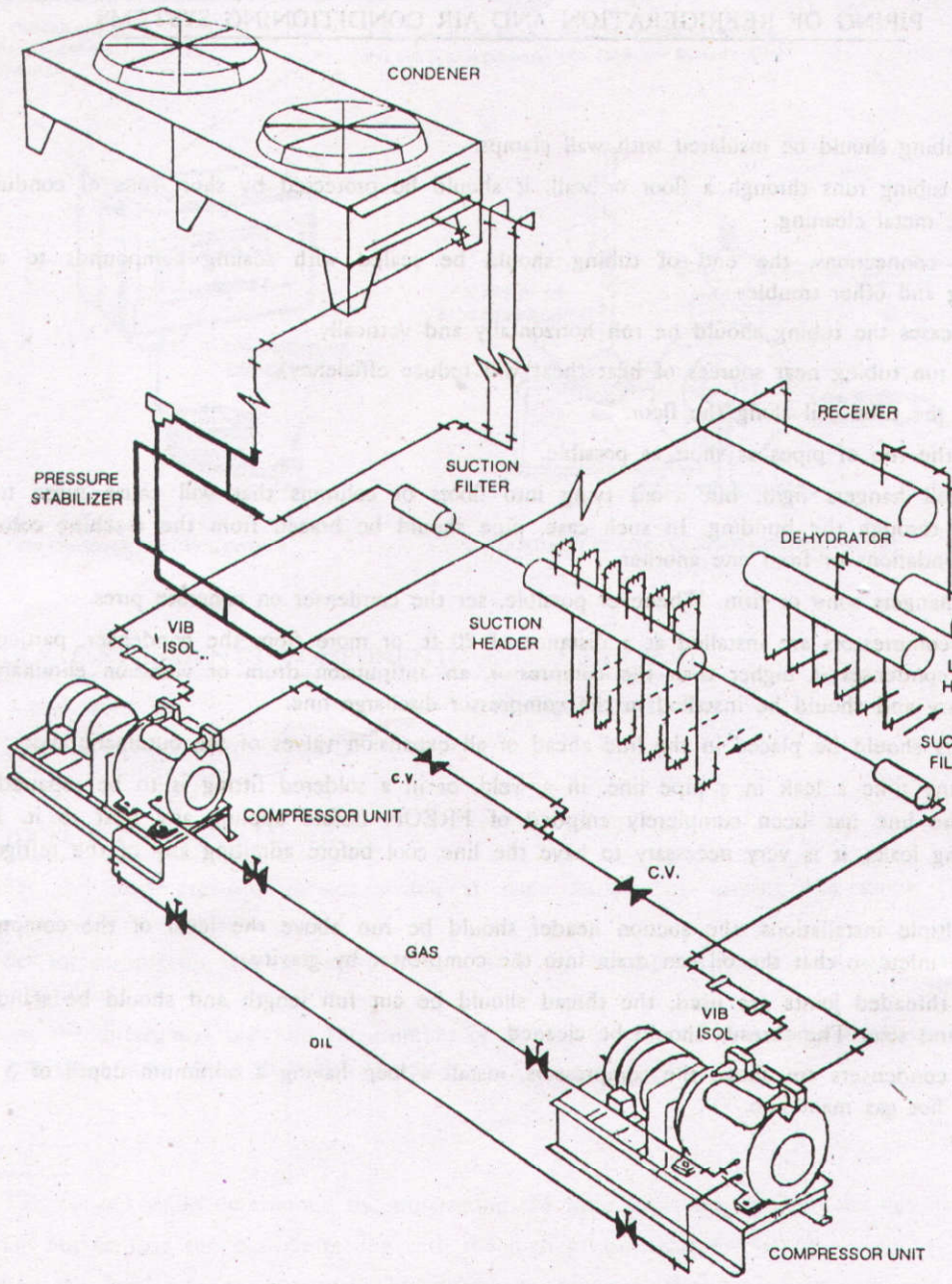
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

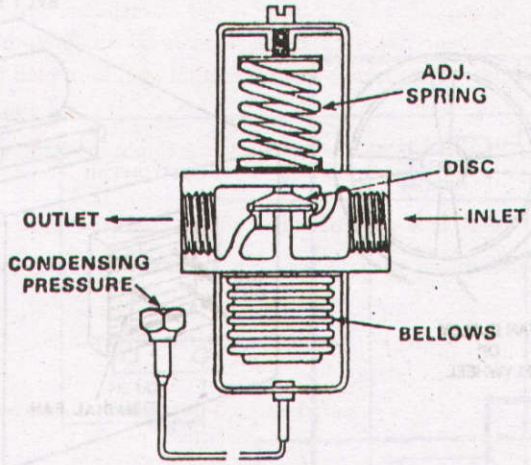
PIPING OF REFRIGERATION AND AIR CONDITIONING SYSTEMS

- The tubing should be insulated with wall clamps.
- When tubing runs through a floor or wall, it should be protected by short runs of conduit or flexible metal cleaning.
- Before connections, the end of tubing should be sealed with sealing compounds to avoid chafing and other troubles.
- In all cases the tubing should be run horizontally and vertically.
- Never run tubing near sources of heat (heat will reduce efficiency).
- Unroll the tube coil along the floor.
- Make the run of pipes as short as possible.
- Make all hangers rigid, but avoid tying into floors or columns that will cause noise to be carried through the building. In such case, pipe should be braced from the machine columns, the foundations or from one another.
- Make hangers solid or firm. Whenever possible, set the condenser on concrete pires.
- When compressors are installed at a distance of 20 ft. or more from the condenser, particularly if the condenser is higher than the compressor, an antiputsion drum or vibration eliminator is necessary and should be installed in the compressor discharge line.
- Strainers should be placed in the line ahead of all expansion valves of the outomatic type.
- If at any time a leak in a pipe line, in a weld, or in a soldered fitting is to be repaired, be sure the line has been completely emptied of FREON before appling any heat to it. After repairing leaks, it is very necessary to have the line cool before admiting any of the refrigerant to it.
- In multiple installations, the suction header should be run above the level of the compressor suction inlets so that the oil can drain into the compressor by gravity.
- When threaded joints are used, the thread should be cut full length and should be standared taper and size. The threads should be cleaned.
- When condensers are above the compressors, install a loop having a minimum depth of 3 feet in the hot gas main line.



Schematic piping diagram for commercial refrigerating system using roof-mounted air cooled condenser, two motor compressors and suction and liquid header, each connected to six refrigerant lines.

SCALE	INFORMATION SHEET	RP/4.15.1/35a
MAT		AIR CONDITIONING



WATER PRESSURE REGULATING VALVE

TOOLS, COMPONENTS AND MACHINERY:

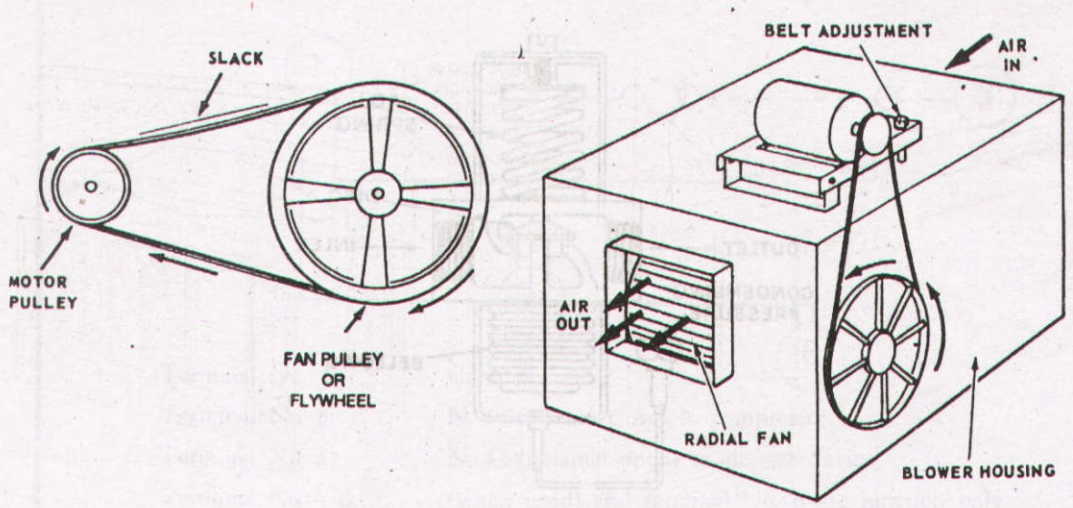
- Pressure actuated modulating water regulating valve.
- Adjustable wrench.

SEQUENCE OF OPERATIONS:

- Select the place where the modulating vlave (water regulating valve) is to be installed (install on the leaving water side of the condenser).
- Connect the pressure sensing line of the valve bellows assembly to any point where it will sense condensing pressure (this connection may be to the hot gas line, compressor discharge manifold of to the top of the condenser).
- Make the water connections with the valve leakproof.
- Make the capillary (pressure sensing line) conections leakproof.
- Adjust the rate of water flow by spring pressure screw (pressure adjusting screw) top on the valve.

NOTE:

- This valve usually does not depend on the pipe for support but is provided with a modulating arrangement of flange.
- Water in and water out connections are clearly levelled because this valve has a gear mechanism for adjusting the pressure.
- Double valve and seat arrangement balancing force from water pressure: one valve is opened and the other is closed by water pressure. This valve may be adjusted by adjusting a spring which presses against the bellows.



TOOLS AND MATERIAL:

- Belt :
- Open end spanner set.

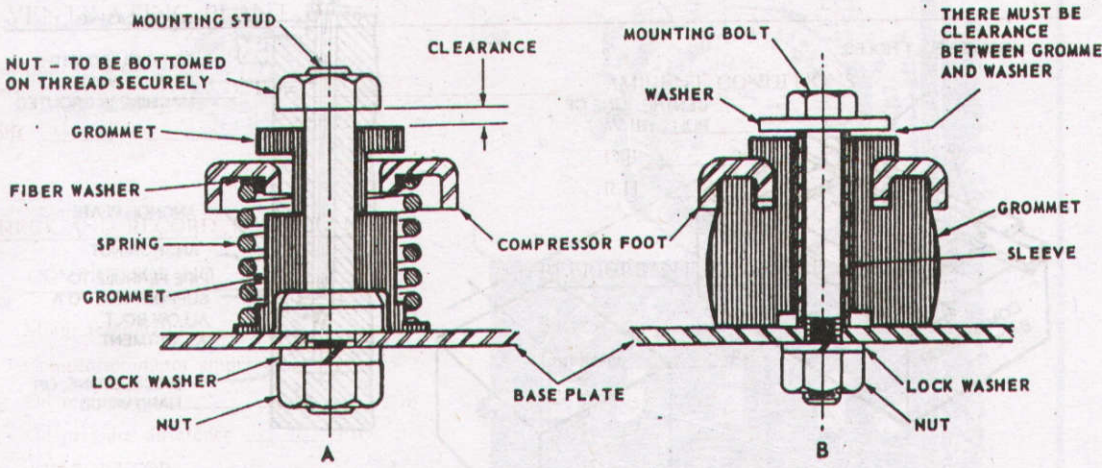
SEQUENCE OF OPERATIONS:

- Align the pulley and flywheel.
- Measure the distance between the pulley and flywheel.
- Select the proper size of the belt according to the pulley shape for moving belt.
- Put the belt on the grooves of the pulley and flywheel.
- Adjust the belt tension, turn the adjustment until the belt can be flexed about 1 inch (25.4mm) with on finger using moderate system.
- Start the unit and check the belt for its proper function.

NOTE:

- A belt that is too narrow will ride the bottom of the pulley. It will slip, causing decrease in efficiency.
- A belt that is too wide will ride high in the pulleys and will not maintain desired efficiency.
- When the motor is bolted to the driving machine, both shafts must be parallel to make the belt ride properly on the pulleys.

SCALE :	INSTALLATION OF BELT	RP/4.15.1/37
MAT :		AIR CONDITIONING



Hermetic motor compressor mountings designed to absorb vibration. A–Synthetic rubber grommet and spring. B–Synthetic rubb grommet only.

TOOLS MATERIAL AND MACHINERY:

- Compressor.
- Adjustable wrench.
- Open end spanner set.
- Hand electric drill machine.

SEQUENCE OF OPERATIONS:

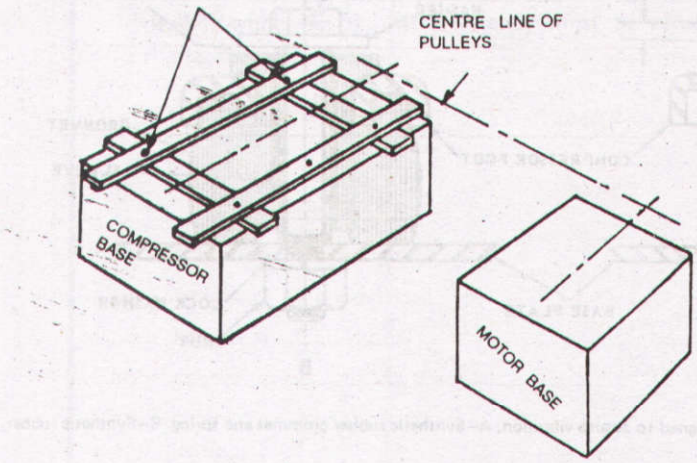
- Make holes in the base plate (foundation plate of iron made).
- Put the stud in the hole.
- Put the lock washer in the bottom side of base plate and tight a nut on it.
- Put the grommet on the upper side of the stud.
- Put the absorbing spring and then the fiber washer on the spring.
- Put the compressor foot on it and put another grommet on it.
- Tight the nut on the stud securely with proper clearance for obsorption of vibration by t spring grommet.
- Foundation should be installed in-accordance with the blue prints furnished with each machine

SCALE :	CONSTRUCTION OF FOUNDATION	RP/4.15.1/38
MAT		AIR CONDITIONIN

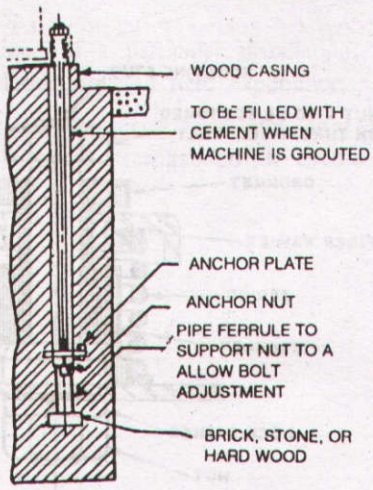
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond



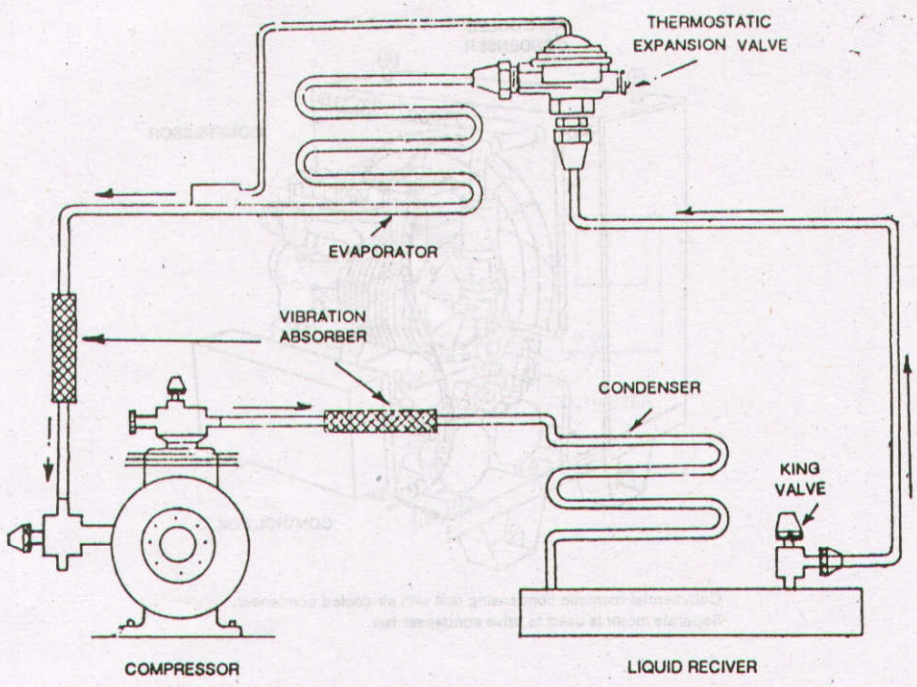
TEMPLATE ARRANGEMENT TO PROVIDE EXACT PLACEMENT OF ANCHOR BOLTS IN A BELT-DRIVEN COMPRESSOR INSTALLATION. (Fig. 1)



ANCHOR-BOLT INSTALLATION DETAILS (Fig. 2)

COMPRESSOR FOUNDATION:

Foundations should be installed in accordance with the blue prints furnished with each machine. Foundations are preferably build of concrete in the proportion of one measure of portland cement to two measures of sand and four measures of screened crushed stone. Allow from 36 to 48 hours to set before the machine is put in place. Be sure the sand used in making the concrete is clean and has absolutely no soil mixed with it. The concrete foundation not less than 6 feet from the footing of the building walls or columns. Prior to pouring the concrete foundation, the templates should be braced thus preventing its movement during the pouring operation. The anchor bolts should be placed through the holes in the templates as shown in Fig. 1. Place ferrules made of tin spouting, pipe or very thin lumber, around the anchor bolts. These ferrules should have an inside diameter atleast three times the diameter of the anchor bolt. This space is essential for moving the machine at the time of levelling and lining up before grouting. The length of the ferrules and setting of the bolt can be determined by above shown, fig.2. The distance from the top of the foundation to the top of the bolt should be equal to thickness of the motor or compressor base casting plus the thickness of the nut and washer, Plus one inch for grouting. A spacing plug should be put at the top of each ferrule to keep it concentric about the bolt. When the motor and the compressor are mounted on a steel base, it is advisable to set this steel base on a solid concrete foundation, and to level and grout it to give a firm footing. Sound isolation can be used where the noise of the compressor may be objectionable. If the compressor is located on a floor of medium or light construction, it should be supported directly over the joints or beams under the floor. As a rule, the concrete slab should weight from one to two times of the total weight of the unit which it supports.



TOOLS, MACHINERY AND COMPONENT:

- Vibration absorber.
- Refrigeration/Air conditioning equipment.
- Open end spanner set.
- Gas welding set.
- Gauge manifold.
- Nitrogen gas.
- Silver soldering rod.

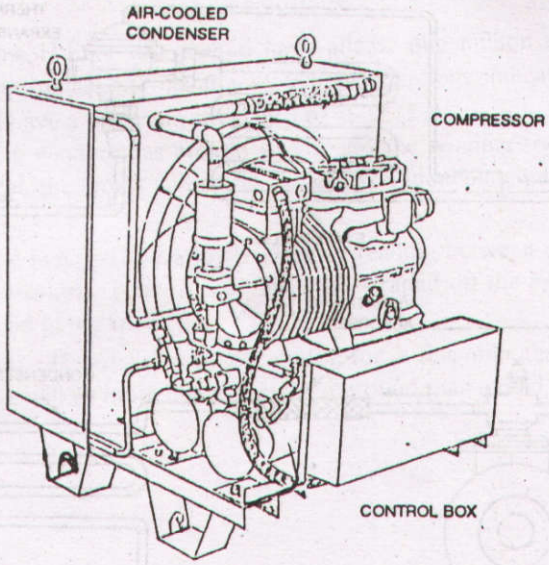
SEQUENCE OF OPERATIONS:

- Measure the suction and discharge line pipe sizes.
- Select the vibration eliminators (vibration absorber) according to the suction and discharge line sizes of the unit.
- Install the vibration eliminators in the suction and discharge lines near the compressor.
- Solder the joints or make a leakproof connections with the lines (suction and discharge) of the unit.
- Check for leaks.

NOTE:

- Vibration eliminators should be placed in a vertical line for best results.
- On larger capacity systems adequate flexiblity is ordinarily obtained by the running and discharge piping approximately 30 pipe diameters in each of two or three directions before anchoring the pipe.

SCALE :	INSTALLATION OF VIBRATION ABSORBER (VIBRATION ISOLATORS))	RP/4.15.1/39
MAT :		AIR CONDITIONING



Commercial hermetic condensing unit with air-cooled condenser.
Separate motor is used to drive condenser fan.

TOOLS AND EQUIPMENT:

- Open end spanner set.
- Hand electric drill machine
- Vibration absorbers.
- Condensing unit.
- Aligning tool.
- Screw driver set.

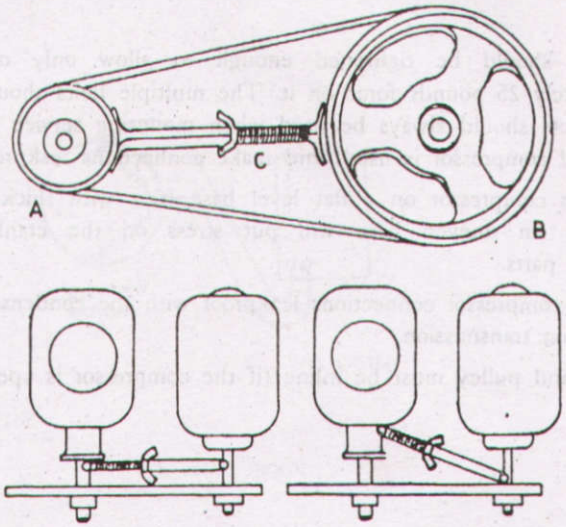
SEQUENCE OF OPERATIONS:

- Clean the condensing unit base plate.
- Put the compressor at the base plate of the condensing unit and mark .the condensing unit base plate according to the foot holes of the compressor (if the condensing unit base plate does not have any holes or not according to the compressor foot holes).
- Put the hold-down bolts in the holes of the condensing unit base plate (which holes are for compressor).
- Put the vibration absorbers (vibration isolators) on the hold-down bolts.
- Put the compressor on hold-down bolts and tight with necessary flexibility (which is recommended by the compressor's manufacturer.
- Align the motor pulley and compressor flywheel (If the compressor is open type.)
- Make the compressor discharge side connections with discharge line (Condenser inlet line.)
- Put the belt safe guard.
- Start the unit and check it for its proper function.

NOTE:

- The belt should be tightened enough to allow only one inch of belt deflection with approximately 25 pounds force on it. The multiple belts should be same amounts.
- New gaskets should always be used when mounting service valves on a compressor (if open or semi-sealed compressor is used) and make connections leakproof.
- Mount the compressor on a flat level base (test with thickness gauge and use shim stock, if necessary). An uneven base will put stress on the crankcase and may cause damage or misaligned parts.
- Make the compressor connections leakproof with the condenser and suitable flexibility to control the vibration transmission.
- Flywheel and pulley must be inline (if the compressor is open type).

SCALE :	INSTALLATION OF COMPRESSOR IN THE CONDENSING UNIT	RP/4.15.1/40a
MAT :		AIR CONDITIONING



Belt adjusting and aligning tool. Top, tool is applied between pulley to tension belt.
A- Pylley, B-Flywheel
C-Aligning tool.
Lower pane, tool applies pressure at bases to align and tension belt drivers.

TOOLS AND MACINERY:

- Aligning tool.
- Open end spanner set.
- Open type compressor.
- Electric motor.

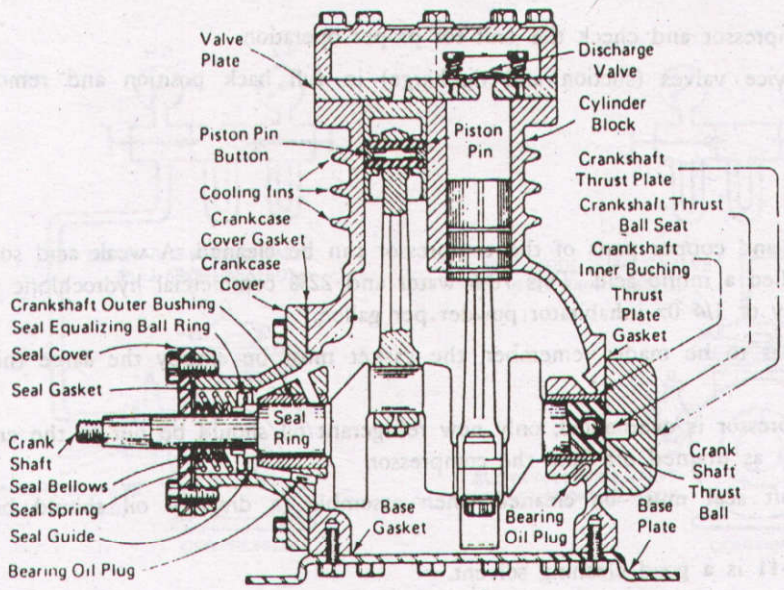
SEQUENCE OF OPERATIONS:

- Adjust the pulley and flywheel on their shafts.
- Put the aligning tool between the pulley and flywheel.
- Unscrew the jaws of the aligning tool in the grooves (grooves for belt) of the pulley and flywheel (as shown in above Fig.)
- Tight the compressor and motor nut/bolts.
- Tight (Fix) the pulley and flywheel on their shafts with key and lock washer combination after alignment.
- Put out the aligning tool from the pulley and flywheel grooves.
- Adjust the belt on the pulley and flywheel.
- Start the dirver (motor) and check for proper function.
- Put the guard on the belt of pulley and flywheel and then start the driver (motor).

NOTE

- To adjust the belt tension, turn the adjustment until the belt can be flexed about one inch with finger using moderate pressure.
- The compressor flywheel and motor pulley must be inclined with each other in two different ways to give longer-life to the belt and to the electric motor.
- The centre line of the compressor must be parallel with the centre line of the electric motor shaft.
- The pulley grooves must be inclined with each other.

SCALE :	ALIGNMENT OF COMPRESSOR AND MOTOR	RP/4.15.1/41
MAT :		AIR CONDITIONING



Crank-type reciprocating compressor.

TOOLS, EQUIPMENT AND MACHINERY:

- Compressor (Open type)
- Refrigeration service valve wrench.
- Valve grinding paste.
- Kerosene oil/ petrol.
- Ring spanner set.
- Screw driver set.
- Compressor oil.

SEQUENCE OF OPERATIONS:

- Seat the suction and discharge service valves in full front position of the compressor.
- Drain off all the oil from the compressor.
- Open the head plate, side plate and flywheel of the compressor.
- Clean all the parts of the compressor.
- Inspect the function of the compressor parts (if any part is found malfunctioning, replace with new one).
- Check and clean oil seals, bearings, pistons, piston rings, flapper valves, valve plate and crankshaft etc.
- Assemble the compressor.
- Add new lubricating oil in the compressor.
- Check the compressor for proper efficiency and function.
- Install gauge manifold at suction side of the compressor and evacuate the compressor.
- Put the service valves in mid position.

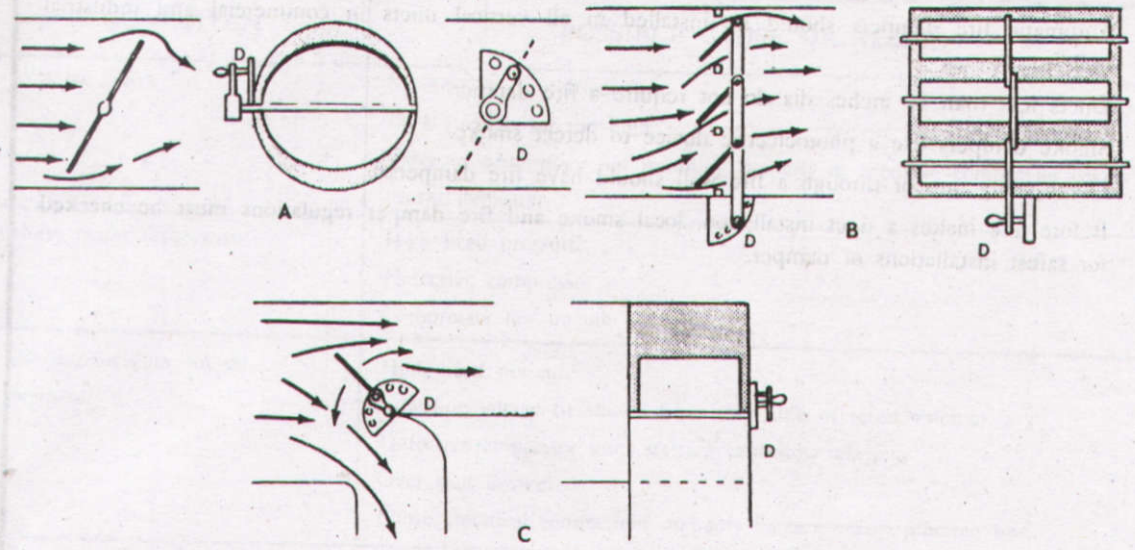
- Start the compressor and check the unit for proper operation.
- Seat the service valves (suction and discharge) in full back position and remove the gauge manifold.

NOTE

- All the brass and copper parts of the compressor can be cleaned, A weak acid solution is used, sometimes called a muric acid. This 78% water and 22% commercial hydrochloric acid with 1.19 specific gravity or 1/4 0z inhabitator powder per gallon.
- If a gasket has to be made, remember, the gasket must be exactly the same thickness as the original.
- When a compressor is overhauled, only new refrigerant oil should be put in the crankcase, same quantity of oil as drained off from the compressor.
- The crankshaft seal must be cleaned when assemble (a drop of oil should be put in the crankcase).
- Refrigerant F-11 is a good cleaning solvent.
- Add same quantity of oil in the compressor as drained off from the compressor.

CAUTION:

- Store the compressor gaskets, and the parts carefully in clean trays.
- Clean the parts with a non-toxic, non-flammable solvents.
- Clean the parts a second time before assembling.
- Assemble gasket surfaces which must be flat, clean and free from burrs.



Three types of duct airflow controls.
A—Butterfly damper. B—Multiple vane damper. C—Splitter damper. D—Adjustment handle.

TOOLS AND MATERIAL:

- Screw driver set.
- Adjustable wrench.
- Measuring tape.
- Damper.
- Scriber.

SEQUENCE OF OPERATIONS:

- Measure the duct size.
- Select the damper size according to the duct size.
- Select the place where the damper will be installed.
- Put the damper in the duct (selected place) and mark the duct for fixing the screws in the damper frame.
- Make holes in the duct for the damper shaft and screws.
- Draw a line on the end of the damper shaft that extends out of the duct to show the position of the damper.
- Put the damper in the duct as shown in the above Fig. 1 and fix it in the duct with screws.

NOTE:

- For accurate air control, these dampers should be tight fitting with minimum leakage of air.

SCALE :	INSTALLATION OF DAMPER	RP/4.15.1/43
MAT		AIR CONDITIONING

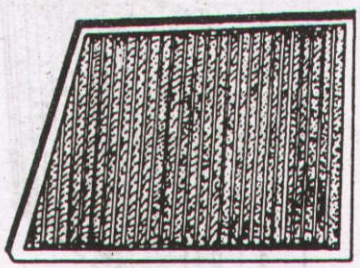
- Automatic fire dampers should be installed in all vertical ducts in commercial and industrial buildings.
- Ducts less than 20 inches dia do not require a fire damper.
- Smoke dampers use a photoelectric device to detect smoke.
- Ducts going into or through a fire wall should have fire dampers.
- Before one makes a duct installation, local smoke and fire damper regulations must be checked for safest installations of damper.

SCALE	INSTALLATION OF DAMPER	RP/4.15.1/43a
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.



TOOLS, EQUIPMENT AND MATERIAL:

- Viscous cleanable filter.
- Cleaning solution.
- Adjustable wrench.
- Viscous oil.
- Screw driver set.

SEQUENCE OF OPERATIONS:

- Check that the filter is loaded or full of dirt by measuring the air pressure across the filter.
- Put out the filter from its casing.
- Wash the filter in a cleaning solution in a tank.
- Dry the filter.
- Give a bath of vicous oil to the filter.
- Drain off the excess oil from the filter.
- Put the filter in its place (casing).

SCALE	CLEANING AND REPLACING OF AIR FILTER	RP/4.15.1/44
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

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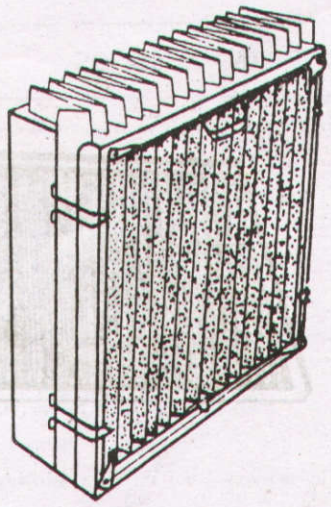
Refg. & Air Cond.



TOOLS EQUIPMENT AND MATERIAL:

- Adjustable wrench.
- Screw driver set.
- Dry disposeable media type filter.

SEQUENCE OF OPERATIONS:

- Connect two manometer openings on the two opposite sides of the filter and measure the air flow (pressure drop) if the pressure drop exceeds 0.5 inch of water across the filter, the filter is dirty.
- Place the strong light on one side of the filter and look through the filter from other side to inspect the filter for tears or holes (if the filter is teared or big holes found, replace the filter with new one).
- Replace the filter with the arrows (pointing on the frame) pointing in the direction of air flow.

NOTE

- The filter should be renewed twice in each year or more frequently, if the dust conditions are high.
- If the housing of he filter shows signs of corrosion, clean it by sand blasting and repaint.
- Visual inspection is one way to decide the filter for replacement. If the filter has turned black, If the fram is bent or warped or if the fitting medium is punched, replace the filter.
- The sides towards the blower are more adhesive and must be on the outside of the filter. If this is not done, the filter will be quickly loaded with dirt & clog.

SCALE :	CHECKING AND REPLACING OF AIR FILTER	RP/4.15.1/45
MAT :		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

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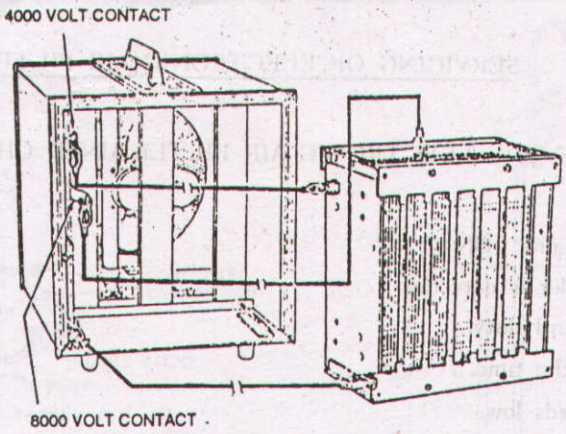


Portable electronic filter showing collector cell removed Electrical leads are being used to test high voltage circuit.

TOOLS, EQUIPMENT AND MATERIAL:

- Electronic air filter.
- Hot water or cleaning solvent.
- Screw driver set.

SEQUENCE OF OPERATIONS:

- Disconnect the electric power supply.
- Remove the mesh screen ahead of the filter.
- Put out the bank of filter plates.
- Wash down the plates with hot water or cleaning solvent.
- Coat with an adhesive oil.
- Put the bank of filter plates in its place.
- Place the mesh screen ahead of the filter.
- Make electric supply connections and check it for proper function.

NOTE:

- In many cases a bank of dry through way filters are installed ahead of electronic air cleaner to prevent large particals from entering.

CAUTION:

- Because of the high voltage, every precaution must be taken that the current (power supply) is off, when entering in the filter chamber for servicing or cleaning.
- The electronic cells and protective screens must be cleaned after every two or three months. Material collected is black in colour.
- After cleaning, rinse away all detergent solutions (the drying action of filter takes place after assembly and operation).

SERVICING OF ELECTRONIC AIR FILTER

FOR SERVICING OF THE ELECTRONIC AIR FILTER UNIT, CHECK THAT IF - - - - - -

- Unit does not arc.
- Trouble lights remain ''ON''
- Strong OZONE odor is detected.
- Rooms arc dusty and dirty.
- The unit arcs all the time.
- Meter (if used) reads low.
- METER SHOWS THAT:----------
- Conditions arc normal.
- Filter is wet (operate dry switch).
- There is an electric failure.

TROUBLES IS IN THE HIGH VOLTAGE CIRCUIT:

- Inspect and electrically test the ''power pack'' capacitors and collecting cells, ionizing wires.

IN THE ''POWER PACK''

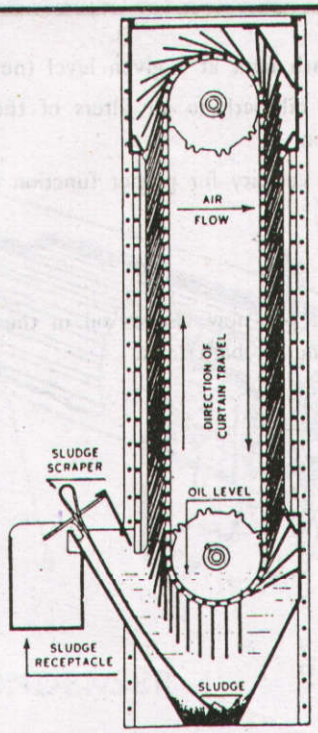
- Inspect the low side first with either a test light or voltmeter.
- Check the transformers, rectifires (A.C and D.C) the capacitor resistors. (should discharge capacitiors in about 10 seconds).
- Check the capacitors by replacement.

COLLECTER SECTION:

- Inspect the bent plates:----------
- Plates are out of position.
- Dirt bridging the gap between the ionizing wires and plates.
- Broken insulators and broken wires.

NOTE

Plates must be straight, remove and replace plates if faulty. A properly operated unit will be indcicated by black water when the cell is cleaned.



ROLLER TYPE, CLEANABLE AIR FILTER

TOOLS AND MATERIAL:

- Roller type cleanable filter.
- Viscouse oil.
- Kerosene oil

Screw driver set.
Adjustable wrench.

SEQUENCE OF OPERATIONS:

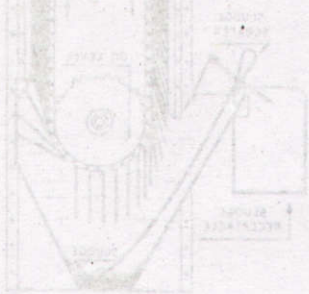
- Check that all the filter are loaded with dirt.
- Check the Viscous oil of the oil bath tank.
- Drain off all the oil from the oil bath tank.
- Remove sluge from the oil bath tank and clean the oil bath tank.
- Unfasten one filter only.
- Wash the filter in cleaning solution in a tank and remove the sluge from the filter with air pressure and then again wash the filter in a new cleaning solution (kerosene oil).
- Dry the filter.
- Fasten (adjust) the filter in its place.
- Move the filter roller manually.
- Unfasten the next filter, clean, wash and dry the filter
- Adjust filter and clean all the filters of the roller one by one by using above prescribed process.
- Start the motor of the roller manually and check for proper function of roller.
- Clean the oil bath tank again.

SCALE :	CLEANING OF FILTER	RP/4.15.1/47
MAT		AIR CONDITIONING

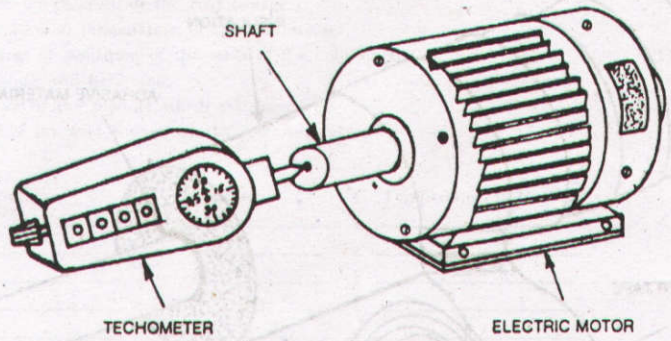
- Put the viscous oil in the oil bath tank at a given level (new viscous oil).
- Start the roller motor and give oil bath to all filters of the roller and stop and then put the roller motor on automatic position.
- Start blowers and check the air velocity for proper function of air moving through filters.

NOTE:

- After cleaning the oil bath tank, put new viscous oil in the oil bath tank as the same quantity and grade as drained off from the oil bath tank.



SCALE :	CLEANING OF FILTER	RP/4.15.1/47a
MAT		AIR CONDITIONING



TOOLS AND MACHINERY:

- Techometer.
- Electric motor.

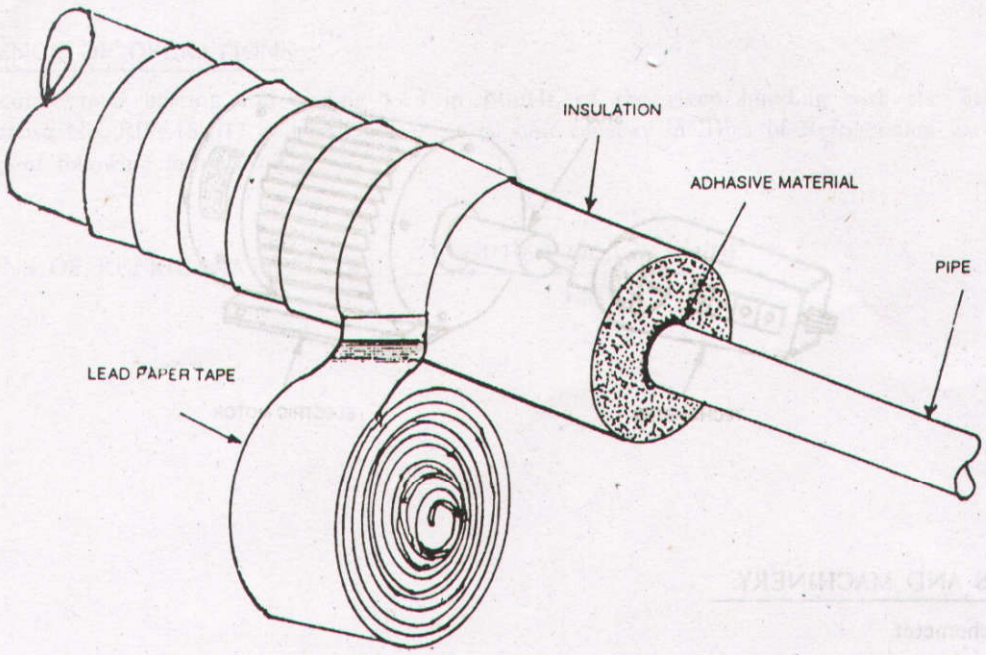
SEQUENCE OF OPERATIONS:

- Make electric connections of the electric motor.
- Adjust the techometer to zero position.
- Switch ''ON" the electric motor.
- Connect the techometer to the centre of the shaft end and measure the reading of the techometer.

NOTE:

- If the techometer is electronic type, put the photo cell light of the techometer on the end of the motor shaft and during measurement of RPM, the motor (shaft) should be in running position.

SCALE :	MEASURING OF RPM	RP/4.15.1/48
MAT :		AIR CONDITIONING



TOOLS AND MATERIAL:

- Insulation.
- Screw driver set.
- Lead paper tape.
- Adhesive material.

SEQUENCE OF OPERATIONS:

- Measure the diameter of the pipe.
- Check the temperature of the pipe.
- Select the proper thickness of insulation in tubular form according to the size of the pipe.
- Put the suitable adhesive on the piping which will be insulated.
- Put the molder tubular of insulation around the pipe.
- Join the cut ends and edges with an adhesive air tight.
- Warp the insulation tape (Lead papaer tape) throughout the insulation with in insulation joints.

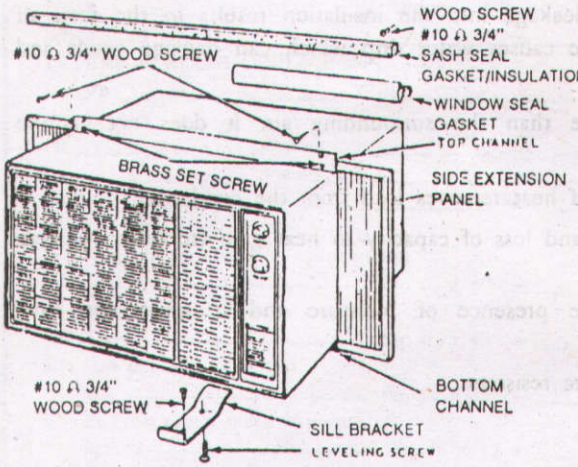
NOTE:

- Snap over the tubular insulation on the previous tabular length end, because one side of the tubular length is slit.

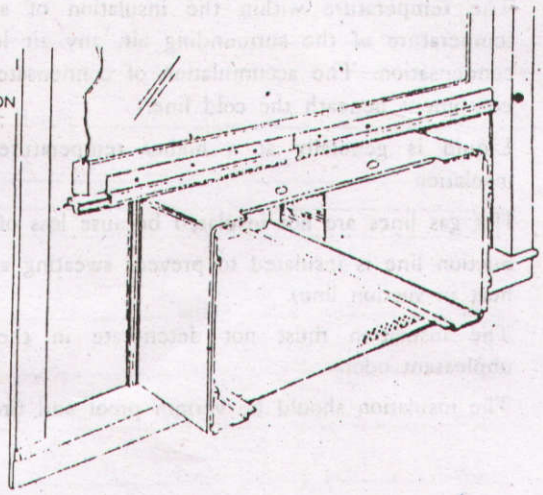
SCALE :	INSTALLATION OF INSULATION ON THE CHILLED WATER PIPING	RP/4.15.1/49
MAT :		AIR CONDITIONING

- The temperature within the insulation of a cold line is frequently below the Dew point temperature of the surrounding air, any air leakage into the insulation results in the form of condensation. The accumulation of condensate causes water drip which can damage goods and equipment beneath the cold line.
- Liquid is generally at a higher temperature than the surrounding air, it does not require insulation.
- Hot gas lines are not insulated because loss of heat removes load from the condenser.
- Suction line is insulated to prevent sweating and loss of capacity to heat gain (to prevent super heat in suction line).
- The insulation must not deteriorate in the presence of moisture and it must not have unpleasant odor.
- The insulation should be vermin proof and fire resistant.

SCALE :	INSTALLATION OF INSULATION ON THE CHILLED WATER PIPING	RP/4.15.1/49a
MAT :		AIR CONDITIONING



Window unit showing necessary parts to safely mount unit in window and seal openings.



Window air conditioning casing installed, showing rubber seal strips and filler boards.

TOOLS AND MATERIAL:

- Window air conditioner.
- Insulation. (rubber sponge or thermopole).
- Screw driver set.

SEQUENCE OF OPERATIONS:

- Put the casing of the air conditioner in the window or in the required installing place.
- Put the rubber sponge or thermopole sheet in the loose spaces.
- Adjust the metal strip or wooden strip with screws to lock the insulation.

SCALE :	INSTALLING AND REFIXING OF INSULATION	RP/4.15.1/50
MAT		AIR CONDITIONING

DAILY CHECK SHEET OF REFRIGERATION, AIR CONDITIONING AND VENTILATING PLANT OF _____

Date _____ Time _____

Shift _____ _____

AMBIENT CONDITIONS

W.B. _____ F

D.B. _____ F

R.H. _____ %

CHECK AND RECORD THE FOLLOWING:

- COMPRESSOR NO. _____

Motor temperature _____ F

Compressor motor amperage _____ A

Oil temperature _____ F

Oil pressure difference _____ Psi

REFRIGERANT PRESSSURE IN PSI

Suction _____ Psi

Discharge _____ Psi

- EVAPORATOR:

Suction pressure _____ Psi

Temperature of chilled water entering _____ F or temperature of air entering _____ F

Temperature of chilled water leaving _____ F or temperature of air leaving _____ F

- CONDENSER:

Temperature of water entering _____ F or Temperature of air entering _____ F

Temperature of water leaving _____ F or Temperature of air leaving _____ F

- COOLING TOWER:

Temperature of air entering _____ F Temperature of water entering _____ F

Temperature of air leaving _____ F Temperature of water leaving _____ F

- ELECTRIC MOTORS:

Evaporator fan motor No. 1 _____ Amperes. Evaporator fan motor No. 2 _____ Amps.

Condenser fan motor No. 1 _____ Amperes Condenser fan motor No. 2 _____ Amps.

Water pump No. 1 motor _____ Amperes Water pump No. 2 motor _____ Amps.

- CHECK THE COMPRESSOR MOTOR BEARINGS:

REMARKS

For any abnormal noise of bearings. _____

Feel bearing temperature by hand _____

Check refrigerant leakage if any _____

Check the position of air damper. _____

- POSITION OF AIR DAMPER OPENING:

Fresh air damper _____ % Conditioned air damper _____ %

Return air damper _____ % By pass air damper _____ %

- CHECK HEATERS:

Room No. 1 _____ Room No. 2 _____ Room No. 3 _____

SCALE	INFORMATION SHEET	RP/4.15.1/51
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

CHECK THE DRY BULB TEMPERATURE AND RELATIVE HUMIDITY OF THE A/C ROOMS

	Room No. 1	Room No. 2	Room No. 3	Room No. 4	Room No. 5
Dry Bulb Temperature °F					
Relative Humidity %					

CHECK THE FOLLOWING AND GIVE REMARKS:

CHECKS	REMARKS
Check condition of evaporators	
Check condition of condensers	
Check condition of air filters	
Check general conditions of the plant	
Check cleanliness of supply air fans, and motor bearings,	
Check for any abnormal noise	
Check motorized valve in operation	
CHECK ANY WATER LEAKAGE	
Check condition of belts	
Check condition of indicating lamps and covers	

Remarks on over all condition of the plant _____

_____

_____

_____
SIGNATURE OF PLANT OPERATOR

_____ SUPERVISOR

_____ SHIFT ENGINEER

_____ CHIEF ENGINEER

CHECK SHEET OF REFRIGERATION, AIR CONDITIONING AND VENTILATING PLANT OF ----------

WEEKLY CHECKS

REMARKS

Check the liquid line sight glass. _____

Check the running amperage of all motors _____

Check, that air cooled condensers are free from obstruction. _____

Check/clean/replace air filters as necessary. _____

Check the condition of air take grilles and filters. _____

Check that condensate drains are free from blockage. _____

Check all belts for condition, tension alignment _____

Check compressor oil levels (if a crankcase sight glass is fitted. _____

QUARTERLY CHECKS

REMARKS

Check water cooled condensers for level of chemical treatment. _____

Check finned heatexchanger surfaces for chemical treatment. _____

Lubricate motors/fan bearings as necessary. _____

Test for leak of the system. _____

Wash out condensate trays etc. with bioacid. _____

Inspect humidifires, if fitted, for freedom from scale. _____

Inspect humidifires, if necessary, clean sensors of the thermometers, thermostats and humidistats. _____

YEARLY CHECKS

REMARKS

Examine all motors/fan/shaft bearings _____

Clear all water strainers. _____

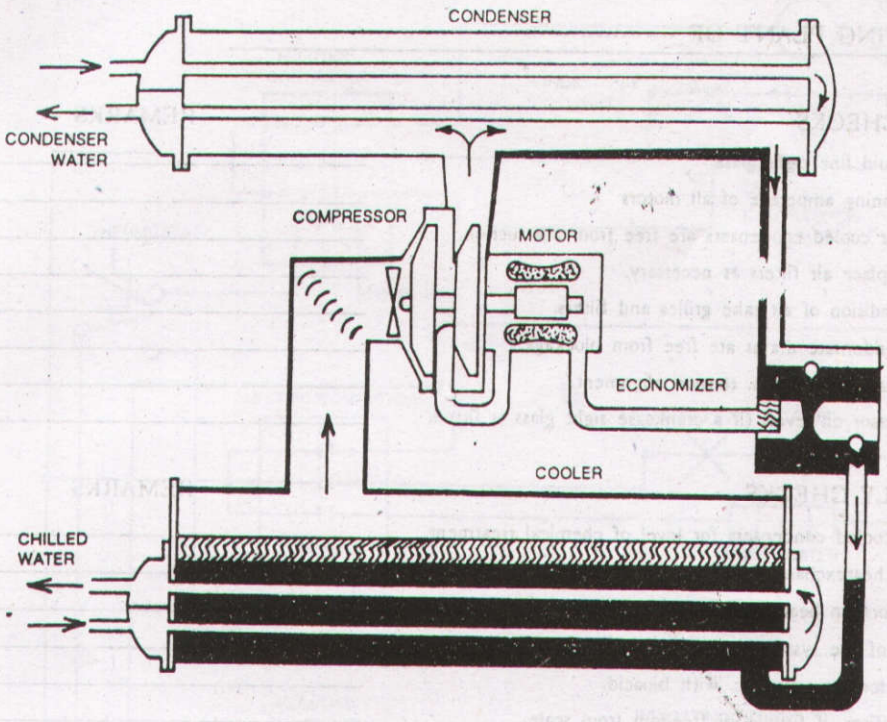
Empty, clean and repaint as necessary all cooling towers, condenser surfaces exposed to water, renew water treatment chemicals. _____

Check all operating and safety controls for correct setting and operations. _____

Megger test all the motors. _____

NOTE:

- When installations are used either centrifugal or absorption type water chillers, the purge system should be operated weekly to remove air, moisture etc.
- Quarterly programme should include the lubrication for external capacity control motors and linkage.
- The linkages and stems of water control valve should be cleaned and lubricated not less than twice a year.

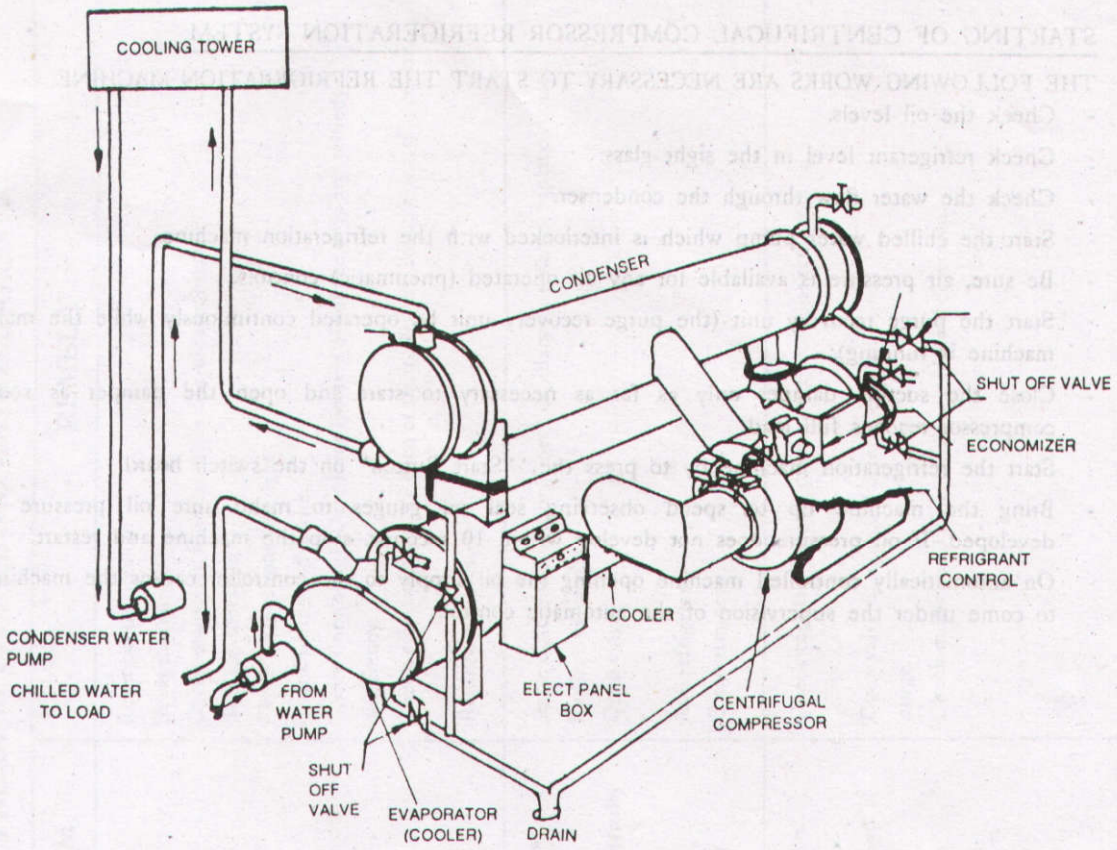


CENTRIFUGAL REFRIGERATION SYSTEM

This Centrifugal refrigeration system employs the same general type of compression and refrigeration cycle.

Large comfort installations use centrifugal type compressor. These systems use low pressure refrigerant and the evaporator operates at below atmospheric pressure.

Both condenser and evaporator are the shell and tube type. In evaporator the chilled water flows through the tubes is warmer than the refrigerant in the shell surrouding the tubes consequently the heat is transfered from chilled water to refrigerant. This heat evaporates the refrigerant at a temperature corresponding to the low pressure in the evaporator as maintained by the compressor. The evaporated refrigerant is drawn into the suction of the compressor. The compressor is two stage centrifugal, driven by hermetically sealed motor. The suction gas which is comming from the economizer through the hermetic motor is used for the motor cooling and this gas enters the second stage of the compressor. The refrigerant discharged by the compressor, condenses on the out side of the condenser tubes (in the condenser shell) at the temperature corresponding to the condenser pressure. This temperature is higher than that of the water in the tubes, so the heat is transferred into the condenser water. The condensed refrigerant drained in to the condenser float chamber, where a float valve maintains a laquid "seal" to prevent gas from passing into the economizer. This rising refrigerant level in this chamber



PIPING CIRCUIT OF CENTRIFUGAL REFRIGERATION SYSTEM

CIRCUIT OF CENTRIFUGAL REFRIGERATION SYSTEM

opens the float valve and allows the liquified refrigerant to pass into the economizer chamber. The pressure in the economizer chamber by a two stage compression is intermediate between the condenser and cooler pressure, consequently, enough of the refrigerant liquid evaporates to cool the remaining liquid to the lower temperature corresponding to the lower pressure in the economizer chamber. Thus evaporation takes place by rapid flushing into gas as it passes through the float valve and conduit leading into the economizer chamber. The evaporated portion passes through eliminators to the hermetic motor where it picks up a small amount of additional heat as it cools the motor. It then goes to the compressor and mixes with gas which has been compressed by the first stage impeller. This mixture enters the second stage impeller. The difference in pressure between the condenser and cooler is approximately the same for each stage.

Capacity is controled by inlet vanes to the two stage Centrifugal compressor. The vanes may be either electronically or pneumatically controlled and hydraulically operated. During starting, vanes are closed to reduce the starting load. This compressor has a forced lubrication system. A seperate motor drives the oil pump. This system has automatic purging device to remove non-condensable gases. The complete piping schematic of this unit is shown on page No RP/4.15.1/52 a. The evaporator, compressor suction line and chilled liquid lines are always insulated.

STARTING OF CENTRIFUGAL COMPRESSOR REFRIGERATION SYSTEM:

THE FOLLOWING WORKS ARE NECESSARY TO START THE REFRIGERATION MACHINE.

- Check the oil levels.
- Check refrigerant level in the sight glass.
- Check the water flow through the condenser.
- Start the chilled water pump which is interlocked with the refrigeration machine.
- Be sure, air pressure is available for any air operated (pneumatic) controls.
- Start the purge recovery unit (the purge recovery unit be operated continuously while the main machine is running).
- Close the suction damper only as far as necessary to start and open the damper as soon compressor reaches full load.
- Start the refrigeration machine by to press the "Start Button" on the switch board.
- Bring the machine up to speed . observing seal oil gauges to make sure oil pressure is developed. If oil pressure does not develop within 10 seconds, stop the machine and restart.
- On automatically controlled machine opening the oil supply to the controller causes the machine to come under the supervision of the automatic control.

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

SCALE :

MAT :

TROUBLE SHOOTING CHART

AIR CONDITIONING

RP/4 15 1/53

TROUBLE, CAUSE AND REMEDY ELECTRONIC CIRCUIT OF ICE CUBE MAKER

TROUBLE	CAUSE/SYMPTOM	REMEDY
Cuber will not start.	Line fuse blown, Bin full of ice. Open circuit in cord of feed wires No money in meter if meter is used Room too cold (below 45 degree) Blown fuse on Control Module Card. Bin probe disconnected or loose. Set too warm counterclockwise. Defective Bin probe. Defective control module P.C. card Status indicator (if used) Timed out Overheated evaporator. Shorted evaporator probe.	Check circuit for short or ground. Replace fuse. use some ice. Repair or replace. Feed meter. Warm room. Consult factory for cold room adaptation. Replace fuse. Install bin probe properly. Set slightly clockwise. Jumper bin probe (B) on P.C. Card, if cuber starts, replace probe. Check with cuber analyzer. Replace Control Module P.C. card. See Status indicator operation page to reset. If evaporator is hot, allow to cool. Check defrost circuit Replace. Replace.
Condensing fan operates but not the compressor.	Compressor stuck. Inoperative capacitors or relay. Overload switch defective. Open wash switch. Open high or low pressure cut-out Defective compressor.	Jar with mallet. Replace capacitors or relay. Replace overload swich or compressor with internal overload. Switch to on or replace. Check charge and condenser. Replace compressor.
Compressor operating but fan off.	Circuit not complete. Fan motor burned out.	Check circuit. Replace motor.
Condenser fan operating, but condesing unit operating intermitteltly during freezing cycle, wait till end of defrost to see if unit returns to normal operation	Dirty condenser coil. Low voltage.	Clean coil. Correct to proper voltage-not less than 5% below that stated on nameplate. Install automatic brownout voltage booster number 5-1320 for 115 volt cuber.

TROBULE	CAUSE / SYMPTOM	REMEDY
Compressor cuts out.	Defective run capacitor. Open high or low pressure cutout.	Run capacitor should draw 1 to 3 amps. Check refrigeration system pressure.
Water plate closes and opens constantly. Water plate closes all the way when cams are up but defrost valve stays open and pump does not run.	Maladjusted pump and defrost switch lift bolt. Water plate does not close all the way.	Adjust lift bolt on water to push switch lever up, closing hot gas valve and starting pump when water plate is up. Tighten jam nut. Remove obstruction. Adjust hinge for clearance between evaporator and water plate. Make sure teflon brackets on water plate are tight against cams. Check springs.
Water plate opens before water probe assembly tube is full.	Spring missing or springs weak allowing water plate to lower slightly (as water fills tank) unit pump switch drops and plate opens under power. Drift stop not adjusted. Cams drift counter-clockwise until water plate lowers slightly and pump switch drops. Slow fill-cold incoming water.	Replace springs. Drift stop on front of actuator motor. Remove drift stop and bend spring for more tension on motor shaft. Adjust cold water control on control module P.C. Card or replace control module P.C. card. Improve water supply. Clean strainer.
Water plate will not completely close.	Obstruction between evaporator and water plate. Life bolt for pump toggle on water plate too high, holding plate away from cams.	Remove obstruction check clearance between water plate and evaporator. Adjust lift bolt so water plate comes up against cams and lift bolt holds pump and defrost toggle switch up without binding and holding water plate down.
Water plate closes before cubes dropped.	Actuator pot on control module P.C. card adjusted too cold. Faulty evaporator probe. Faulty control module P.C. Card.	Adjust to warmer position (counter-clockwise). water plate should remain in down position 10 to 30 seconds after ice drops. Replace probe. Check with cuber analizer. Replace control module P.C. card.

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

TROUBLE SHOOTING CHART

SCALE :

MAT

AIR CONDITIONING

RP/4 15 1/53a

Refg. & Air Cond.

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

SCALE

MAT

TROUBLE SHOOTING CHART

AIR CONDITIONING

RP/4 15 1/53b

Refg. & Air Cond.

TROBULE	CAUSE / SYMPTOM	REMEDY
Holes in right hand cubes (evaporator outlet)	Shortage of refrigerant. Expansion valve too far closed	Check for leaks and recharge. Open 1/8 turn at a time (counter-clockwise).
Holes in all cubes sometimes and solid cubes most of the time.	Power shut off while water is filling tank or temporary power shut off near end of freeze cycle. Bin control shuts the cuber off during water fill.	Correct power source if possible. Interlock between water fill control and bin control not operating. Replace control module P.C. card.
Holes in cubes all of the time. Control stream does not go over the dam at end of freeze cycle.	Water level too low. Lower water level probe too high.	Measure from the top of the circulation tank down to the water level in the water level control tube, sight carefully across water in the control tube. See "chart of water levels, etc." Adjust low water level probe to remain immersed in water in control tube atleast 10 seconds after control stream starts "going over the dam .
Holes incubes all of the time. Control stream does go over the dam.	Control stream too high allowing water to splash over the dam during freeze cycle. (it should only go over the dam after cubes are fully formed.	Lower control stream, turn adjusting screw clockwise.
Cuber will harvest water plate will not come down.	Control stream obstructed. Inoperative lower probe. Actuator motor problem. Warm air infiltration from compressor compartment or room.	Loosen adjusting screw to flush out foreign matter. Check water level probe connection or replace probe assembly. Replace control module P.C. Card. Check motor and circuit. A Secure all skin panels. B Skin gasket must seal. C All panels must seal to prevent air from compressor compartment getting into ice making comartment. Check specially, top cover over partition.
Cuber stops when bin is not full.	Bin control adjusted too warm. Bin probe connecter loose or dirty. Defective bin probe. Intermittent Evaporator probe.	Readjust bin control slightly clockwise. Clean connector and install properly. Replace if considerably more than 5600 ohms at 32°F. Replace.

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

TROUBLE SHOOTING CHART

TROBULE	CAUSE / SYMPTOM	REMEDY
Water plate stays wide after defrost and all ice is out of evaporator.		Adjust actuator control slightly clockwise. Check and replace the evaporator probe or control module P.C. card if adjustment has not effect. Check wiring. Replace actuator toggle switch.
Water plate open evaporator will not defrost.	Refrigerant charge low. Inadequate hot gas charge.	Check for leaks and recharge. Check for tube obstruction or cold condenser.
Water pump does not operate.	Fuse blown in transformer box, or in control module box. Pump bearings are defective. Pump winding burned out or off on thermal overload. Circuit incomplete between water pump and pump defrost switch.	Replace fuse. Replace pump motor bearing or water pump. Allow to cool, or replace motor, check for 220V plus or minus 10%. Check circuit and switch.
Water pumpt motor running but not pumping water.	Impeller loose Strainer in tank outlet to pump clogged. Impeller brokern.	Replace impeller. Clean or replace screen. Replace impeller, Replace screen in tank outlet.
Most cubes not fully formed.	Not enough pressure from water pump. Clogged strainer in tank outlet to pump. Leak in water circulation system. Water plate not aligned.	Check bearing. Check voltage. Replace pump. Clean or replace screen. Fix leak or replace water plate. Check alignment with evaporator.
A few cloudy cubes other okay.	Some holes in water plate clogged.	Unplug with 1/8" drill. Flush laterals by removing plug.
Holes in left hand cubes (evaporator inlet)	Expansion valve too far open	Close 1/8 turn at a time (clockwise).

SCALE

MAT

AIR CONDITIONING

RP/4 15 1/53c

Refg. & Air Cond.

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

SCALE :

MAT :

TROUBLE SHOOTING CHART

AIR CONDITIONING

RP/4 15 1/53d

TROBULE	CAUSE / SYMPTOM	REMEDY
Cubes do not harvest in a slab but some cubes hange up in the evaporator and become deteriorated after other fail out.	Fin too thin. Deformed evaporator cells.	Adjust water plate hinges to 1/32" fin thickness. Straighten cells with some jaw pliers or tool.
Slab does not break up into individual cubes.	Fin too thick.	Adjust hinges up or evaporator down. Level 1/32" space between water plate and evaporator.
Unusually long cycles.	Voltage below required potential at the cuber. Dirty condenser. Hot air leaks between condensing unit compartment and freezing compartment. Expansion valve too far open. Expansion valve too far shut and large holes in right hand rows of evaporator. Water level too high after water fill Refrigerant low. Compressor defective. Control stream too low. Fan not operating.	Check power source for full voltage. Run at least No. 12 wire directly to cuber to pevent line loss. Clean Check for leaks and close with permagum, or presstite tap. All skin parts must be tight. Close valve 1/8 turn at a time so that there will be no frost back to compressor and pressures are according to ``chart of water levels, etc`` Open expansion valve 1/8 turn, but recheck to see that there is no frost-back to compressor at end of freeze cycle. Adjust water level according to ``chart of water levels etc.`` Check for leak and add refrigerant. Close refrigerant valve on receiver, pump down; low side should go to 15" Hg. of vacuum, with L.P cutout jumpered. If not, repalce compressor. Adjust control stream up, but not so high that it goes over dam at begining of cycle. Check fan wires, replace motor if necessary.
Some cubes do not form in right hand corners of evaporator.	Jet holes in ends of laterals frozen shut and will not thaw because of very low incoming water temperature.	Thaw out by shutting off unit adjust cold water control warmer CCW. Adjust expansion valve 1/8 turn closed.

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

SCALE

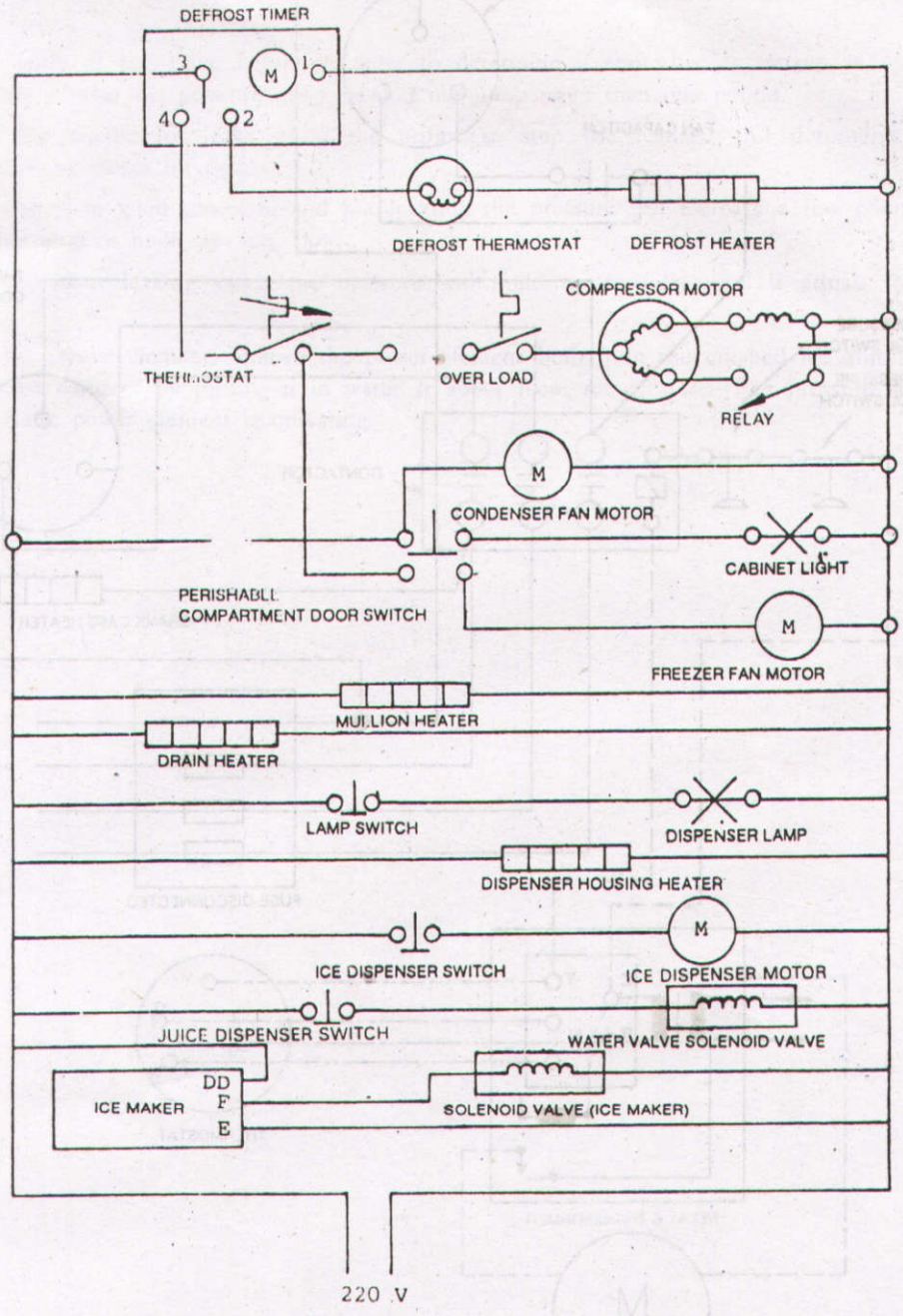
MAT

TROUBLE SHOOTING CHART

AIR CONDITIONING

RP/4 15 1/53e

TROBULE	CAUSE / SYMPTOM	REMEDY
Water valve stays closed.	Water level probs connector loose or dirty. Defective water probe assembly. Circuit okay, 115 volts to water valve Coil open. Flow control jumped cockyed. Defective P.C. card.	Clean connector and install properly, low probe lead to right (close). Use any electrical contact cleaner. Check witn probes standing in 32°F ice water mixture.Resistance should be 5600 ohms ± 20%. Replace coil. Clear water passages or replace valve. Replace P.C. card.
Water valve stays open after upper probe covered, will not shut off.	Water level probe connector loose or dirty. Defective water probe assembly. Defective P.C, card Water pressure below 15 P.S.I. Defective water valve.	Clean connector and install properly, low probe lead to right (close). Use any electrical contact cleaner. Check with probes standing in 32 °F ice mixture. Resis resistance should be 5600 ohms ± 20%. Replace P.C. card.
Water valve stays open more than 5 second after upper probe covered, then shuts off.	Upper probe covered with scale.	Clean cuber with ice machine cleaner OSCO, If necessary, remove and clean probe carefully.
Status indicatorshuts cuber off on ``service required`` but cuber operates normally most of the time and timer resets when ice harvest switch triggered manually (cubers).	Cubelet ice does not trip harvest switch. Maladjusted impact switch. Time out period too short.	Trip wire on switch too high. Bend trip wire until it is only 3/8 higher than water plate surface. Turn adjusting screw in to increase sensitivity. Lengthen time out period by adjustin$_g$ status indicator pot slightly clockwise.



COMPLETE THE ELECTRIC WIRING CIRCUIT OF REFRIGERATOR ACCORDING TO THE DRAWING

SCALE	ELECTRIC WIRING CIRCUIT OF REFRIGERATOR	RP/4.15.1/54
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

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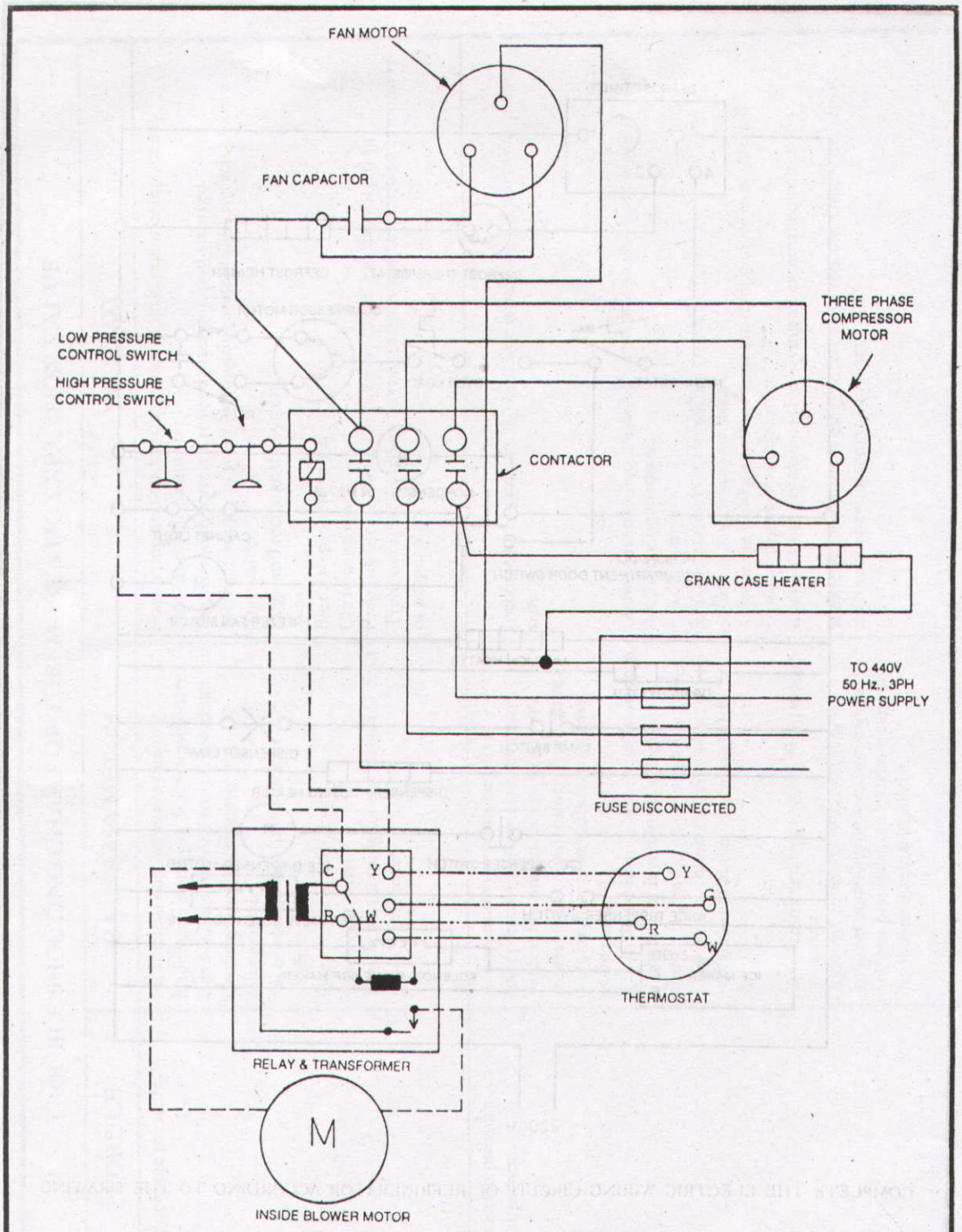
Refg. & Air Cond.



COMPLETE THE ELECTRIC WIRING CIRCUIT ACCORDING TO THE DRAWING

SCALE	ELECTRIC WIRING CIRCUIT OF AIR CONDITIONING UNIT	RP/4.15.1/55
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

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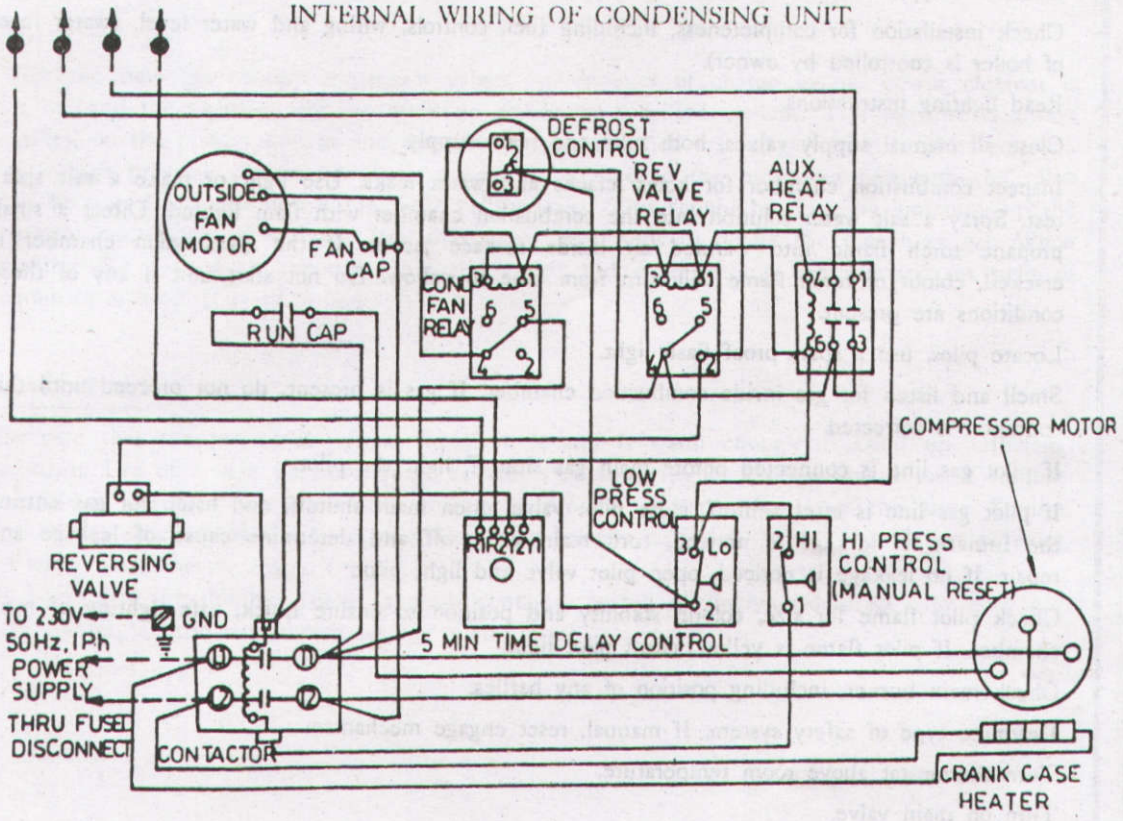
Refg. & Air Cond.

INTERNAL WIRING OF CONDENSING UNIT



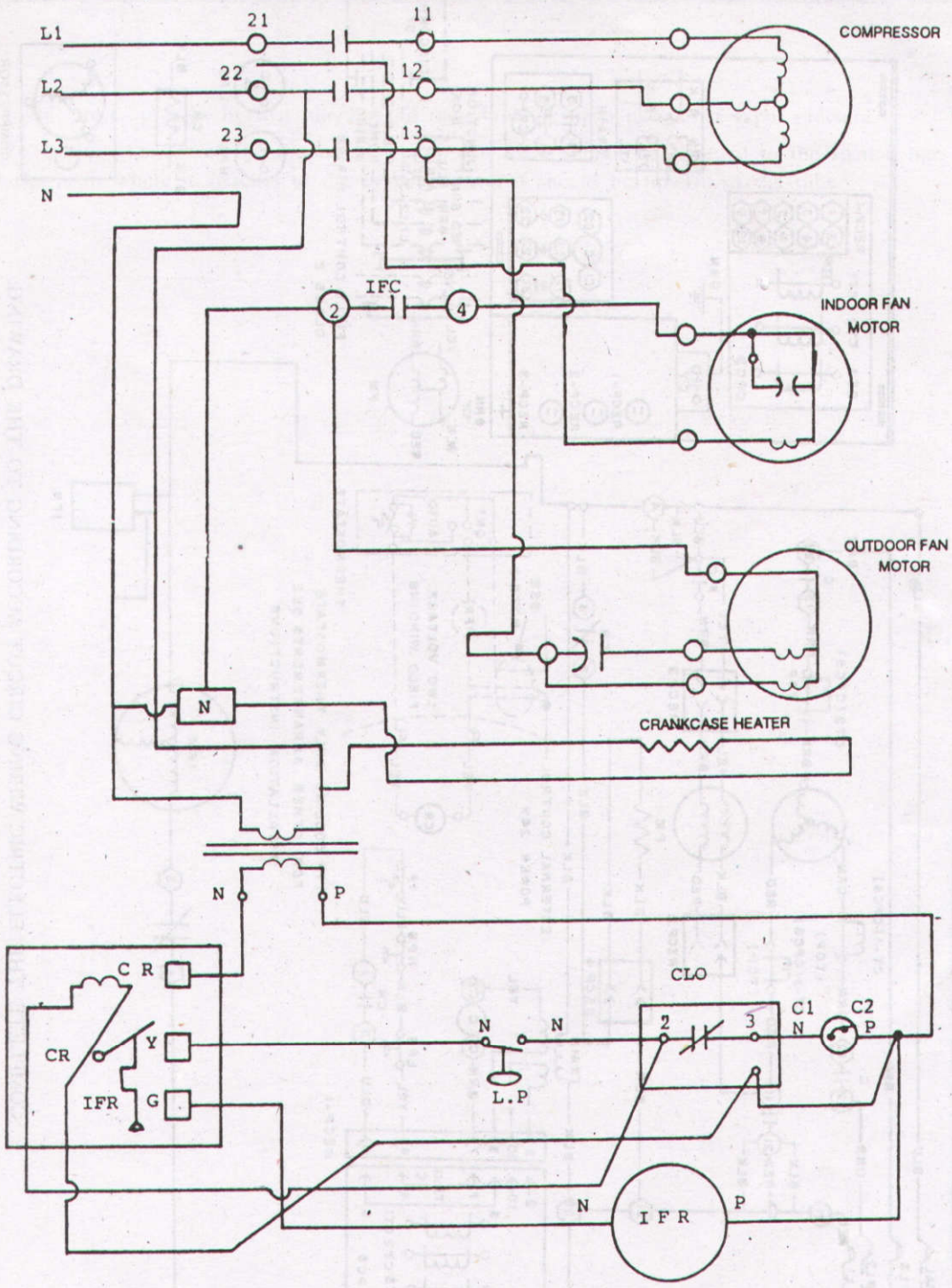
COMPLETE THE ELECTRIC WIRING CIRCUIT ACCORDING TO THE DRAWING

SCALE :	ELECTRIC WIRING CIRCUIT OF CONDENSING UNIT	RP/4 15.1/56
MAT :		AIR CONDITIONING
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK - GERMAN TECHNICAL TRAINING PROGRAMME		Refg. & Air Cond.

STARTING OF A GAS FURNACE:

THE FOLLOWING STEPS SHOULD BE TAKEN TO STARTING A GAS FURNACE:

- Adjust the thermostat to its lowest setting.
- Determine type of system (forced air, water or steam).
- Check installation for completeness, including fuel, controls, wiring and water level, (water level of boiler is controlled by owner).
- Read lighting instructions.
- Close all manual supply valves, both pilot and main supply.
- Inspect combustion chamber for holes, cracks and water leaks. Use light or make a salt spray test. Spray a salt water solution into the combustion chamber with flam lighted. Direct a small propane torch flame into warmed air inside furnace jacket. If the combustion chamber is cracked, colour of torch flame will turn from blue to yellow. Do not start unit if any of these conditions are present.
- Locate pilot, use a spark-proof flash light.
- Smell and listen for gas inside combustion chamber. If gas is present, do not proceed until this condition is corrected.
- If pilot gas line is connected before main gas shutoff, light the pilot.
- If pilot gas line is after shutoff, close pilot valve, open main shutoff, and listen for gas entring the furnace. If leakage is noticed, turn main valve off and determine cause of leakage and repair. If no leakage is noticed, open pilot valve and light pilot.
- Check pilot flame for size, colour, stability and position to ensure quick, safe lighting of main chamber. If pilot flame is yellow, clean pilot light.
- Check main burner, including position of any baffles.
- Detrmine type of safety system. If manual, reset engage mechanism.
- Turn thermostat above room temperature,
- Turn on main valve.
- Check ''OFF TIME" after pilot has heated up.
- Inspect all controls and operate them.
- Check gas pressure with a manometer.
- Adjust the thermostat to temperature as desired.



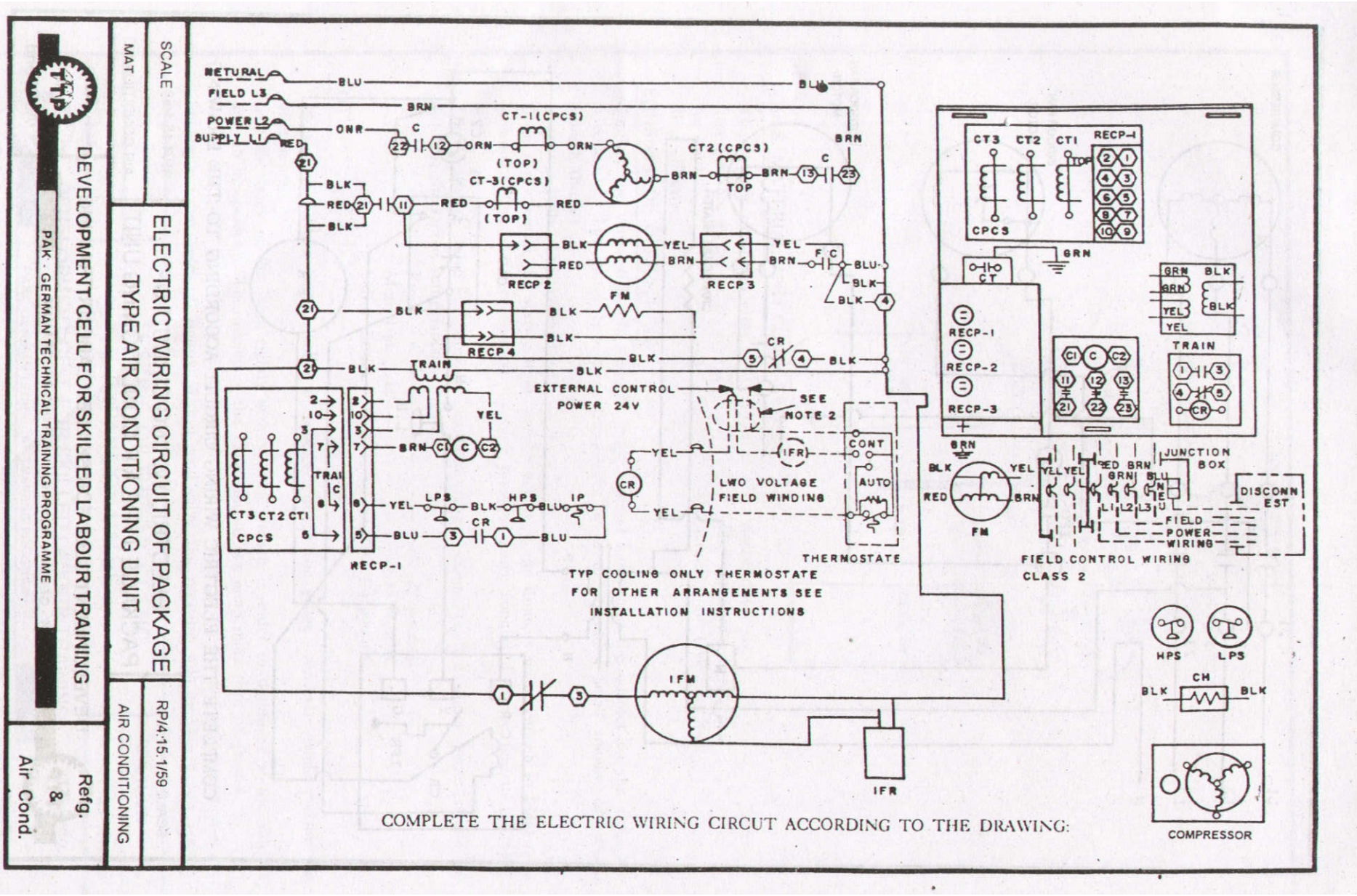
COMPLETE THE ELECTRIC WIRING CIRCUIT ACCORDING TO THE DRAWING

SCALE :	ELECTRIC WIRING CIRCUIT OF PACKAGE TYPE AIR CONDITIONING UNIT	RP/4.15.1/58
MAT :		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.



COMPLETE THE ELECTRIC WIRING CIRCUT ACCORDING TO THE DRAWING:

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

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ELECTRIC WIRING CIRCUIT OF PACKAGE TYPE AIR CONDITIONING UNIT

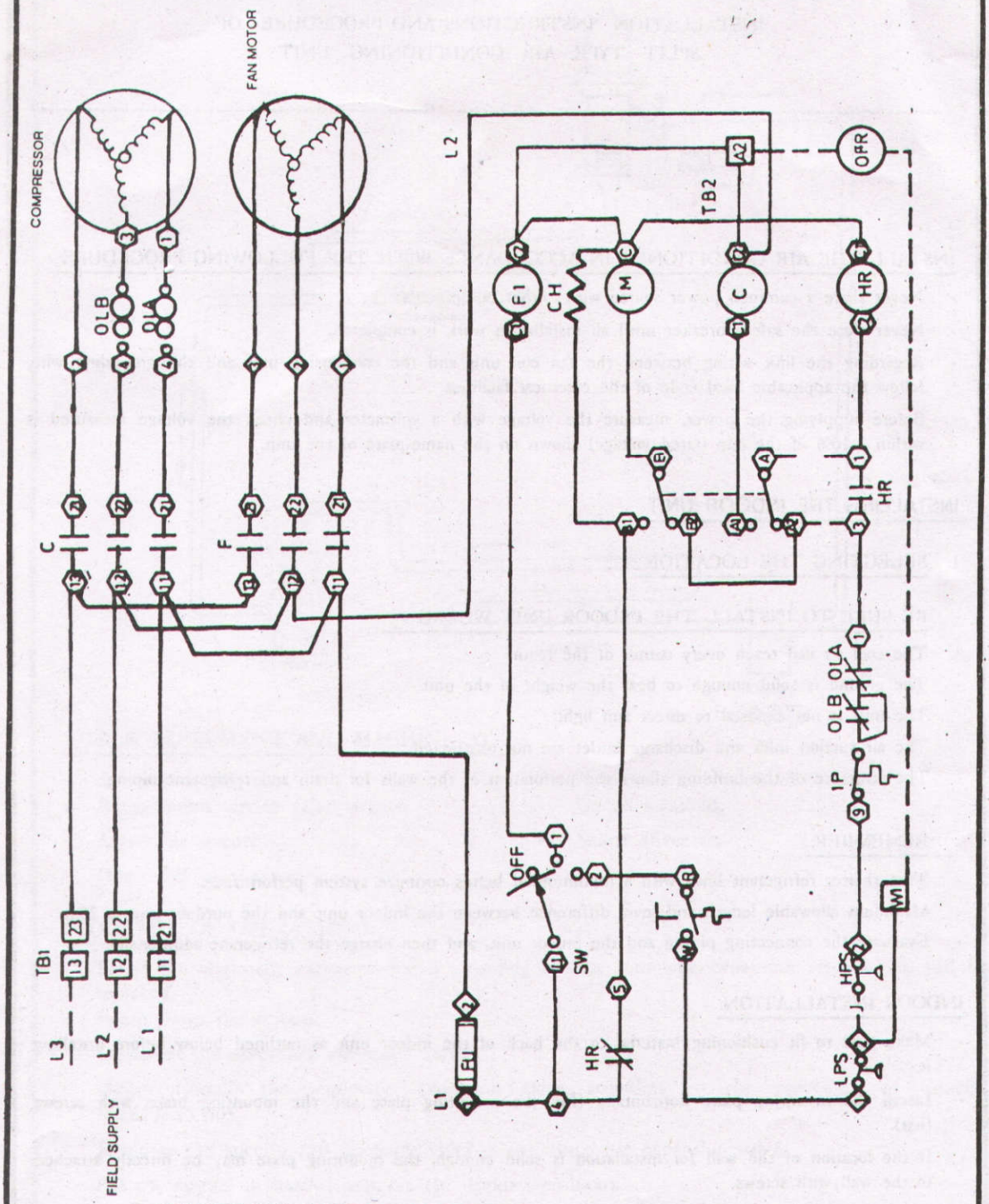
Refg. & Air Cond.

AIR CONDITIONING

RP/4.15.1/59

SCALE

MAT



COMPLETE THE ELECTRIC WIRING CIRCUIT ACCORDING TO THE DRAWING

SCALE :	ELECTRIC WIRING CIRCUIT OF PACKAGE TYPE AIR CONDITIONING UNIT	RP/4.15.1/60
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air. Cond.

INSTALLATION INSTRUCTIONS AND PROCEDURE OF SPLIT TYPE AIR CONDITIONING UNIT

INSTALL THE AIR CONDITIONER IN ACCORDANCE WITH THE FOLLOWING PROCEDURE

- Never share a common power source with other equipments.
- Never close the safety breaker until all installation work is completed.
- Regarding the link wiring between the fan coil unit and the condensing unit and the grounding wire, follow the applicable local code of the electrical facilities.
- Before supplying the power, measure the voltage with a voltmeter and check the voltage measured is within) 10% of the one (rated voltage) shown on the name-plate of the unit.

INSTALLING THE INDOOR UNIT

1. SELECTING THE LOCATION

- BE SURE TO INSTALL THE INDOOR UNIT WHERE:
- The cool air can reach every corner of the room.
- The ground is solid enough to bear the weight of the unit.
- The unit is not exposed to direct sun light.
- The air suction inlet and discharge outlet are not obstructed.
- The structure of the building allows the perforation of the walls for drain and refrigerant piping.

REMEMBER:

- That shorter refrigerant lines with a minimum of bends optimize system performance.
- Maximum allowable length and level difference between the indoor unit and the outdoor unit is 25m.
- Evacuate the connecting piping and the indoor unit, and then charge the refrigerant additionally.

INDOOR INSTALLATION:

- Make sure to fit cushioning material to the back of the indoor unit as outlined below before installing it.
- Install the mounting plate horizontally (Fix the mounting plate and the mounting brace with screws first).
- If the location of the wall for installation is solid enough, the mounting plate may be directly attached to the wall with screws.
- In case of the concrete wall, firmly fix the mounting plate with special clamps for concrete.

- After fixing the mounting plate, check it for stability by pulling back the upper part of the plate.
- When laying the drain hose and auxiliary piping through the through-wall (without removing the blind flare nut), hook the fitting provided on the back of the indoor unit on the mounting plate.
- It is difficult to connect an extension drain hose after the indoor unit has been hanged, connect the drain hose.
- Wind the attached insulation tape around the surface from the thermal insulation pipe to the internal part of the inter unit piping so as to wound by overlapping each other atleast more than half width of the lape.

INSTALLING THE REMOTE CONTROLLER:

SELECTING THE LOCATION:

IN CASE THE WIRELESS REMOTE CONTROLLER:

- Before installing the remote controller, check that air conditioner is operative by the remote controller in the place. It operates when the controller makes receiving tones. However avoid installing the controller in the following places.
- Place where direct sunlight effects the remote controller.
- Moist places where there is a considerable amount of moist present.
- Check that the signal is received before finally deciding on the position.

IN CASE OF THE WIRED REMOTE CONTROLLER:

- For wall mounting remote controller, use the wall mounting plate for the remote controller, use the wall mouting plate for the remote controller.
- Fix the remote controller by use of the staple.
- Set the batteries to the controller correctly and put the cover.

INSTALLING THE OUTDOOR UNIT:

SELECTING THE LOCATION:

BE SURE TO INSTALL THE OUTDOOR UNIT WHERE:

- The foundation is solid enough to bear the weight and vibration of the unit.
- The space around the unit is adequate for ventilation.
- The site is not near a concentration of falmmable gases.
- The site is not exposed to a salty atmosphere of sulfate gas.
- The site is efficiently isolated that the running noise and hot exhaust do not disturb the users or their neighbourers.
- Since drain comes out of the condensing unit, do not place anything that must be kept from moisture. If drainage is bad, place concrete blocks as bases.
- Leave sufficient space for piping and electric wiring, or atleast enough space for unscrewing and removing the terminal cover of the condensing unit.

REFRIGERANT PIPING WORK:

- Place a cap to the open end of the pipe to protect dust and moisture.
- Avoid bending the pipe as much as possible, but when necessary, bend it gently with a radius of more than 3 or 4cm.
- When the flare nuts in the gas and liquid piping are loosened, gas or oil might leak. This does not indicate any trouble, so proceed to loosening the flare nuts.
- Fare nuts should be tightened with the following torques.

(Pipe dia.)	(Tightening torque)
6.4 mm	140 - - - - - - - - - 180 Kg-Cm
15.9 mm	630 - - - - - - - - - 770 Kg-Cm

Quick joints should be tightened with the following torques.

(Pipe dia)	(Tightening torque)
6.4 mm	- - - - - - - - - - 550 Kg-Cm
15.9 mm	- - - - - - - - - - 490 Kg-Cm

CHECK FOR LEAKAGE:

Purge the refrigerant circuit and check all connections for leakage. To do this check, apply soap suds to the connections and inspect carefully. After check, wipe them off completely.

AIR PURGING:

Air purging is required only for flare nut connections and not for quick-joint connections.

For air purging, remove the blind caps from the liquid and gas valves, loosen the liquid valve stem by 1/4 turn, and 5 seconds later tighten it up swiftly.

The air will leak from connection on the gas pipe with hiss. Be sure that such hissing continues at least for 10 seconds. As soon as such hissing stops, tighten the flare nut in the gas piping firmly with a wrench.

CAUTION:

the hissing stops before 10 seconds, perform the air purge agian.

DRAIN PIPING WORK:

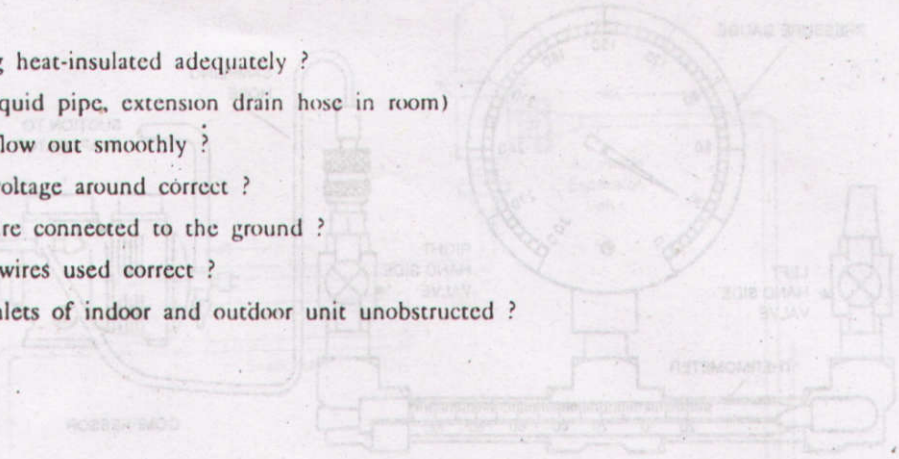
TEST RUN AND CHECK:

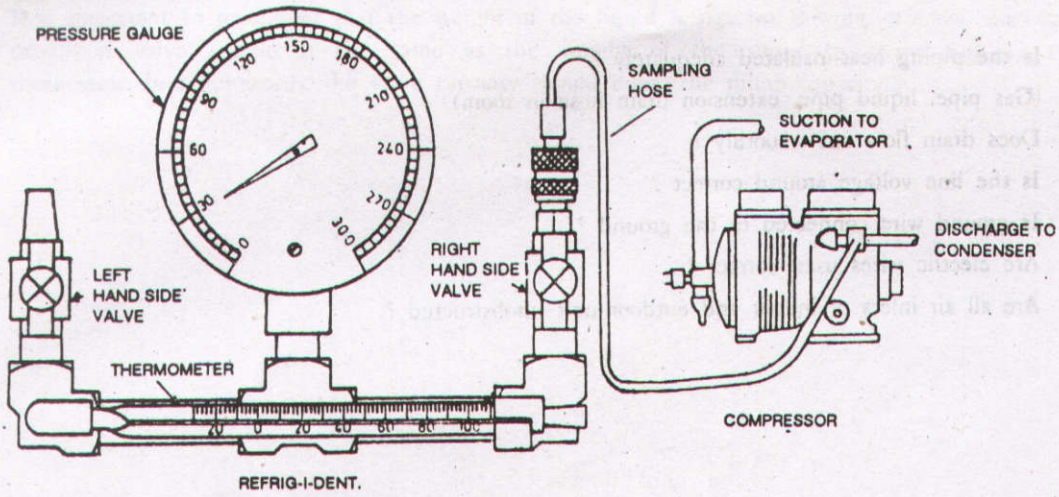
- Set the thermostat knob to the lowest temperature position. (After testing, slide the knob back to an appropriate position)
- Test the operating voltage at the power terminal block on the outdoor unit and check that it accords with the one of the specifications.
- Operate the air conditioner on the Owners Manual and check.
- If the room temperature is low, the Air Conditioner does not operate. In that case use the test running switch. (After testing put the switch back).

AFTER INSTALLATION CHECK THE FOLLOWING POINTS

- Are the indoor units securely installed?
- Check for gas leakage?

- Is the piping heat-insulated adequately ?
  (Gas pipe, liquid pipe, extension drain hose in room)
- Does drain flow out smoothly ?
- Is the line voltage around correct ?
- Is ground wire connected to the ground ?
- Are electric wires used correct ?
- Are all air inlets of indoor and outdoor unit unobstructed ?





TOOLS AND MATERIAL:

- Refrig-I-Dent.
- Refrigeration unit.

Refrigeration service valve wrench.

SEQUENCE OF OPERATIONS:

- Remove the valve stem cap from the high side of the compressor valve and ''back seat" the valve.
- Attach a 1/4" flared connector to the compressor valve.
- Attach the sampling hose to this flared connector and to the right hand connection of the Refrig-I-Dent, after removing the dust cover. (Both quick connectors should be finger tight).
- Open the compressor valve very slowely, about !/8 of a turn clockwise. (Trainee will see and feel the pressure buildup in the sampling hose).

  Purge the hose by loosening the quick connector at the Refrig-I-Dent. This purge reduces the possiblity of oil contamination in the Refrig-I-Dent. (Tighten the quick connector finger tight).
- Open the inlet valve on the right hand side of the Refrig-I-Dent.
- Purge the air from the Refrig-I-Dent by opening the discharge valve, left hand side, momentarily.
- After an adequate purge of the mainfold has been made, close the discharge valve and then the inlet valve on the the Refrig-I-Dent.
- ''Back seat" the compressor valve. A sample of refrigerant is now trapped in the manifold of the Refrig-I-Dent. (Should a liquid or a partially liquid sample of refrigerant be obtained, a refrigeration effect may take place).
- Allow the pressure and temperature to stabilize, and then reocrd the readings of the pressure gauge and of the thermometer.
- Compare the pressure and temperature readings to the Chart on page on page No. RP/4.15.1/62b or the tables on pages RP/4.15.1/62c to Rp/4.15.1/62e.

SCALE :	IDENTIFICATION OF REFRIGERANT	RP/4.15.1/62
MAT :		AIR CONDITIONING

EXAMPLE:

If the sample of a refrigerant indicates pressure of 145 psig and temperature of 114°F. Checking the Charts or Tables, we find that R-12 has a vapor pressure of 145 psig at 114°F. Therefore, the sample is identified as R-12. If the readings were 80°F and 145 psig, the refrigerant would be R-22.

PRESSURE GAUGE ZERO ADJUSTMENT:

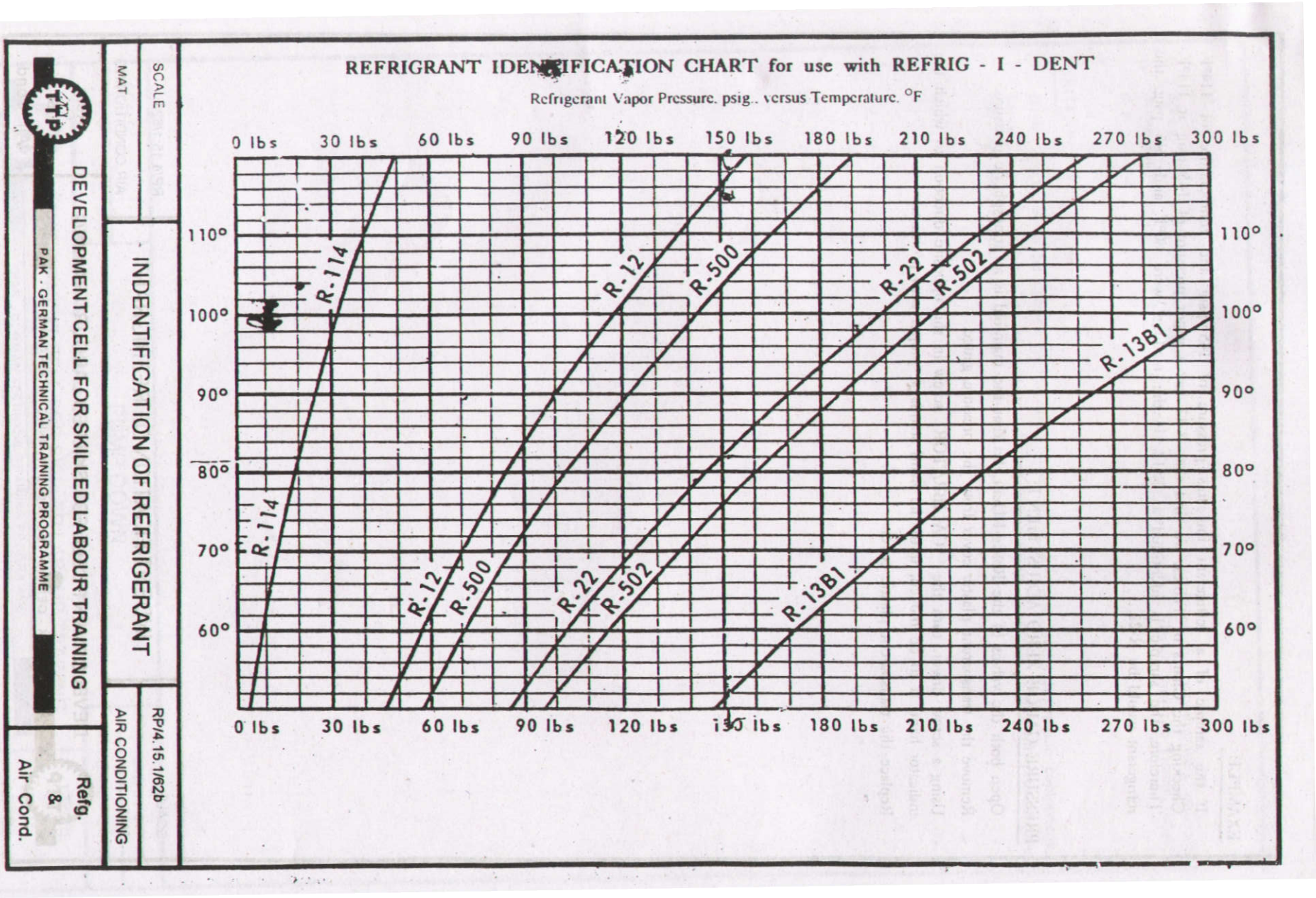
- Open both the valves of the Refrig-I-Dent, So that the manifold is at atmospheric pressure.
- Remove the transparent plastic cover from the pressure gauge.
- Using a screw driver, turn the "CALIBRATOR screw in the opposite direction to which the indicator hand is to be moved, until the hand stands at proper zero position.
- Replace the transparent plastic cover.

SCALE	INDENTIFICATION OF REFRIGRANT	RP/4 15.1/62a
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.


REFRIGRANT IDENTIFICATION CHART for use with REFRIG - I - DENT
Refrigerant Vapor Pressure, psig., versus Temperature, °F
0 lbs
30 lbs
60 lbs
90 lbs
120 lbs
150 lbs
180 lbs
210 lbs
240 lbs
270 lbs
300 lbs
110°
100°
90°
80°
70°
60°
R-114
R-12
R-500
R-22
R-502
R-13B1
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING
PAK - GERMAN TECHNICAL TRAINING PROGRAMME
SCALE
MAT
INDENTIFICATION OF REFRIGERANT
AIR CONDITIONING
RP/4.15.1/62b
Refg. & Air Cond.

REFRIGERANT VAPOR PRESSURE, Psig:, versus TEMPERATURE

°F	R-11	R-12	R-13	R-22	R-113	R-114	R-502	R-500 **
-50		15.4*	57.0	6.0*		27.2*	0.0	
-48		14.6*	60.0	4.7*		27.0*	0.8	
-46		13.8*	63.0	3.3*		26.8*	1.6	
-44		12.9*	66.2	1.8*		26.6*	2.5	
-42		11.9*	69.4	0.3*		26.3*	3.4	
-40	28.4*	11.0*	72.7	0.6		26.1*	4.3	7.9*
-38	28.3*	10.0*	76.2	1.4		25.9*	5.2	6.7*
-36	28.2*	8.9*	79.7	2.3		25.6*	6.2	5.4*
-34	28.1*	7.8*	83.3	3.2		25.3*	7.2	4.2*
-32	28.0*	6.7*	87.1	4.1		25.0*	8.3	2.8*
-30	27.8*	5.5*	90.9	5.0	29.3*	24.7*	9.4	1.4*
-28	27.7*	4.3*	94.9	6.0	29.3*	24.4*	10.5	0.0
-26	27.5*	3.0*	98.9	7.0	29.2*	24.0*	11.7	0.8
-24	27.4*	1.6*	103.0	8.1	29.2*	23.4*	12.9	1.5
-22	27.2*	0.3*	107.3	9.2	29.1*	23.3*	14.2	2.3
-20	27.0*	0.6	111.7	10.3	29.1*	22.9*	15.5	3.1
-18	26.9*	1.3	116.2	11.5	29.0*	22.5*	16.9	4.0
-16	26.7*	2.1	120.8	12.7	28.9*	22.1*	18.3	4.9
-14	26.5*	2.8	125.7	13.9	28.9*	21.6*	19.7	5.8
-12	26.2*	3.7	130.5	15.2	28.8*	21.1*	20.2	6.8
-10	26.0*	4.5	135.4	16.6	28.7*	20.6*	22.8	7.8
-8	25.8*	5.4	140.5	18.0	28.6*	20.1*	24.4	8.8
-6	25.5*	6.3	145.7	19.4	28.5*	19.6*	26.0	9.9
-4	25.3*	7.2	151.1	20.9	28.4*	19.0*	27.7	11.0
-2	25.0*	8.2	156.5	22.5	28.3*	18.4*	29.4	12.1
0	24.7*	9.2	162.2	24.1	28.2*	17.8*	31.2	13.3
2	24.4*	10.2	167.9	25.7	28.1*	17.2*	33.1	14.5
4	24.1*	11.2	173.7	27.4	28.0*	16.5*	35.0	15.7
6	23.8*	12.3	179.8	29.2	27.9*	15.8*	37.0	17.0
8	23.5*	13.5	185.9	31.0	27.7*	15.1*	39.0	18.4
10	23.1*	14.6	192.2	32.9	27.6*	14.3*	41.1	19.8
12	22.7*	15.8	198.6	34.9	27.5*	13.5*	43.2	21.2
14	22.3*	17.1	205.2	36.9	27.3*	12.7*	45.4	22.7
16	21.9*	18.4	211.9	39.0	27.1*	11.9*	47.7	24.2
18	21.5*	19.7	218.8	41.1	27.0*	11.0*	50.1	25.7
20	21.1*	21.0	225.8	43.3	26.8*	10.1*	52.4	27.3
22	20.6*	22.4	233.0	45.5	26.6*	9.1*	54.9	29.0
24	20.2*	23.9	240.3	47.9	26.4*	8.1*	57.4	30.7
26	19.7*	25.4	247.8	50.2	26.2*	7.1*	60.0	32.5
28	19.1*	26.9	255.5	52.7	26.0*	6.1*	62.7	34.3
30	18.6*	28.5	263.3	55.2	25.8*	5.0*	65.4	36.1
32	18.1*	30.1	271.3	57.8	25.6*	3.9*	68.2	38.0
34	17.5*	31.7	279.5	60.5	25.3*	2.7*	71.1	40.0
36	16.9*	33.4	287.8	63.3	25.1*	1.5*	74.1	42.0
38	16.3*	35.2	296.3	66.1	24.8*	0.2*	77.1	44.1

SCALE :	IDENTIFICATION OF REFRIGERANT	RP/4.15.1/62c
MAT ·		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

REFRIGERANT VAPOR PRESSURE, Psig., versus TEMPERATURE

°F	R-11	R-12	R-13	R-22	R-113	R-114	R-502	R-500 ••
40	15.6•	37.0	305.0	69.0	24.5•	0.5	80.2	46.2
42	14.9•	38.8	313.9	72.0	24.2•	1.2	83.4	48.4
44	14.2•	40.7	322.9	75.0	23.9•	1.9	86.6	50.7
46	13.5•	42.7	332.2	78.2	23.6•	2.6	90.0	53.0
48	12.8•	44.7	341.6	81.4	23.3•	3.3	93.4	55.4
50	12.0•	46.7	351.2	84.7	22.9•	4.0	96.9	57.8
52	11.2•	48.8	361.1	88.1	22.6•	4.8	100.5	60.3
54	10.4•	51.0	371.1	91.5	22.2•	5.6	104.1	62.9
56	9.5•	53.2	381.3	95.1	21.8•	6.4	107.9	65.5
58	8.7•	55.4	391.7	98.8	21.4•	7.3	111.7	68.2
60	7.7•	57.7	402.4	102.5	21.0•	8.1	115.6	71.0
62	6.8•	60.1	413.3	106.3	20.6•	9.0	119.6	73.8
64	5.8•	62.5	424.2	110.2	20.1•	9.9	123.7	76.7
66	4.8•	65.0	435.6	114.2	19.7•	10.9	127.9	79.7
68	3.7•	67.6	447.0	118.3	19.2•	11.9	132.2	82.8
70	2.6•	70.2	458.8	122.5	18.7•	12.9	136.6	85.8
72	1.5•	72.9	470.7	126.8	18.2•	13.9	141.1	89.0
74	0.4•	75.6	482.9	131.2	17.6•	15.0	145.6	92.3
76	0.4	78.4	495.3	135.7	17.1•	16.1	150.3	95.6
78	1.0	81.3	508.1	140.3	16.5•	17.2	155.1	99.0
80	1.6	84.2	521.0	145.0	15.9•	18.3	159.9	102.5
82	2.2	87.2	534.1	149.8	15.3•	19.5	164.9	106.1
84	2.9	90.2	547.5	154.7	14.6•	20.7	170.0	109.7
86	3.6	93.3		159.8	13.9•	22.0	175.1	113.4
88	4.3	96.5		164.9	13.2•	23.3	180.4	117.3
90	5.0	99.8		170.1	12.5•	24.4	185.8	121.2
92	5.7	103.1		175.4	11.8•	25.9	191.3	125.1
94	6.5	106.5		180.9	11.0•	27.3	196.9	129.2
96	7.3	110.0		186.5	10.2•	28.7	202.6	133.3
98	8.1	113.5		192.1	9.4•	30.2	208.4	137.6
100	8.9	117.2		197.9	8.6•	31.7	214.4	141.9
102	9.8	120.9		203.8	7.7•	33.2	220.4	146.3
104	10.6	124.6		209.9	6.8•	34.8	226.6	150.9
106	11.5	128.5		216.0	5.9•	36.4	232.9	155.4
108	12.5	132.4		222.3	4.9•	38.0	239.3	160.1
110	13.4	136.4		228.7	4.0•	39.7	245.8	164.9
112	14.4	140.5		235.2	3.0•	41.4	252.5	169.8
114	15.3	144.7		241.9	1.9•	43.2	259.2	144.8
116	16.4	148.9		248.7	0.8•	45.0	266.1	179.9
118	17.4	153.2		255.6	0.1	46.9	273.1	185.0
120	18.5	157.7		262.6	0.7	48.7	280.3	190.3
122	19.6	162.2		269.7	1.3	50.7	287.6	195.7
124	20.7	166.7		277.0	1.9	52.7	295.0	201.2
126	21.9	171.4		284.4	2.5	54.7	302.5	206.7
128	23.0	176.2		291.8	3.1	56.7	310.2	212.4

ABOVE CRITICAL TEMPERATURE

• inches mercury below one atmosphere.

Patented by carrier Corporation

SCALE :	IDENTIFICATION OF REFRIGERANT	RP/4.15.1/62d
MAT		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

°F	R-11	R-12	R-13	R-22	R113	R-114	R-502	R-500**
130	24.3	181.0		299.3	3.7	58.8	318.0	218.2
132	25.5	185.9		307.1	4.4	61.0	326.0	224.1
134	26.8	191.0		315.2	5.1	63.2	334.1	230.1
136	28.1	196.1		323.6	5.8	65.5	342.3	236.3
138	29.4	201.3		332.3	6.5	67.7	350.7	242.5
140	30.8	206.6		341.3	7.2	70.1	359.2	248.8
142	32.2	212.0		350.3	8.0	72.5	367.8	
144	33.7	217.5		359.4	8.8	74.9	376.7	
146	35.1	223.1		368.6	9.6	77.4	385.6	
148	36.6	228.8		377.9	10.4	80.0	394.7	
150	38.2	234.6		387.2	11.2	82.6	404.0	
152	39.7	240.5		396.6	12.1	85.2	413.4	
154	41.3	246.5		406.1	13.0	87.9	423.0	
156	43.0	252.6		415.6	13.9	90.7	432.7	
158	44.6	258.8		425.1	14.8	93.5	442.6	
160	46.3	265.1		434.6	15.7	96.4	452.6	

ABOVE CRITICAL TEMPERATURE

inches mercury below one atmosphere.

Patented by Carrier Corporation.

SCALE :	IDENTIFICATION OF REFRIGERANT	RP/4.15.1/62e
MAT :		AIR CONDITIONING

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

PAK - GERMAN TECHNICAL TRAINING PROGRAMME

Refg. & Air Cond.

TRADE TESTING BOARD

DIGNITY OF LABOUR