HP14 SERIES UNITS WITH TWO SPEED COMPRESSOR

I - INTRODUCTION

The HP14, introduced in the fall of 1982, incorporates the Lennox two speed compressor which shifts speeds to match load requirements. The HP14 can be applied to installations with cooling load matched to low speed capacity and heating load matched to high speed capacity. During the cooling season the heat transfer surfaces are oversized increasing capacity and efficiency. During the heating season the unit can switch to high speed for maximum capacity when required. For optimum energy efficiency in this application, do not connect thermostat lead identified as "M2"; the unit automatically switches to high speed heat pump operation at outdoor temperatures below 45°F.

TABLE 1

UNIT	Tonnage at Low Speed	Tonnage at High Speed
HP14-261/411	2	3
HP14-310/510	2-1/2	4
HP14-410/650	3	5

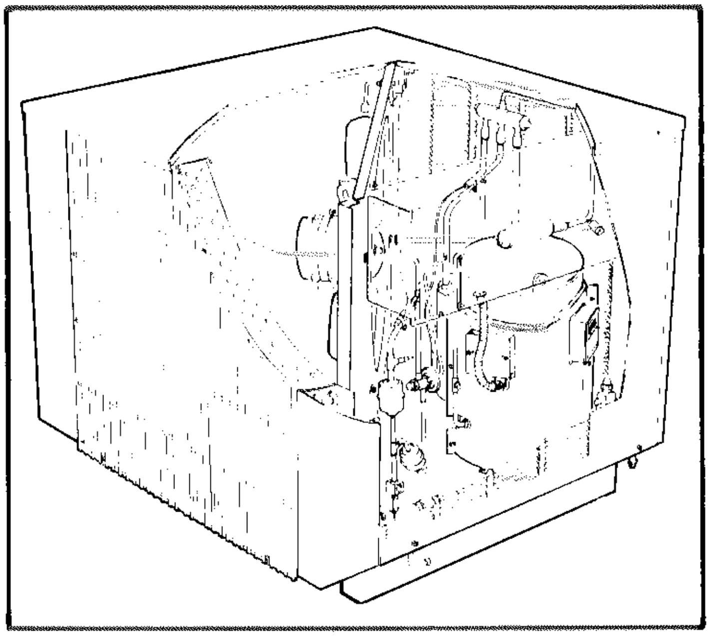


FIGURE 1

II - UNIT INFORMATION

A - Specifications

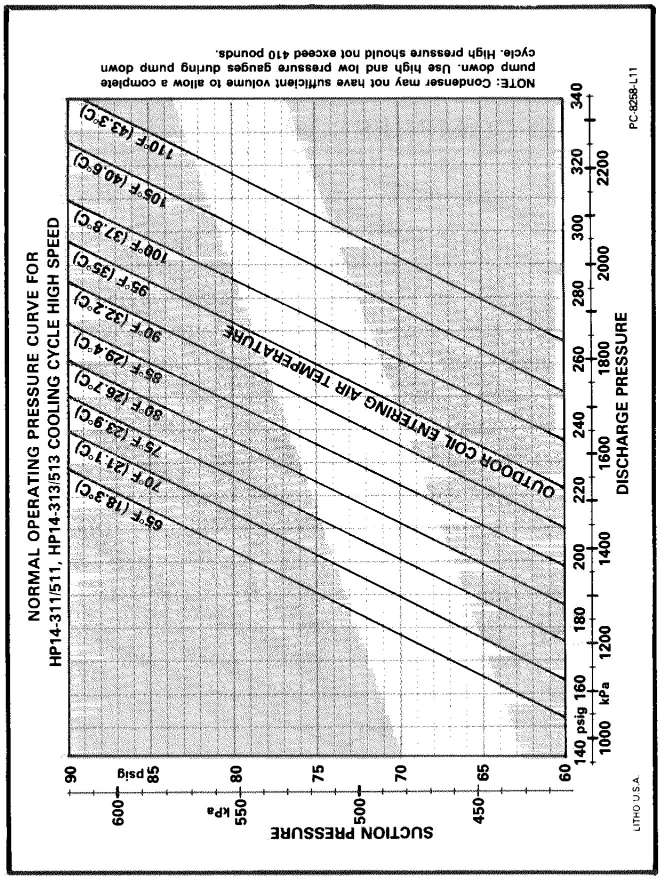
Model No.		HP14-261/411V	HP14-311/511V HP14-313/513V	HP14-411/651V HP14-413/653V
Outdoor Coil	Net face area (sq. ft.)	10.11	12.9	12.9
	Tube diameter (in.)	3/8	3/8	3/8
	No. of rows	3	3	4
	Fins per inch	15	15	15
Outdoor Fan	Diameter (in.)	22	24	24
	No. of blades	4	4	4
	Motor hp	1/4	1/3	1/3
	Cfm (factory setting)	3100	3600	3800
	Rpm (factory setting)	830	840	810
	Watts (factory setting)	285	370	425
Refrigerant-22 (charge furnished)		11 lbs. 5 oz.	14 lbs. 4 oz.	18 lbs. 2 oz.
Liquid line connection (sweat)		3/8	3/8	1/2
Vapor line connection (sweat)		3/4	7/8	1 1/8
Shipping weight (lbs.)		374	408	438
Number of packages in shipment		1	1	1

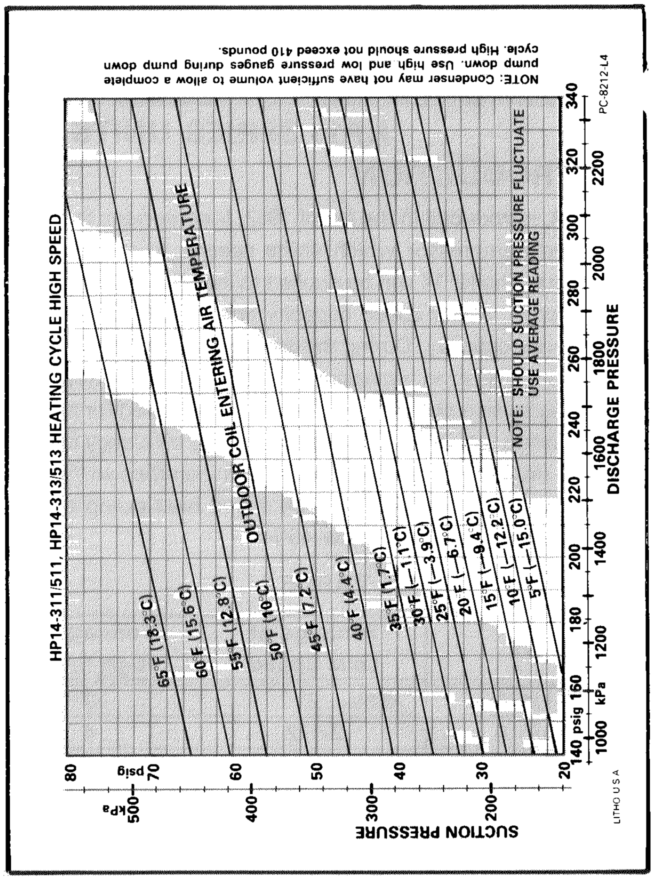
B - Electrical Data

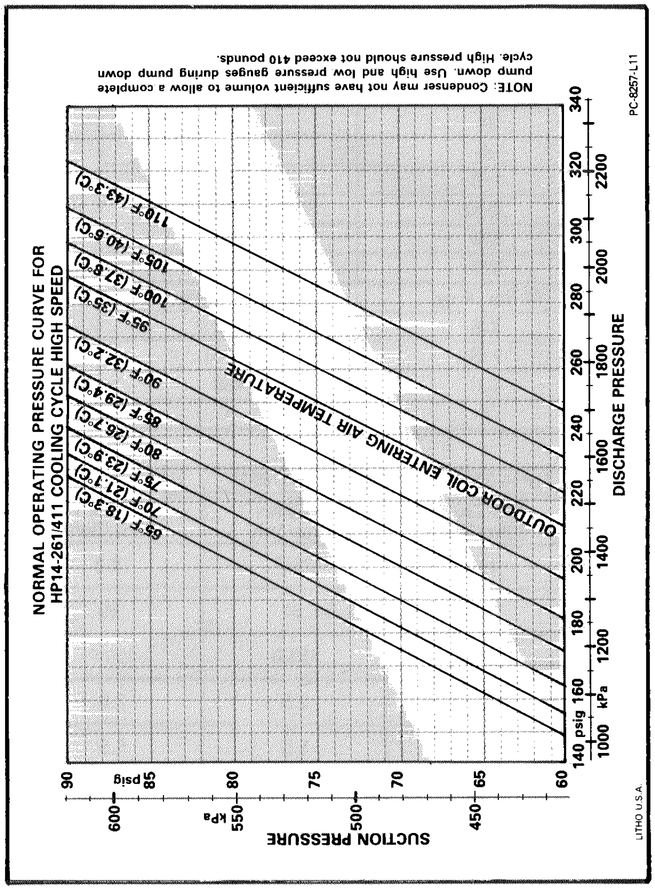
Model Number		HP14-261/411V	HP14-311/511V	HP14-313/513V	HP14-411/651V	HP14-413/653V
Line voltage data		208-230v 60hz/1ph	208-230v 60hz/1ph	208-230v 60hz/3ph	208-230v 60hz/1ph	208-230v 60hz/3ph
Compressor	Rated load amps	17.0	21.8	15.0	28.5	19.0
	Power factor	.97	.97	.90	.97	.90
	Locked rotor amps	90.0	108.0	100.0	153.0	100.0
Outdoor Coil Fan Motor	Full load amps	2.0	2.5	2.5	2.5	2.5
	Locked rotor amps	4.0	5.5	5.5	5.5	5.5
Recommended maximum fuse size (amps)		40	50	35	60	45
*Minimum circuit ampacity		23.3	29.8	21.3	38.1	26.3

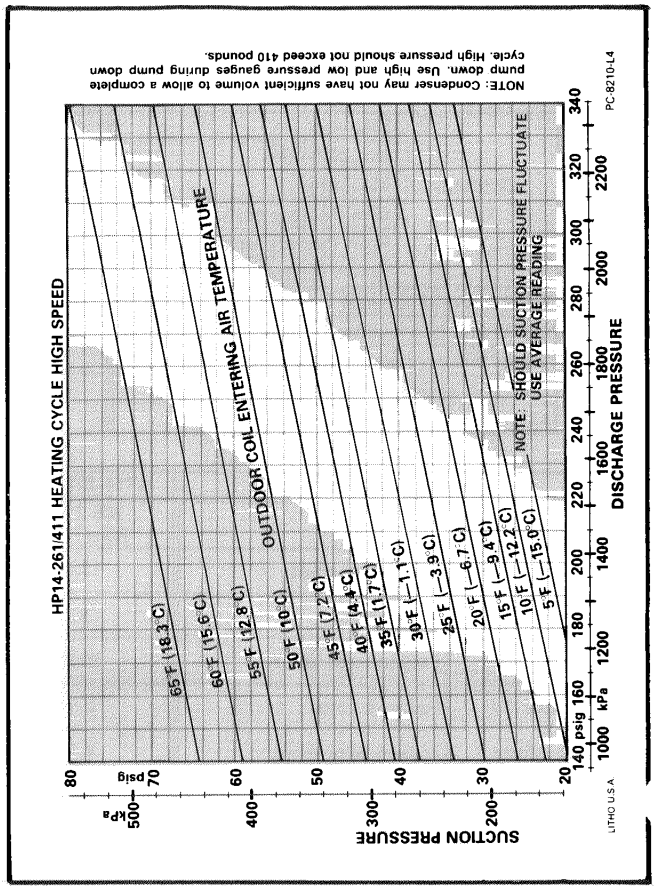
*Refer to National Electrical Code manual to determine wire, fuse and disconnect size requirements.
NOTE - Extremes of operating range are plus and minus 10% of line voltage.

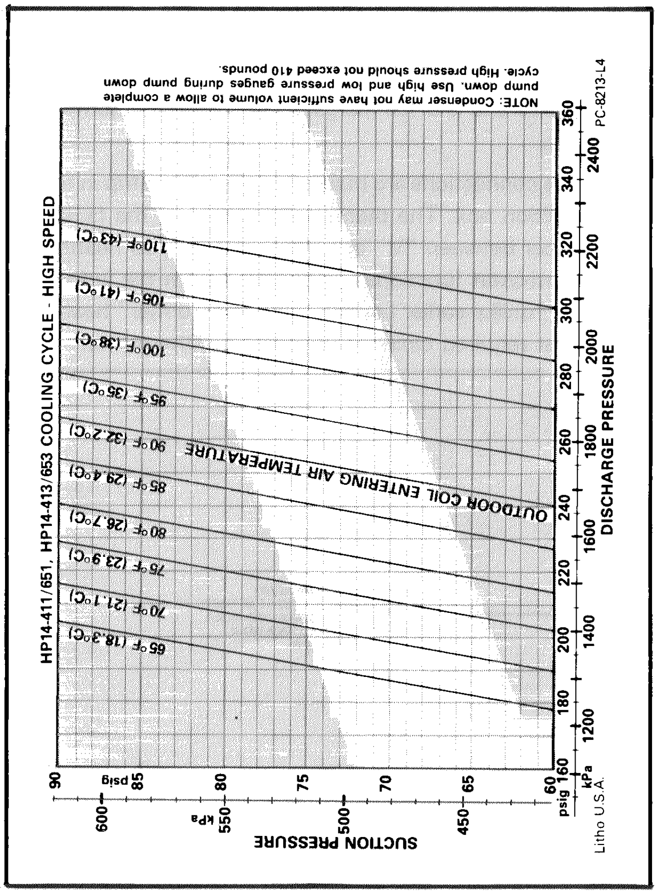
C - Pressure Curves

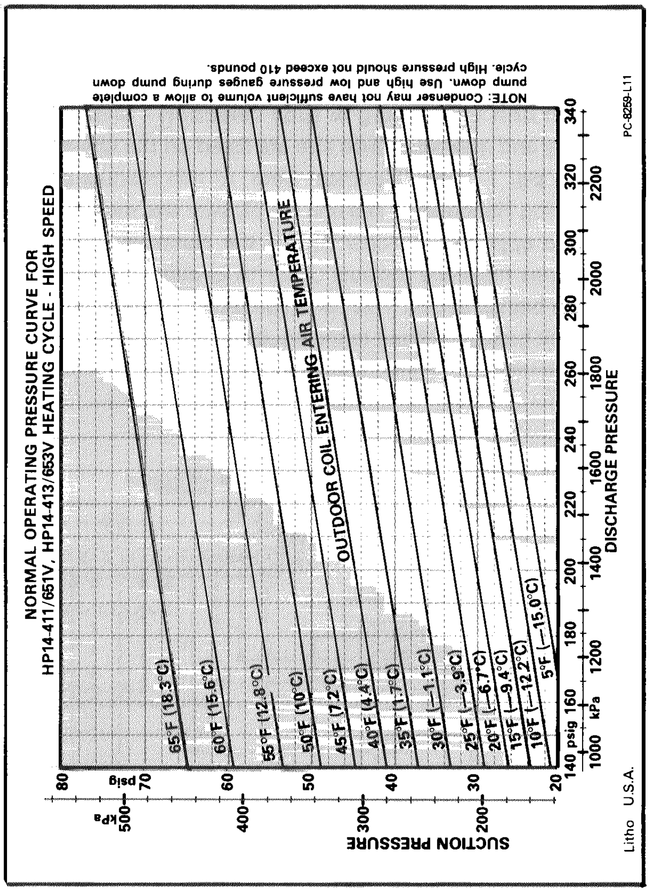




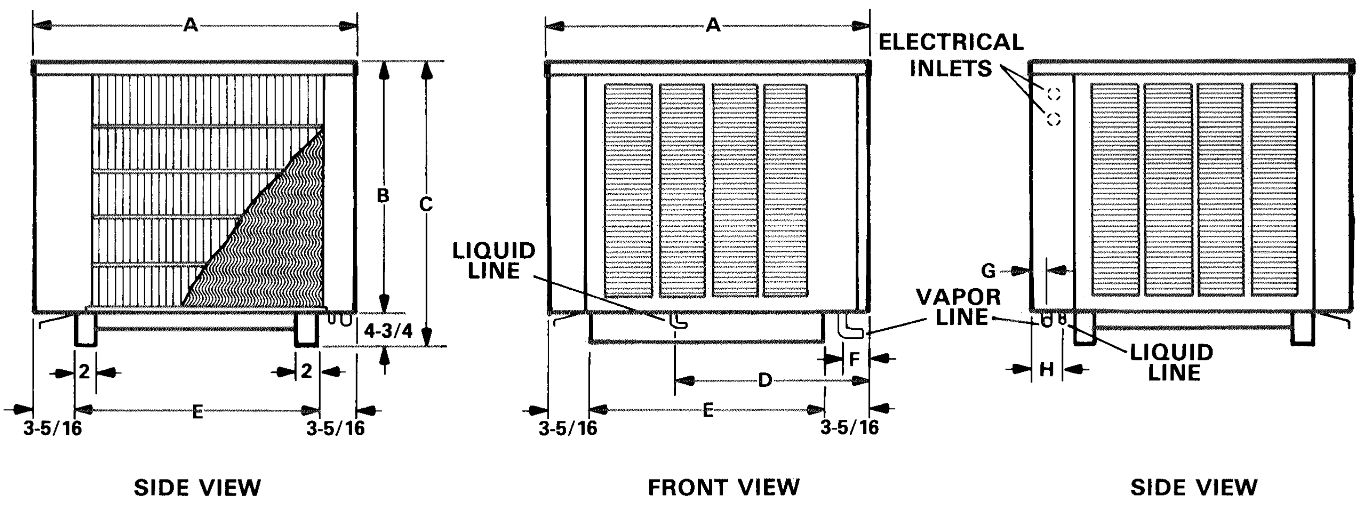








D - Unit Dimensions



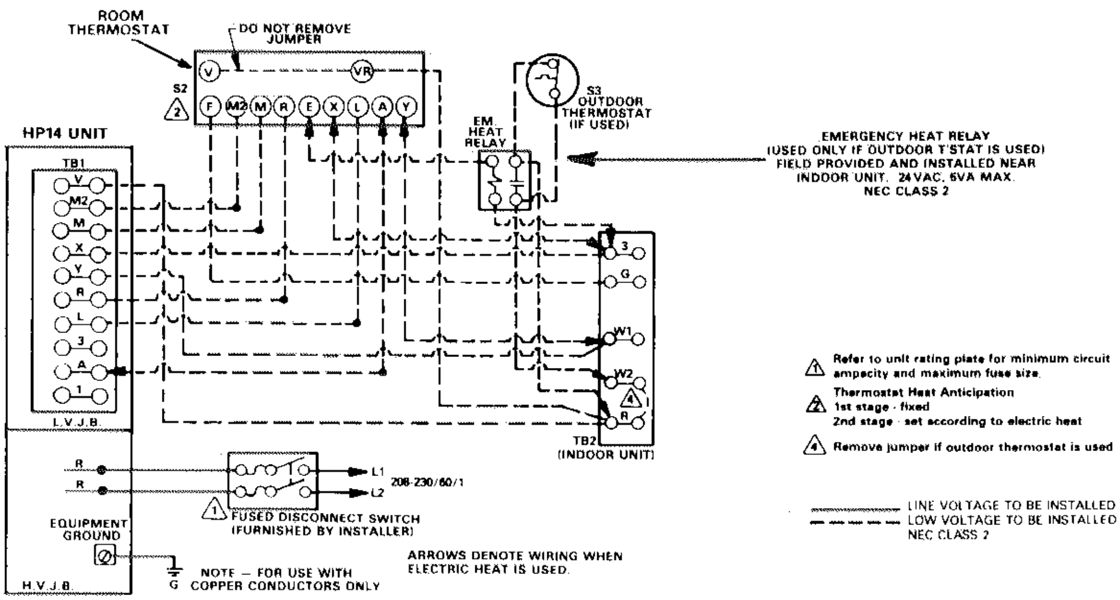
Model No.	A	B	C	D	E	F	G	H
HP14-261/411V	36-1/8	28-1/4	33	28-3/8	29-1/2	2-1/8	1	2-1/4
HP14-310/510V HP14-410/650V	40	30-1/4	35	29-1/8	33-3/8	1-5/8	1-1/2	1-3/4

E - Typical Field Wiring Diagram (Figure 2)

High voltage pigtail leads are provided in the make-up area of control box for connection to power supply. A ground lug is also provided.

Note on unit wire sizing & fuse selection - Minimum circuit ampacity and maximum fuse size are listed on the unit nameplate (also on pg. 1 under 'Electrical Data' of this manual and in the Engineering Handbook). The unit supply wire size must be obtained from the appropriate Table 310 of the National Electric Code. Sometimes nuisance tripouts occur to circuit breakers that may be in the branch circuit. This condition is usually encountered when the circuit breaker is sized to the equipment's minimum circuit ampacity (MCA) instead of the maximum fuse size. Lennox recommends using the maximum fuse size listed on the unit nameplate to assure maximum current-carrying capacity. A circuit breaker size from MCA is normally one or two sizes smaller than the maximum fuse size and is often marginal in carrying the normal starting current.

Low voltage connections are made at the terminal strip in the low voltage junction box. The thermostat must have the factory installed jumper between "V" and "VR" in place; all heating and cooling thermostat functions are operated from the indoor unit transformer; unlike earlier Lennox "two transformer" heat pump systems that required circuit isolation at the thermostat.



HP14 FIELD WIRING DIAGRAM

FIGURE 2

F - Optional Latent Load Discriminator (LB-34857BA)

The optional Latent Load Discriminator Kit controls the speed of the indoor blower motor to obtain maximum dehumidification during low speed compressor operation in the cooling mode. The kit is controlled by a remote mounted dehumidistat that switches blower to low speed at high humidity conditions for latent cooling. During low humidity conditions, blower operates at high speed for maximum sensible cooling. The indoor blower motor automatically runs at high speed whenever compressor operates at high speed. Figure 3 shows the field wiring for the Latent Load Discriminator.

The dehumidistat mounts in the conditioned space. It is adjustable. The recommended setting is 50%.

Cooling Cycle - With Dehumidistat contacts closed (high humidity), the Latent Load Relay is energized through the N.C. contacts of the Dehumidistat Relay. The blower runs at low (or minimum recommended speed).

A high speed demand will energize the Dehumidistat Relay to consequently de-energize the Latent Load Relay and run the blower motor at high speed.

With dehumidistat contacts open (low humidity), the Latent Load Relay is de-energized and the blower motor runs at high speed.

Heating Cycle - During heat pump operation the Latent Load Relay remains de-energized and the blower operates on high speed.

Defrost Cycle - Blower operates on high speed with Dehumidistat open and low speed if Dehumidistat is closed. Conditions creating need for defrost are at outdoor temperatures below 45°F at which the HP14 compressor runs on high speed only.

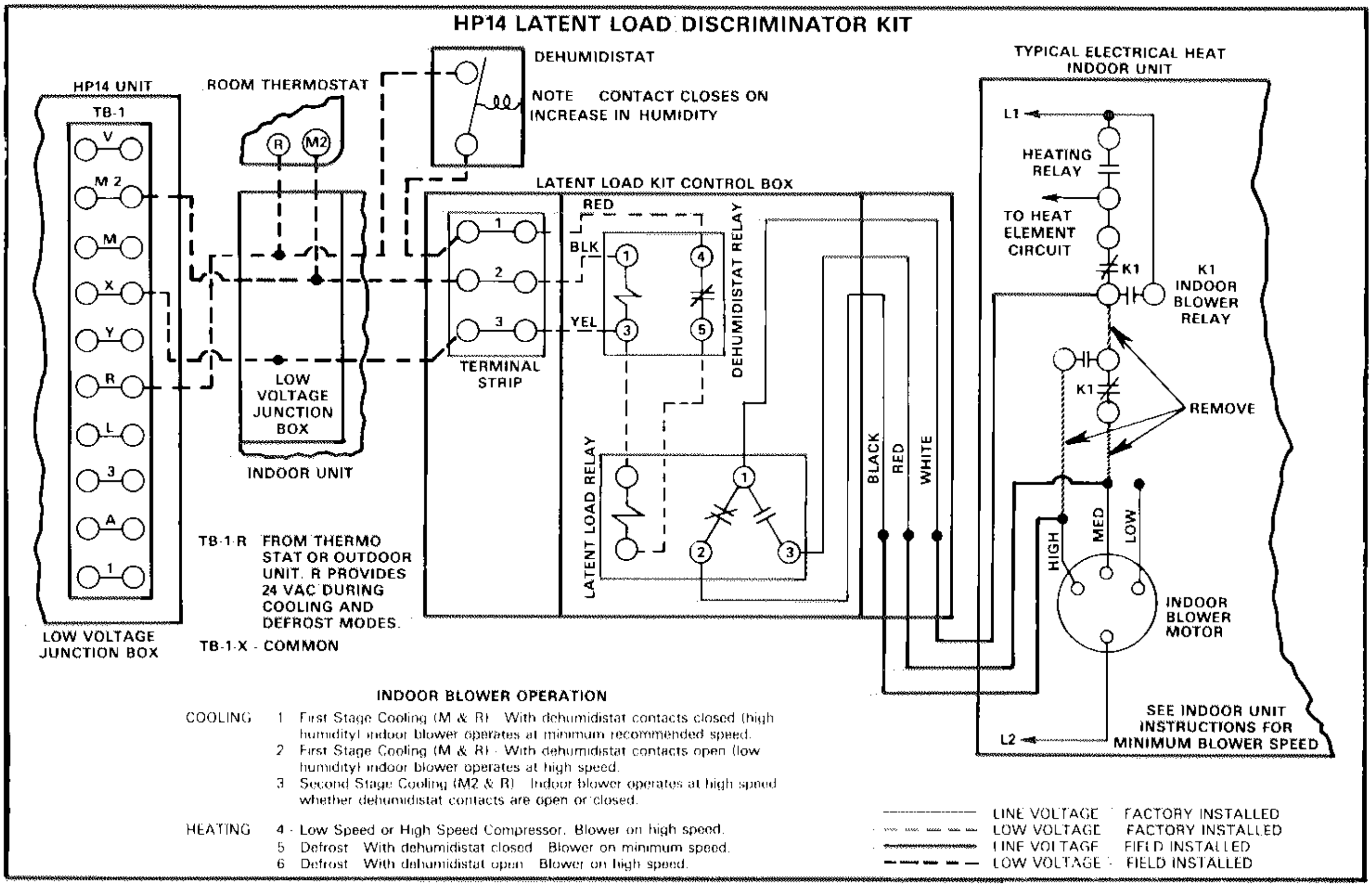


FIGURE 3

G - Approved Matchups

The HP14 is for use with single circuit coils with expansion-check valve systems only.

All major components (indoor blower/coils) must be matched according to Lennox recommendations for the compressor to be covered under warranty. Refer to the Engineering Handbook for approved system matchups. A misapplied system will cause erratic operation and can result in early compressor failure.

Refrigerant line sets are available for the HP14-261/411 and 310/510 units. Line sets for the HP14-410/650 are field fabricated. Lines are furnished with a flare fitting for connection to matching indoor coil and stubbed on opposite end for sweat connection to outdoor unit. Table 2 gives the line set model numbers and line sizes.

TABLE 2

Outdoor Unit Model No.	Line Set Model No.	Length of Lines (ft.)	Liquid Line (o.d. in.)	Vapor Line (o.d. in.)
HP14-261/411	L10-41-20	20	3/8	3/4
	L10-41-30	30		
	L10-41-40	40		
	L10-41-50	50		
HP14-310/510	L10-65-30	30	3/8	7/8
	L10-65-40	40		
	L10-65-50	50		
HP14-410/650	field fabricate	----	1/2	1-1/8

III - COMPONENTS

Figure 4 shows a cutaway of the unit with components identified.

A - Control Box (Figures 5 & 6)

1 - Protection Module

The module connects to sensors within the compressor motor windings through S1 and S2. The module is supplied with 24 VAC at terminals P1 & P2. The compressor control circuit is connected to K1 & K2. If the sensors detect excessive winding temperatures, the module breaks power to the compressor control circuit.

2 - Current Limiting Device (RT-2) (Single phase units only)

The current limiting device (RT-2) is a NTC thermistor (negative temperature coefficient - increase in temperature decreases resistance). Resistance at 77°F = 5 ohms ±10%

When the compressor is shut off the potential relay drops out immediately. RT absorbs the current surge created when the potential relay contacts close and discharge the run capacitor(s). This prevents the relay contacts from welding.

3 - Transformer (T1)

208/240V primary, 24V secondary, 45VA. This control Transformer is used to power the protection module, timed-off control and components not controlled directly from the room thermostat.

HP14 PARTS ARRANGEMENT

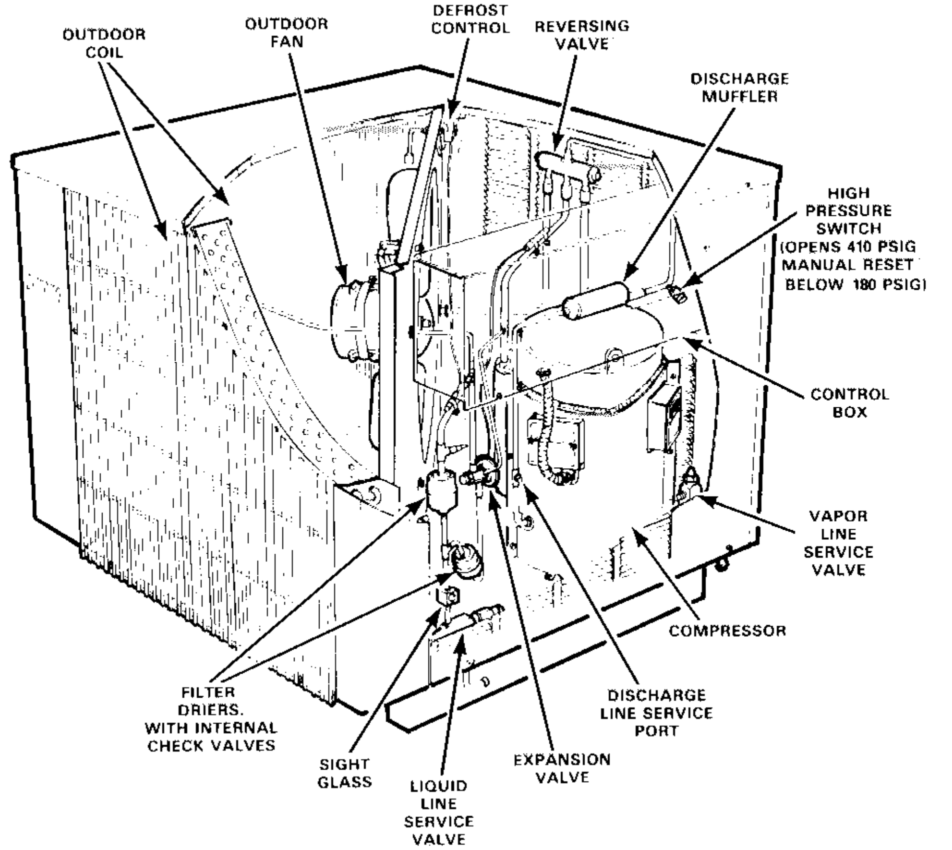
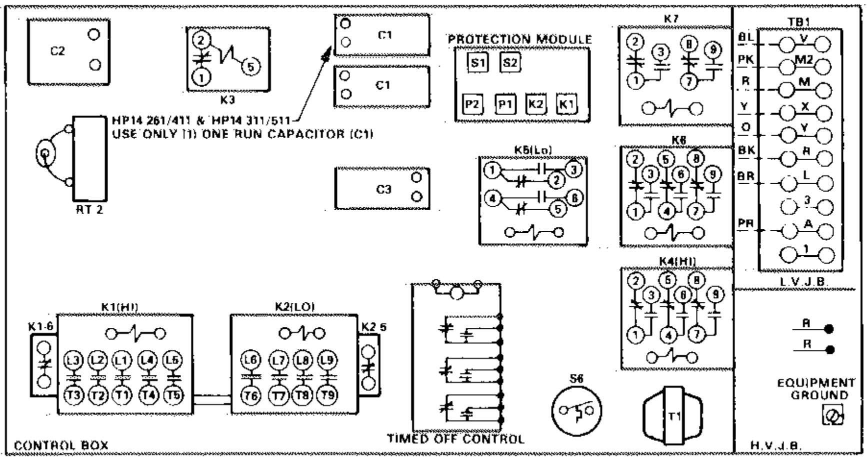


FIGURE 4

CONTROL BOX - SINGLE PHASE UNITS



KEY	DESCRIPTION COMPONENT
C1	CAPACITOR-RUN
C2	CAPACITOR-OUTDOOR FAN
C3	CAPACITOR-START
K1	CONTACTOR-COMPRESSOR (HI)
K2	CONTACTOR-COMPRESSOR (LO)
K3	RELAY - POTENTIAL
K4	RELAY-HIGH SPEED
K5	RELAY-LOW SPEED
K6	RELAY-DEFROST CONTROL
K7	RELAY-AMBIENT SPEED CONTROL
RT-2	THERMISTOR-CURRENT LIMITING DEVICE
S6	THERMOSTAT-SPEED CONTROL
T1	TRANSFORMER-(208/230V PRI./24V SEC.)
TB-1	BLOCK-TERMINAL
HVJB	HIGH VOLTAGE JUNCTION BOX
LVJB	LOW VOLTAGE JUNCTION BOX

FIGURE 5

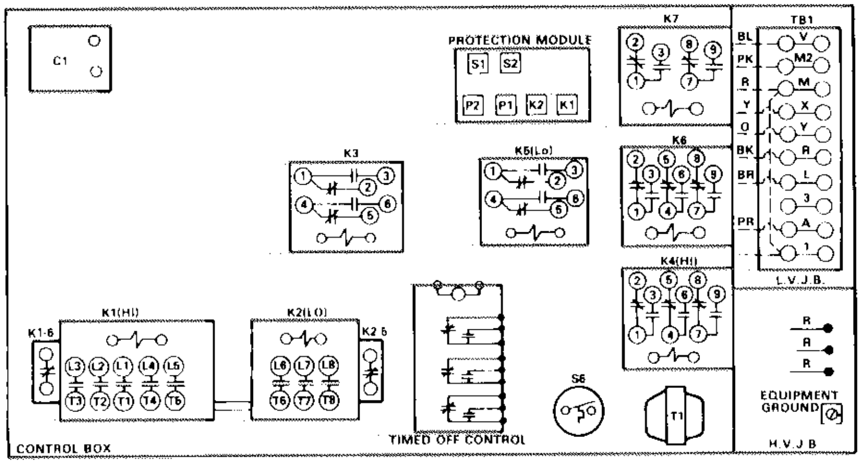
4 - Compressor Contactor - Combination K1 (High Speed) & K2 (Low Speed)

The HP14 uses a special combination contactor with two coils: K2 with 4 poles and K1 with 5 poles. Two normally closed (N.C.) auxiliary switches are integral to the contactor, one on the K2 side (K2-5) and one on the K1 side (K1-6). The K1 & K2 sections are mounted on a common base plate and mechancially interlocked to prevent simultaneous operation.

The auxiliary switches are used to electrically interlock the contactor coils also preventing simultaneous operation.

The electrical and mechanical interlocks protect against any condition that could attempt to energize both K1 & K2 together. This condition would result in a direct short across the line causing definite contactor and fuse or circuit breaker damage. In addition, power surges could be created possibly damaging the compressor motor windings. Never attempt to bypass the mechanical or electrical interlocks.

CONTROL BOX - THREE PHASE UNITS



KEY	DESCRIPTION COMPONENT
C1	CAPACITOR-OUTDOOR FAN
K1	CONTACTOR-COMPRESSOR (HI)
K2	CONTACTOR (LO)
K3	RELAY-FAN
K4	RELAY-HIGH SPEED
K5	RELAY-LOW SPEED
K6	RELAY-DEFROST CONTROL
K7	RELAY-AMBIENT SPEED CONTROL
S6	THERMOSTAT-SPEED CONTROL
T1	TRANSFORMER-(208/230V PRI./24V SEC.)
TB-1	BLOCK-TERMINAL
HVJB	HIGH VOLTAGE JUNCTION BOX
LVJB	LOW VOLTAGE JUNCTION BOX

FIGURE 6

5 - Fan Relay (K3) (3 Phase Units Only)

Used to control the fan motor and crankcase heater. When the compressor is off K3 energizes the crankcase heater; when the compressor is on K3 de-energizes the crankcase heater and energizes the fan motor. K3 is a D.P.D.T. (Double pole-double throw) relay and breaks both sides of the line feeding the fan motor or crankcase heater when either one is off.

6 - Potential Relay (K3) (Single Phase Units Only)

Used to disconnect the start capacitor from the circuit when the compressor reaches operating speed. The potential relay is matched specifically to each compressor size.

7 - Control Relays (K4 & K5)

Energized by the room thermostat, K5 low speed and K4 high speed relays provide switching in conjunction with the timed-off-control to operate the compressor on low or high speed.

8 - Defrost Relay (K6)

Energized by the defrost control pressure switch, the 3 P.D.T. (3 pole-double throw) defrost relay energizes the reversing valve and first stage electric heat and de-energizes the outdoor fan during a defrost cycle.

9 - Ambient Speed Control Relay (K7)

K7 is energized by S6 speed control thermostat when the outdoor temperature drops below 45°F to allow the compressor to operate only on high speed for the duration of the cycle.

10 - Speed Control Thermostat (S6)

S6 determines the compressor speed during the heating mode. At outdoor temperatures below 45°F the compressor is operated only on high speed to provide maximum heating capacity. Above 45°F the compressor is run on low speed. S6 closes at 45 ± 6°F and opens at 55 ± 6°F.

11 - Fan Motor Capacitor (C1 on 3 Phase units & C2 on Single Phase units)

The outdoor fan motor capacitor is rated at 7 mfd, 370 VAC for all three unit sizes.

12 - Compressor Run Capacitors (C1) & Start Capacitor (C3) (Used on Single Phase units only)

The start and run capacitors are matched specifically for each single phase compressor motor. During starting the start and run capacitors are in parallel for increased capacitance. Values are as follows:

261/411 Series:

Start - 145 - 175 mfd (330 VAC)
Run - 35 mfd (440 VAC)
Parallel Capacitance - 180 - 210 mfd (330 VAC)

311/511 Series:

Start - 145 - 175 mfd (330 VAC)
Run - 40 mfd (440 VAC)
Parallel Capacitance - 185 - 215 mfd (330 VAC)

411/651 Series:

Start - 145 - 175 mfd (330 VAC)
Run - 30 mfd (480 VAC)
Run - 30 mfd (480 VAC)
Parallel Capacitance - 205 - 235 mfd (330 VAC)

Note - The 411/651 uses 2 run capacitors in parallel totaling 60 mfd

13 - Timed-Off-Control

The compressor timed-off-control is new to Lennox two speed heat pumps. Previous two speed heat pumps used a timed-on-control.

The timed-off-control prevents compressor short cycling and also allows adequate time for suction and head pressures to equalize. It also prevents speed changes from occuring before the compressor can come to a complete stop.

Figure 7 shows two views of the timed-off-control. It is a motor driven cam switch timer. The motor uses 24 VAC at 3 watts, powered form the HP14 T1 transformer. The motor drives 3 cams in a clockwise rotation (as viewed from the cam end) to operate 3 snap action S.P.D.T. switches.

With the timer mounted in the control box Cam 1 is the top cam, Cam 2 is center and Cam 3 is the bottom cam. When the unit is on high speed, the top switch arm can be seen engaging the notch in the top cam (1). On low speed, the center switch arm can be seen engaging the notch in the center cam (2). When the unit is cycled off, the bottom switch arm is engaged in the notch of the bottom cam (3).

Figure 8 is the switch timing sequence chart for the timed-off-control. Control functions of the timer are explained in the Sequence of Operation section in this manual.

The timer has a manual reset screw on the cam end. The screw is accessable from the bottom of the control box in the compressor compartment. Rotating the screw clockwise (as viewed from the cam end) resets the control. Remember that the compressor MUST come to a COMPLETE STOP between speed changes. If you reset the timer, be sure to stop each time a cam switch disengages allowing compressor to come to a complete stop before advancing to the next position. Failure to do this can damage the compressor.

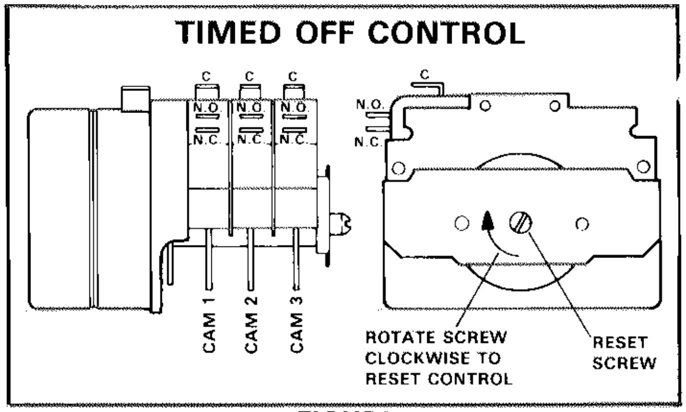


FIGURE 7

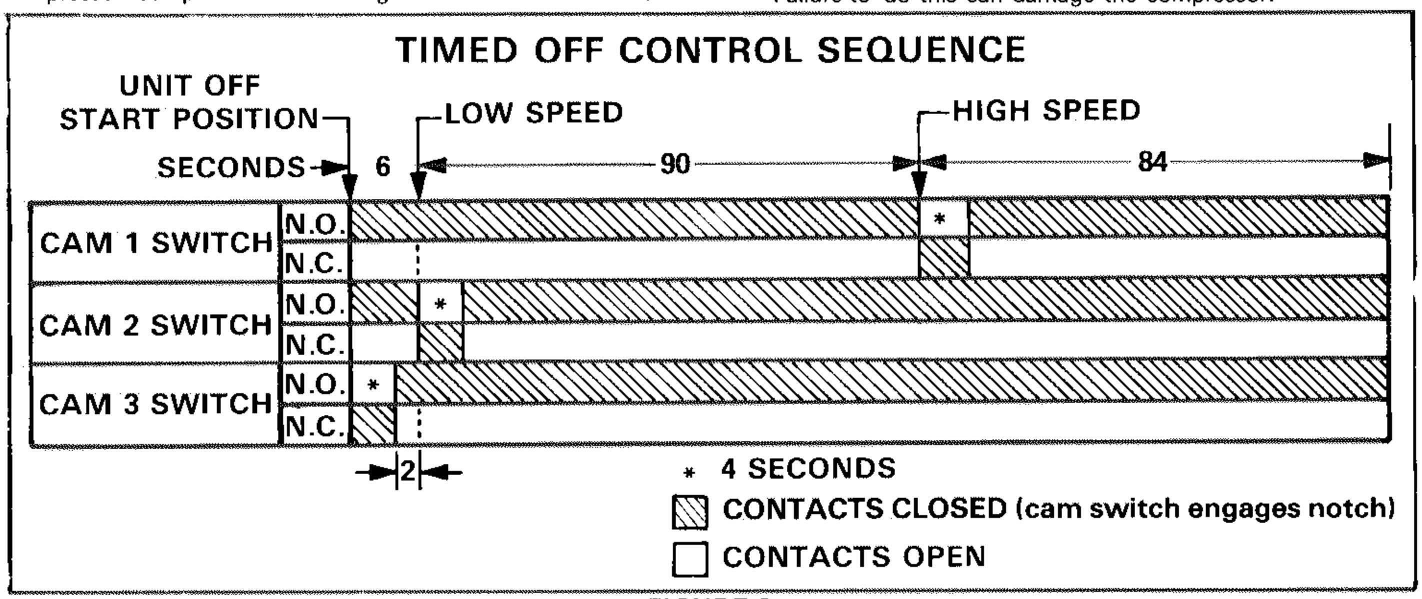


FIGURE 8

B - Compressor Compartment

1 - Crankcase Thermostat (S4)

The crankcase thermostat is located under the compressor wrapper on the lower half of the compressor. It senses the temperature of the compressor crankcase. It opens at 190 ± 5°F de-energizing the compressor controls to stop the compressor protecting it from excessive temperatures. It automatically resets at 110 ± 7°F.

2 - High Pressure Switch (S5)

S5 is mounted in the discharge line downstream of the discharge muffler. It opens at 410 psig de-energizing the compressor controls to stop the compressor protecting it from excessive pressure. It is manual reset and will manual reset only after the system pressure drops below 180 psig.

3 - Service Light Thermostat (S7)

S7 is mounted on the discharge line upstream of the discharge muffler. It is used in conjunction with the room thermostat. It monitors discharge temperature and closes on a temperature fall (closes at 110 ± 5°F, opens at 130 ± 5°F). If the room thermostat is in a heating demand mode with the second stage bulb (H2) made and S7 closes, a red "service light" comes on at the room thermostat; this indicates the compressor is not operating with demand. The service light may briefly come on during compressor startup until S7 opens, this is normal.

4 - Ambient Thermistor (RT-1)

RT-1 is mounted on the fan orifice panel behind the left corner of the control box. RT-1 is used in conjunction with a resistor in the room thermostat to provide constant heat anticipation from lower to higher cycle per hour rates as the outdoor temperature falls. RT-1 is a NTC thermistor (negative temperature coefficient - increase in temperature equals decrease in resistance). Resistance at 77°F = 260 ohms ± 10%; at 100°F = 150 ohms, at 32°F = 861 ohms.

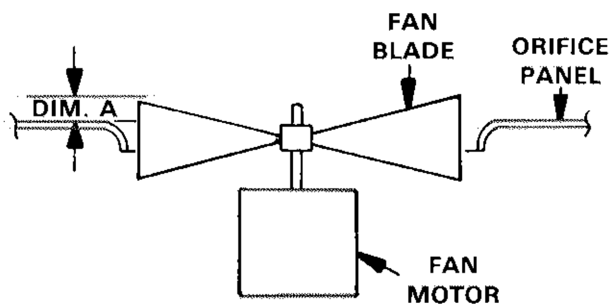
C - Outdoor Coil Compartment

The high pressure monitor portion of the defrost control is located between the outdoor coil and outdoor fan. The outdoor coils are circuited with refrigerant flow from bottom to top during a defrost cycle. This provides more positive defrost and better condensate run-off.

The outdoor coils are blow-through with horizontal discharge. The fan motor is in the outdoor coil section. The fan pulls air through the compressor compartment and blows through the outdoor coils.

The fan motor is prelubricated for an extended period of operation. Check motor for lubrication requirements. For fan service access remove top of unit and then remove the bolts securing fan assembly. Figure 9 illustrates the condenser fan and motor assembly for blade position in orifice panel.

OUTDOOR FAN & MOTOR ASSEMBLY



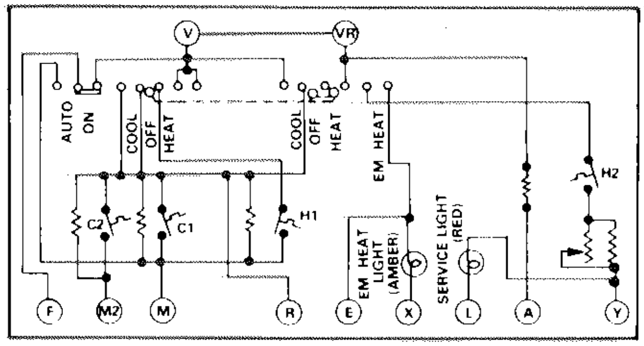
UNIT	DIM. A
HP14-261/411	2-3/4" ± 1/8"
HP14-310/510	2-1/4 ± 1/8"
HP14-410/650	2-7/8 ± 1/8"

FIGURE 9

D - Room Thermostat (Figure 10)

The HP14 uses a two stage cool-two stage heat thermostat with ambient compensation and emergency heat subbase. The ambient compensation feature works with the heat anticipator to improve anticipation characteristics over the operating range of the system.

Thermostat is equipped with two indicator lights. The red service light warns the homeowner that the compressor is not operating properly and the heat pump is in the need of service. As the HP14 is cycled "on" by a heating demand, this light may come on briefly until the compressor reaches its normal operating conditions. The homeowner should be made aware that this short intermittent lighting is normal. The amber light comes on whenever the thermostat is placed into emergency heat. It reminds the homeowner that he is not getting the benefit of his heat pump and that he is using only expensive electric heat.



C1 FIRST STAGE COOLING BULB
C2 SECOND STAGE COOLING BULB
H1 - FIRST STAGE HEATING BULB
H2 - SECOND STAGE HEATING BULB
VR INDOOR TRANSFORMER
V INDOOR TRANSFORMER
F - INDOOR BLOWER RELAY
M LOW SPEED COMPRESSOR
M2 - HI SPEED COMPRESSOR
R REVERSING VALVE
E - EMERGENCY HEAT RELAY
X "COM" EMERGENCY HEAT LIGHT
L - SERVICE LIGHT THERMOSTAT
A - AMBIENT COMPENSATING THERMISTOR
Y - AUXILIARY HEAT

HP14 ROOM THERMOSTAT

FIGURE 10

E - Two Speed Compressor (Figure 11)

The two speed compressor has two electrical makeup boxes for connection to the motor winding terminals. One makeup box also contains the two terminals S1 & S2 for connection of the internal winding sensors to the protection module.

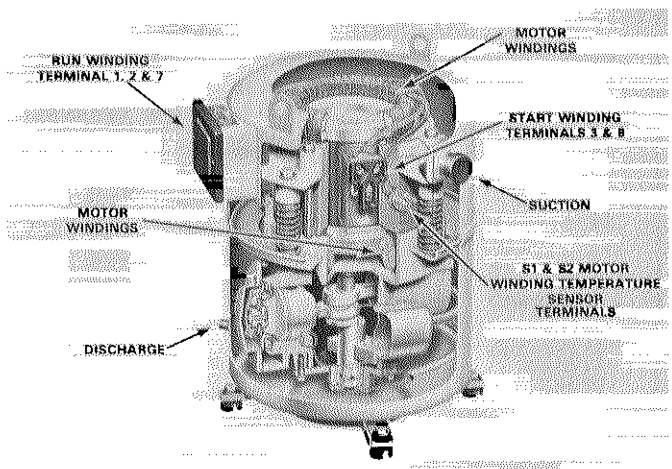
Each compressor has an external crankcase heater. The heater output is 50 watts at 240V with a resistance of 1150 ohms ± 10%.

Compressor Oil - Oils for use in the compressors:

Texaco # WF68

Suniso #4-GSD (Sun Oil Co.)

Amount: 3, 4 & 5 ton - 75 ounces.



TWO SPEED COMPRESSOR (SINGLE PHASE ILLUSTRATION)

FIGURE 11

1 - **Single Phase Two Speed Compressor (Figure 12)**

The single phase compressor has a two speed, capacitor start-capacitor run motor. For starting, the start and run capacitors are in parallel to provide the proper starting torque. The start capacitor is disconnected by the potential relay when the motor comes up to speed. The run capacitor remains connected to the start winding and the motor runs as a 2 phase induction motor with improved power factor and torque characteristics.

Low speed compressor motor operation is provided by powering the run windings (internally connected in **series**) from terminals 1 (common) & 7. The windings form a four pole motor operating at 1800 RPM. The four low speed start windings are in series and connected to terminals 1 (common) & 8. They are used with the start & run capacitors and potential relay to start and bring the motor up to speed.

High speed compressor motor operation is provided when the run windings are connected in **parallel**; terminals 1 (common) & 7 to L1 and terminal 2 to L2. The windings form a 2 pole motor operating at 3600 RPM. The two high speed start windings are in series and connected to terminals 1 (common) & 3.

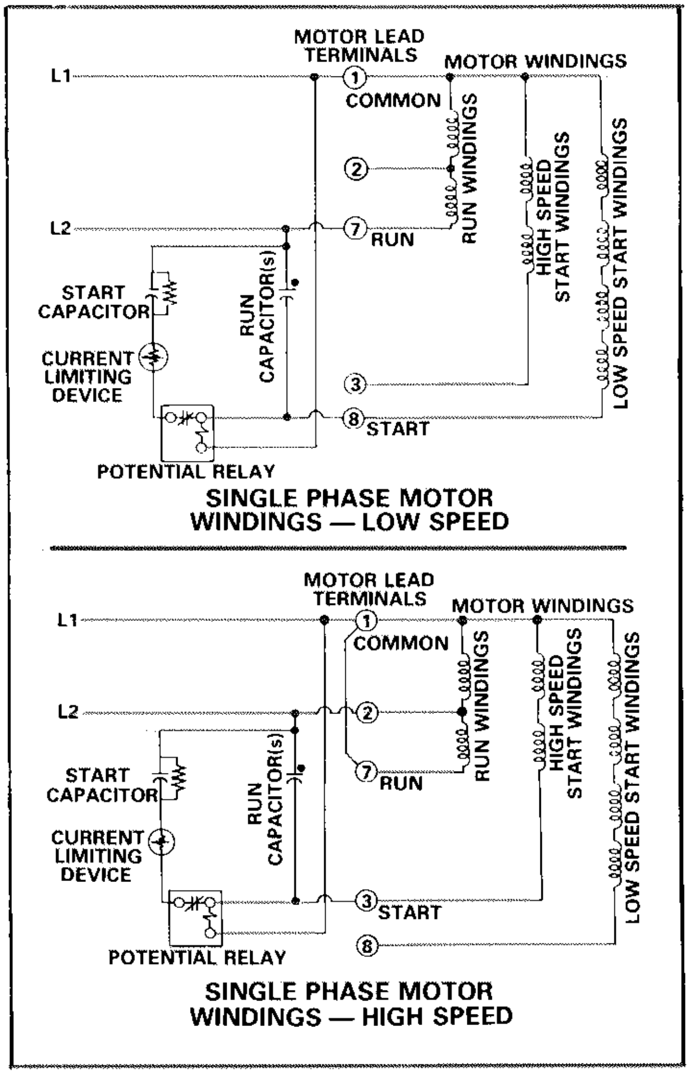


FIGURE 12

2 - **Three Phase Two Speed Compressor (Figure 13)**

This compressor has a two speed, 3 phase induction motor.

Low speed operation is provided when the motor windings are connected in a **series "Y"** circuit. This forms a four pole motor operating at 1800 RPM.

High speed operation is provided when the motor windings are connected in a **parallel "Y"** circuit. This forms a two pole motor operating at 3600 RPM.

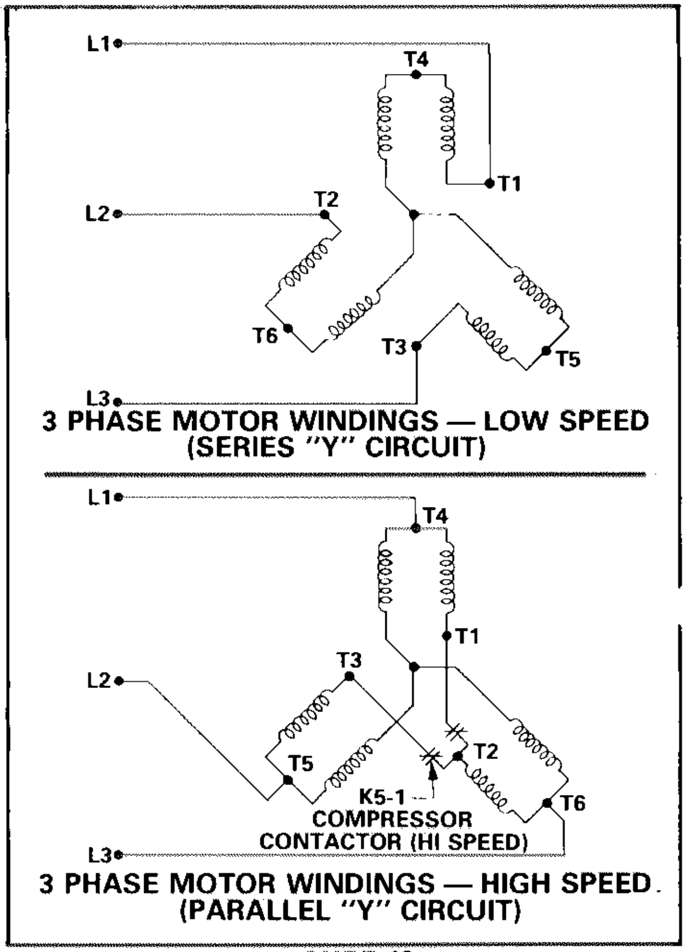


FIGURE 13

F - Defrost Control

Robertshaw defrost control is pressure initiated and temperature terminated. The high pressure monitor portion of the defrost control is located in the outdoor fan section between the coil and fan. Low pressure is monitored from the compressor compartment. The sensing bulb is clamped to the liquid line.

The control will initiate the defrost cycle at a pressure difference across the outdoor coil at approximately 0.27 ± 0.03" WC. The defrost cycle will terminate when the temperature sensor clamped to the liquid line on the outdoor coil reaches 65 ±5°F.

IV - REFRIGERANT SYSTEM

All units in the HP14 series have stubbed liquid and vapor lines for sweat connections to line set feeding indoor coil. Each unit also has liquid and vapor line service valves inside the unit cabinet. Standard heat pump refrigeration circuitry is used with inverse outdoor coil circuiting, the inverse circuiting allows for refrigerant flow from bottom to top of outdoor coils in the defrost mode providing positive defrost and better condensate run-off.

Separate discharge and suction service ports are provided at the compressor for connection of gauge manifold during charging procedures. Figures 14 and 15 show the gauge manifold connections to the service ports and refrigerant flow in the cooling and heating cycles.

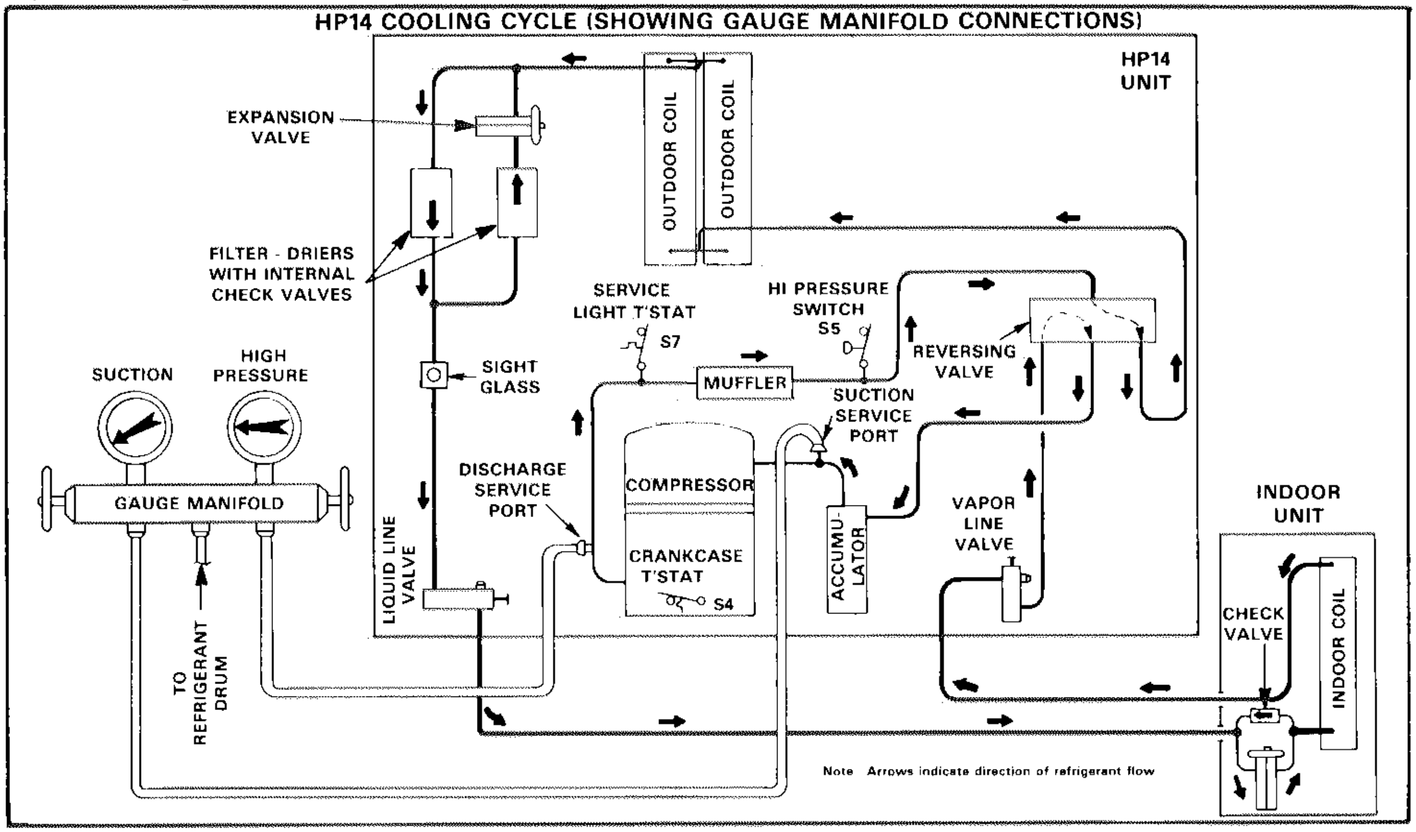


FIGURE 14

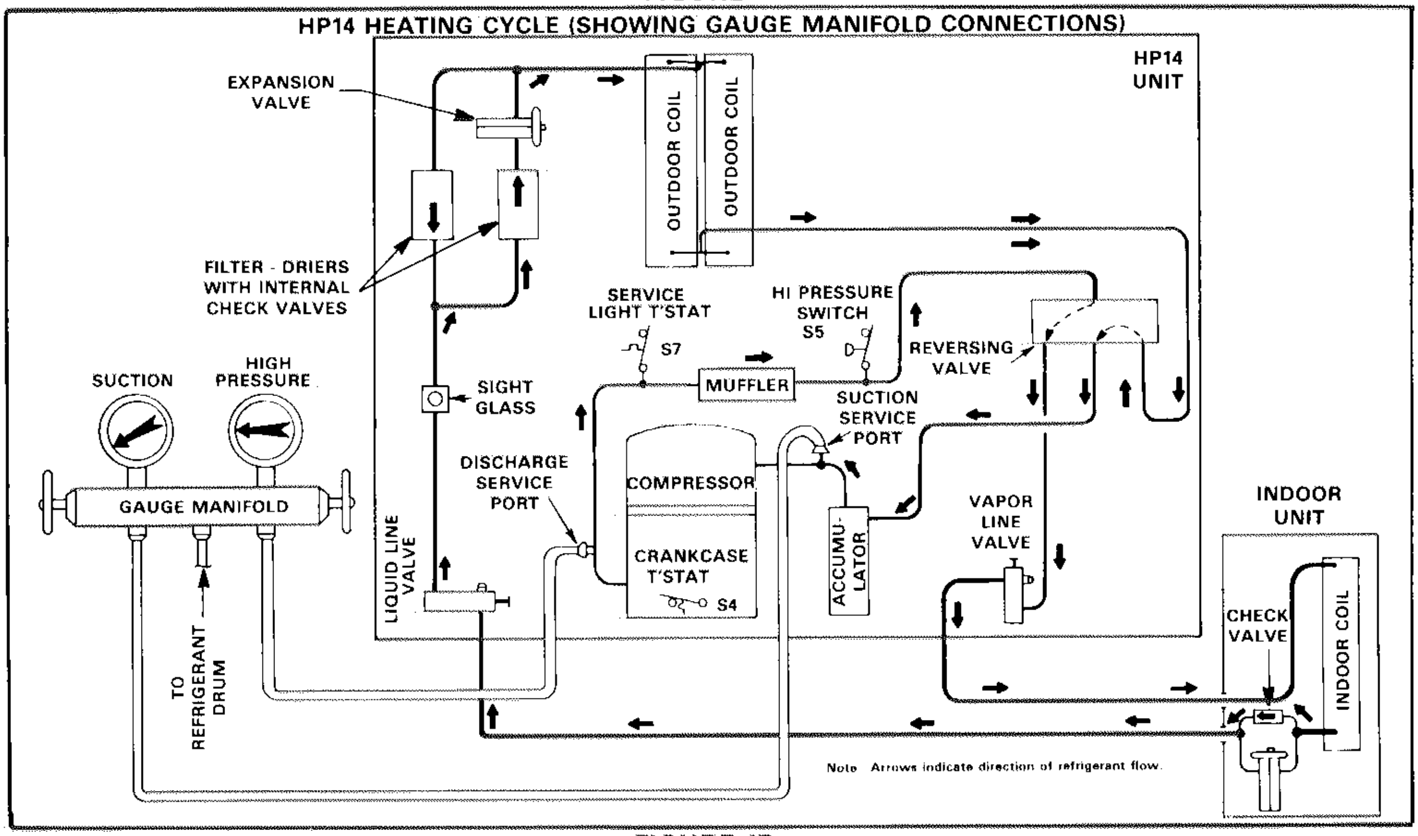


FIGURE 15

It is very critical not to overcharge a heat pump system. It is recommended to charge the system in the cooling cycle if weather conditions permit. If the unit must be charged in the heating cycle, the charge should be rechecked in the cooling cycle as soon as outdoor conditions permit. The HP14 must be run on HIGH speed when checking charge with the normal operating pressure curve.

Each unit is furnished with a normal operating pressure curve. The curve uses suction pressure, discharge pressure and outdoor temperature comparison. To use the chart, first check suction pressure, then move over to the outdoor temperature and finally down to the discharge pressure. If the discharge pressure is within five pounds of this reading, the unit is properly charged, providing the three conditions meet in the unshaded area of the chart. If they meet in the shaded area, there is something wrong with the system and further checks are needed.

V - DEFROST CYCLE

Figure 16 shows basic operation. The defrost control is a pressure initiated/temperature terminated-single pole double throw switch. Terminals 2 and 1 are normally open and as ice builds up restricting the air flow, the pressure difference between point "A" and point "B" increases and the switch is activated closing contacts 2 to 1. Contacts 2 to 1 then energize the defrost relay to turn off the condenser fan, energize the reversing valve and auxillary heat at the indoor unit. The defrost control monitors the liquid line temperature through a sensing bulb clamped to the liquid line; when liquid temperature reaches approximately 65°F the defrost cycle is terminated by the control opening contacts 2 to 1 and the unit reverts to the heating mode.

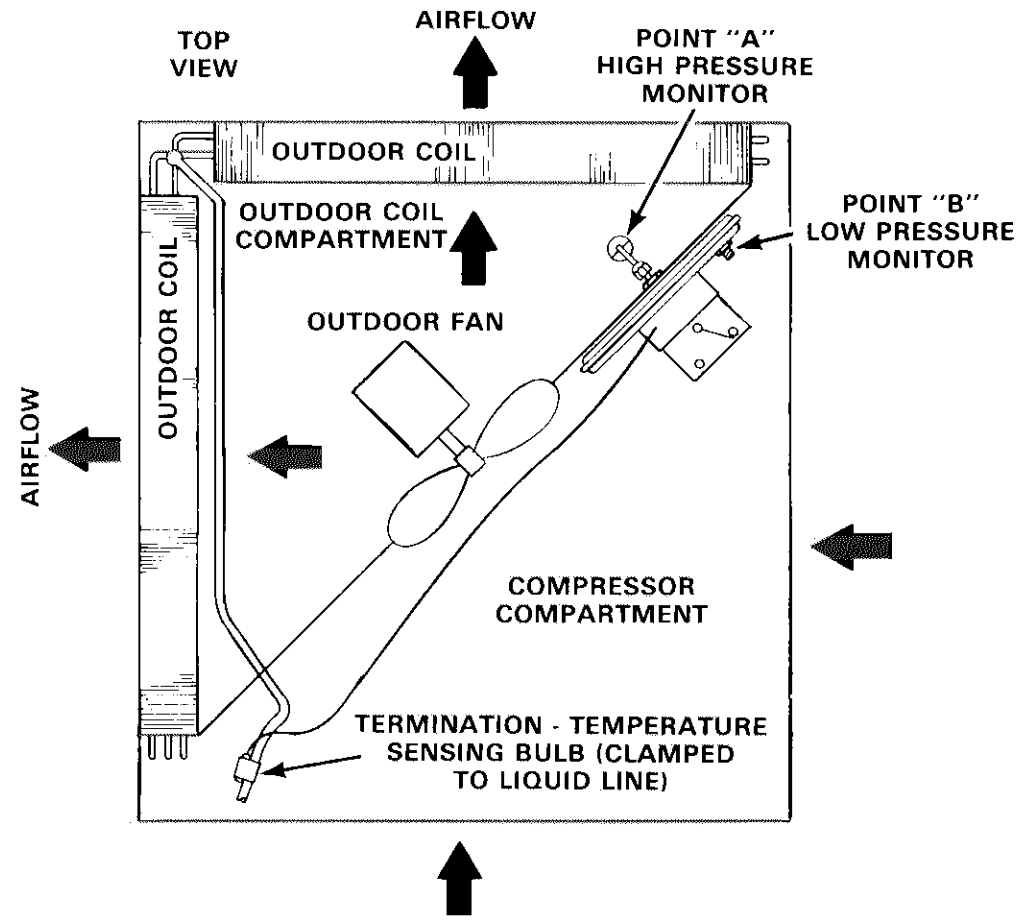


FIGURE 16

VI - OPERATING SEQUENCE TIMING

The HP14 operating sequence timing following a thermostat cooling or heating demand is determined by the Timed-Off-Control. It is the heart of the unit control system protecting the two speed compressor from short cycling and instantaneous speed changes.

Figure 17 illustrates the timing sequence following a cooling or heating demand.

A - Cooling Cycle Timing (Figure 17)

Upon a demand there is always an approximate 6 second delay before stage 1 (low speed) is energized. With an increase in demand for stage 2 (high speed), low speed is de-energized and following a 90 second delay high speed is energized. As the stage 2 demand is satisfied, high speed is de-energized and following a 90 second delay low speed is energized. When the demand is completely satisfied low speed is de-energized and the timed-off-control prevents the unit from re-starting during the timed-off cycle of 174 seconds (2.9 minutes).

If the unit is running on high speed and the demand for both high and low speed becomes satisfied (by turning the thermostat to 'OFF' or raising the setpoint) the compressor is stopped and the timed-off-control prevents the unit from restarting during a timed-off cycle of 84 seconds (1.4 minutes).

With initial demand for stage 2 (high speed), the unit always cycles through low speed before energizing high speed. Initially there is the 6 second delay, then low speed is energized for approximately 4 seconds followed by 90 seconds off before high speed is energized.

B - Heating Cycle Timing (Figure 17)

Upon a demand there is always an approximate 6 second delay before the compressor is energized. The compressor speed is determined by outdoor ambient. Above 45°F low speed is energized, below 45°F high speed is energized. When the demand is satisfied the compressor is de-energized and the timed-off-control prevents the unit from re-starting during the timed-off cycle of 174 seconds (2.9 minutes).

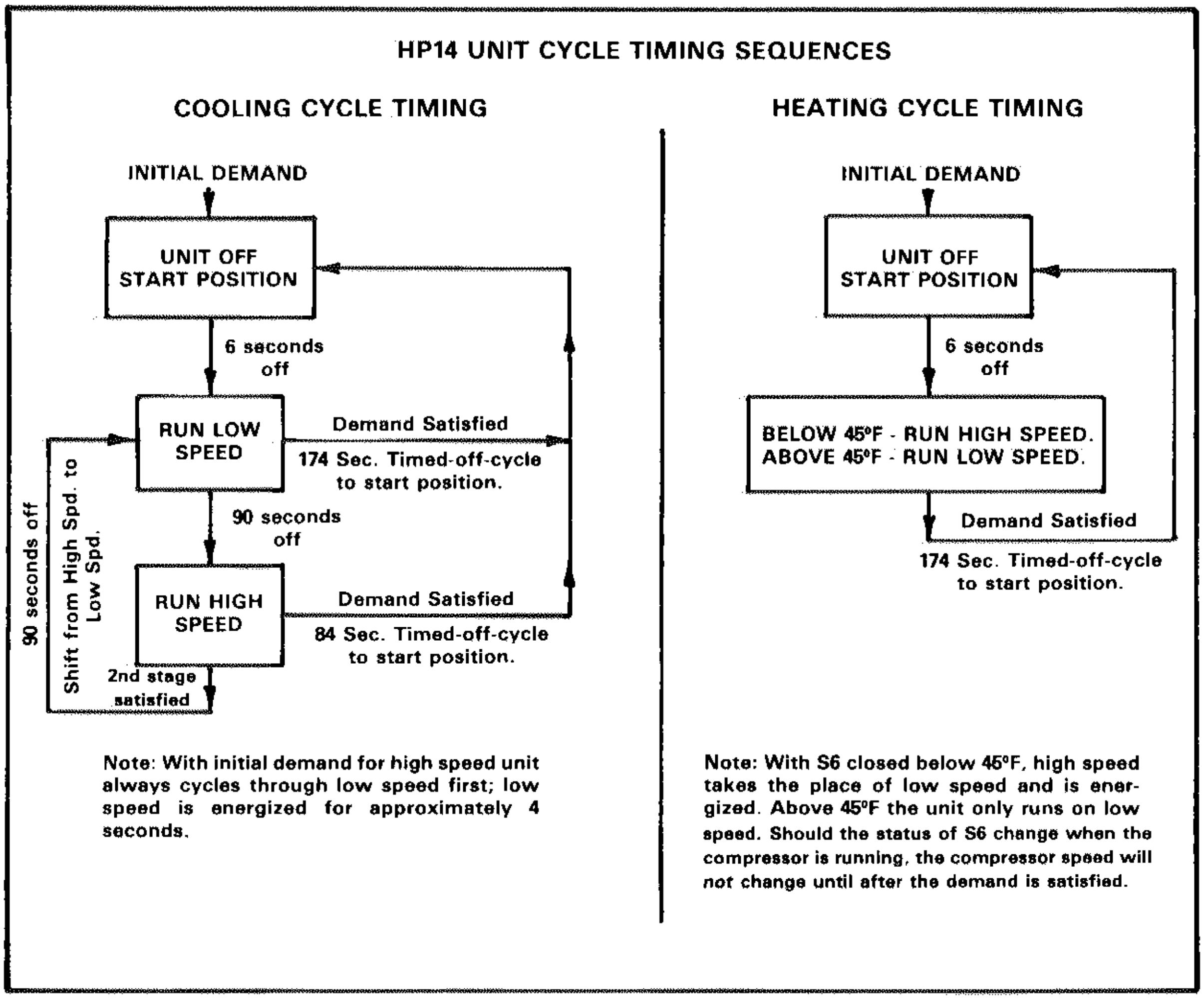


FIGURE 17

VII - SCHEMATIC WIRING DIAGRAM OPERATING SEQUENCE

Each of the following steps within this section are labeled in the corresponding diagram.

A - Thermostat Control Circuit Operation

Cooling Mode (Figure 18)

1 - The thermostat is powered at terminals V and VR with 24VAC from the indoor unit transformer.

2 - The Reversing Valve is energized anytime the thermostat is switched to the COOL mode from thermostat terminal R.

3 - On a stage 1 cooling demand C1 cooling bulb closes energizing K5 Low Speed Control Relay (and K3 Outdoor Fan Relay on 3 phase units only) through thermostat terminal M.

4 - On an increased demand for cooling, stage 2 cooling bulb C2 closes energizing K4 High Speed Control Relay through thermostat terminal M2.

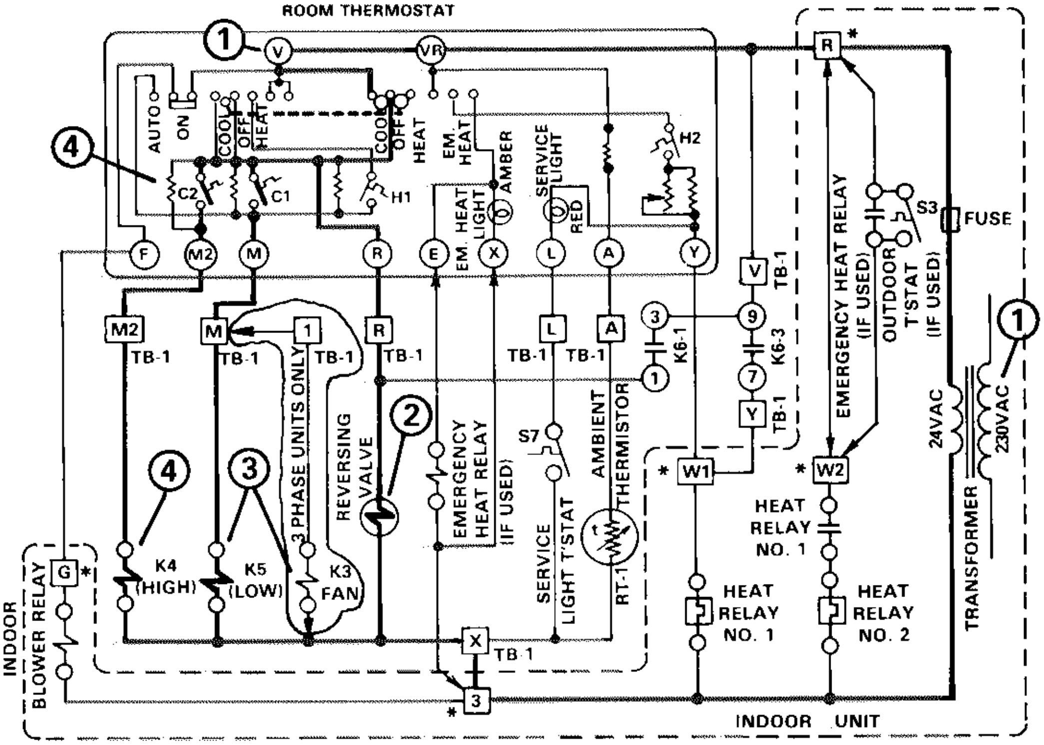
Heating Mode (Figure 19)

1 - On an initial heating demand H1 heating bulb closes energizing K5 Low Speed Control Relay (and K3 Outdoor Fan Relay on 3 phase units only) through thermostat terminal M.

2 - On an increased heating demand stage 2 heating bulb H2 closes energizing Heat Relay No. 1 (thermal time delay relay) in the indoor unit through thermostat terminal Y. This energizes the first stage of auxiliary electric heat.

3 - Heat Relay No. 1 auxiliary N.O. contacts close to energize Heat Relay No. 2 (thermal time delay relay) for stage 2 auxiliary heat.

4 - If an Outdoor Thermostat S3 is used, Heat Relay No. 2 can be energized only at outdoor temperatures below S3 setting through S3 and Heat Relay No. 1 N.O. contacts.



* INDOOR UNIT LOW VOLTAGE TERMINAL STRIP

THERMOSTAT CONTROL CIRCUIT OPERATION

COOLING MODE

FIGURE 18

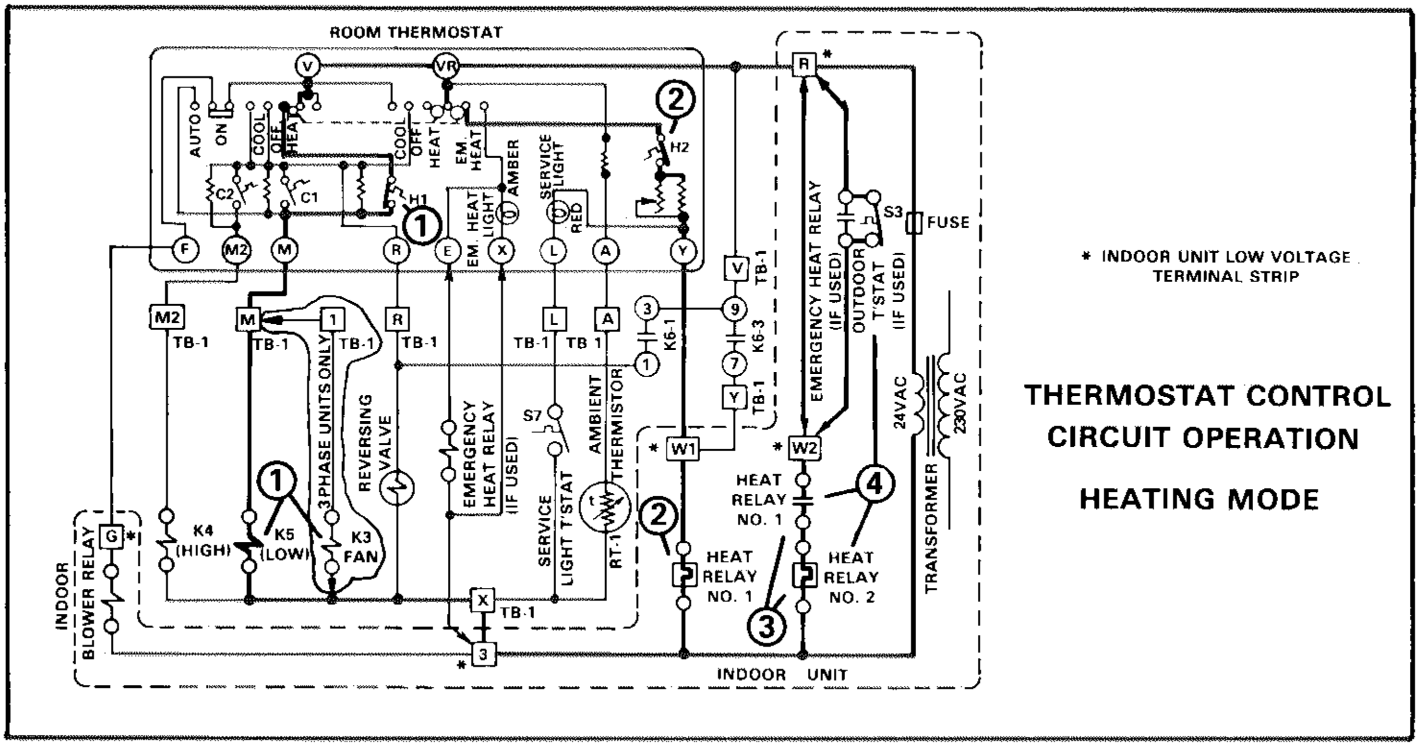


FIGURE 19

Emergency Heat Mode (Figure 20)

1 - Thermostat is switched to EM. HEAT position. Compressor control circuit is locked out between terminal V & M by the subbase switch.

2 - The amber emergency heat indicator light is energized from VR terminal through thermostat switch and to common of indoor transformer from terminal X.

3 - The Emergency Heat Relay is energized through thermostat terminal E. Em. Heat Relay N.O. contacts close to bypass the Outdoor Thermostat S3.

4 - Auxiliary electric heat only is controlled by the H2 heating bulb. Heat Relay No. 1 is energized from H2 bulb through thermostat terminal Y for stage 1 electric heat.

5 - Heat Relay No. 2 is energized through Em. Heat Relay N.O. contacts and Heat Relay No. 1 N.O. contacts to energize 2nd stage electric heat.

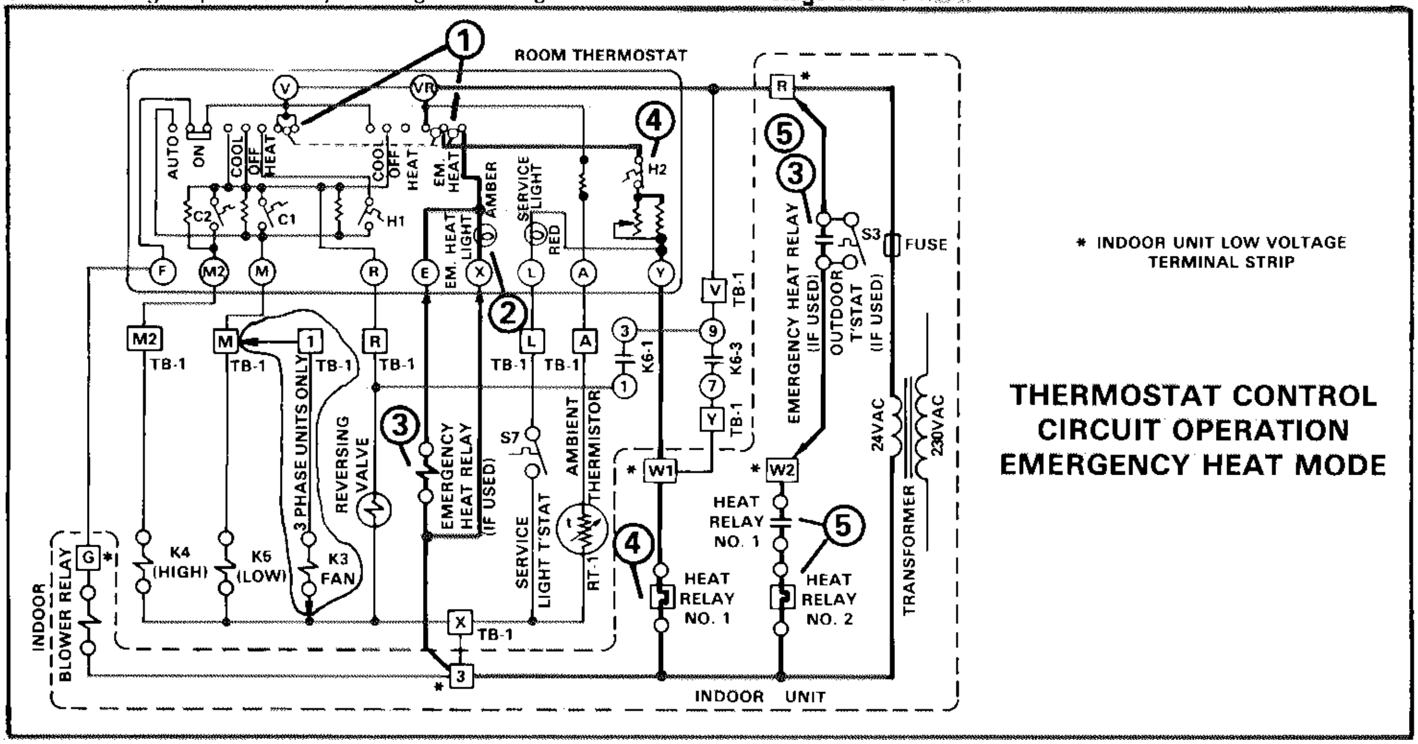


FIGURE 20

B - Cooling Cycle Low Voltage Compressor Control (Figure 21)

The sequence of operation steps are numbered corresponding to the schematic diagram and the cooling cycle timed off control sequence. The T.O.C. sequence shows position of cam switches and function through each step of the cycle.

1 - T1 Control Transformer provides 24VAC to power the timed off compressor control circuit through the Compressor Protection Module P2 to K1 N.C. circuit, N.C. Crankcase Thermostat S4 and N.C. High Pressure Switch S5. Any one of these three devices can de-energize the compressor controls if abnormal conditions are sensed.

2 - Upon an initial cooling demand for low speed (K5 control relay energized by thermostat) the timer motor is energized from Cam 2 - N.O. through K5-1 N.O. and K4-1 N.C. contacts.

3 - Following approximately 6 seconds the timer motor is stopped when Cam 2 switch changes position. Cam 2 - N.O. contacts open breaking circuit to timer motor.

4 - Low speed compressor contactor K2 is now energized from Cam 2 - N.C. contacts through K5-2 N.O., K7-3 N.C. and K1-6 N.C. contacts.

5 - If the demand increases for high speed (K4 control relay energized by thermostat) the timer motor is energized from Cam 1 - N.O. through K4-1 N.O. contacts.

6 - As the timer begins to run Cam 2 switch changes position opening its N.C. contacts breaking the circuit to K2 low speed contactor. Low speed is de-energized.

7 - Following 90 seconds the timer motor is stopped when Cam 1 switch changes position. Cam 1 - N.O. contacts open breaking circuit to timer motor.

8 - High speed compressor contactor K1 is now energized from Cam 1 - N.C. contacts through K4-3 N.O. and K2-5 N.C. contacts.

9 - If the demand for high speed becomes satisfied the thermostat drops out K4 control relay. K4-3 N.O. contacts open de-energizing K1 high speed compressor contactor. (K5 control relay remaining energized by t'stat for low speed) The timer motor is started from Cam 2 - N.O. through K5-1 N.O. and K4-1 N.C. contacts.

10 - Following 90 seconds the timer motor is stopped when Cam 2 switch changes position. Cam 2 - N.O. contacts open breaking circuit to timer motor.

11 - Low speed compressor contactor K2 is now energized from Cam 2 - N.C. contacts through K5-2 N.O., K7-3 N.C. and K1-6 N.C. contacts.

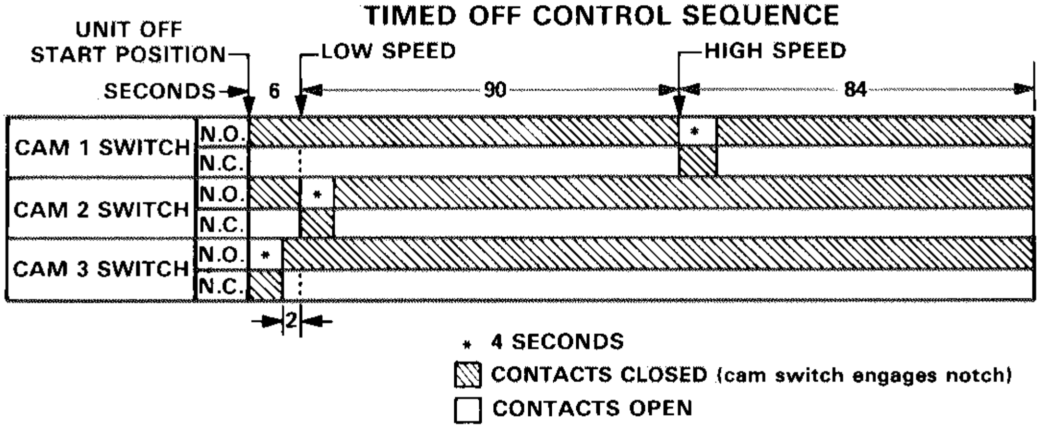
12 - When the demand is satisfied for low speed, the thermostat drops out K5 control relay. K5-2 N.O. contacts open de-energizing K2 low speed compressor contactor. The timer motor is started from Cam 3 - N.O. through K5-1 N.C. and K4-1 N.C. contacts. This is start of the timed-off-cycle following low speed.

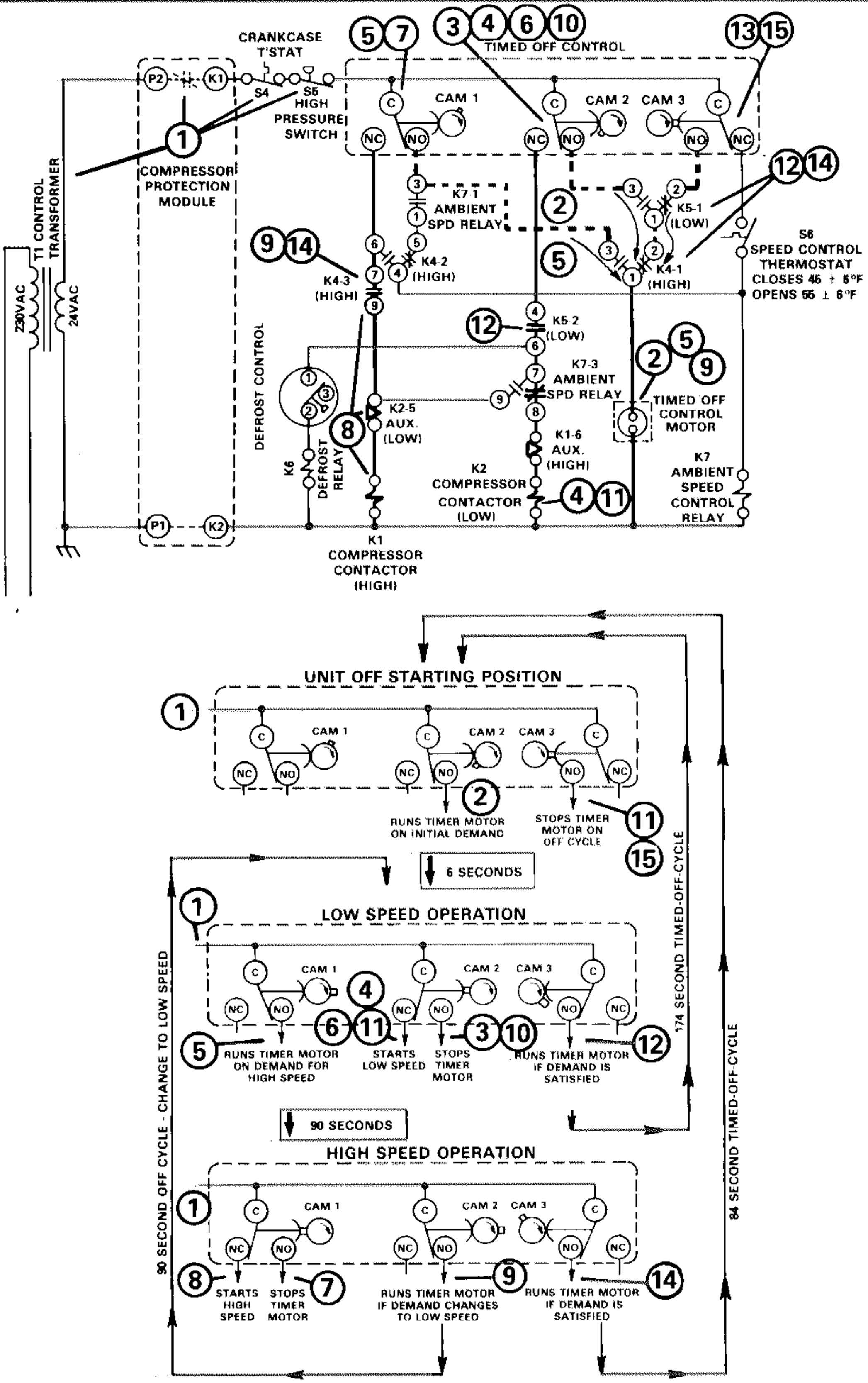
13 - Following 174 seconds (2.9 minutes) timed-off-cycle Cam 3 switch changes position. Cam 3 - N.O. contacts open breaking circuit to timer motor and motor stops. The timer is set for the next demand cycle.

14 - If the unit is running on high speed and the demand is satisfied, by either turning the thermostat to 'OFF' or raising setpoint, K4 & K5 control relays are de-energized. K4-3 N.O. contacts open to de-energize K1 high speed compressor contactor. The timer motor is started from Cam 3 - N.O. through K5-1 N.C. and K4-1 N.C. contacts. This is start of the timed-off-cycle following high speed.

15 - Following 84 seconds (1.4 minutes) timed-off-cycle Cam 3 changes position. Cam 3 - N.O. contacts open breaking circuit to timer motor and motor stops. The timer is set for the next demand cycle.

TIMED OFF CONTROL SEQUENCE





COOLING CYCLE TIMED OFF CONTROL SEQUENCE

FIGURE 21

C - Heating Cycle Low Voltage Compressor Control (Figure 22)

The sequence of operation steps are numbered corresponding to the schematic diagram and the heating cycle timed off control sequence. The T.O.C. sequence shows position of cam switches and function through each step of the cycle.

1 - T1 Control Transformer provides 24VAC to power the timed off compressor control circuitry through the same controls as in the cooling mode; Protection Module P2 to K1 N.C. circuit, N.C. Crankcase Thermostat S4 and N.C. High Pressure Switch S5.

2 - S6 speed control thermostat is powered with unit in the OFF - no demand mode (K5 not energized) through Cam 3 - N.C. contacts. If the outdoor temperature is above 45°F, K7 ambient speed control relay is not energized and K7-3 N.C. changeover contacts remain closed in the Cam 2 low speed circuit; the compressor will run on low speed when energized.

3 - If the outdoor temperature is below 45°F, K7 ambient speed control relay is energized through Cam 3 - N.C. contacts and S6 (closed below 45°F).

4 - K7 is 'latched' on through Cam 1 - N.O., K7-1 N.O. and K4-2 N.C. contacts.

5 - Upon a heating demand (K5 control relay energized by thermostat) the timer motor is energized from Cam 2 - N.O. through K5-1 N.O. and K4-1 N.C. contacts.

6 - As the timer begins to run Cam 3 switch changes position opening its N.C. contacts breaking power to S6 speed control t'stat. K7 remains energized because it is 'latched' on as in steps 3 & 4.

7 - Following approximately 6 seconds the timer motor is stopped when Cam 2 switch changes position. Cam 2 - N.O. contacts open breaking circuit to timer motor.

8 - High speed compressor contactor K1 is now energized from Cam 2 - N.C. contacts through K5-2 N.O., K7-3 N.O. and K2-5 N.C. contacts.

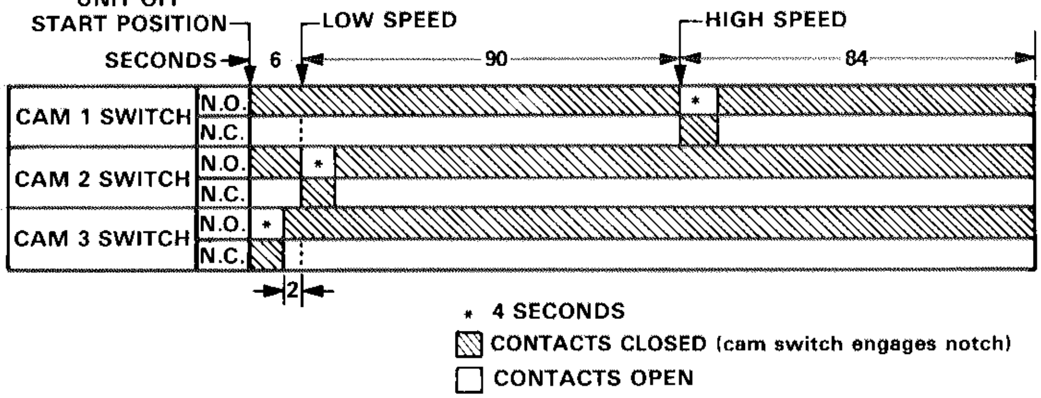
9 - When the demand is satisfied the thermostat drops out K5 control relay. K5-2 N.O. contacts open de-energizing K1 compressor contactor. The timer motor is started from Cam 3 - N.O. through K5-1 N.C. and K4-1 N.C. contacts. This is start of the timed-off-cycle of 174 seconds (2.9 minutes).

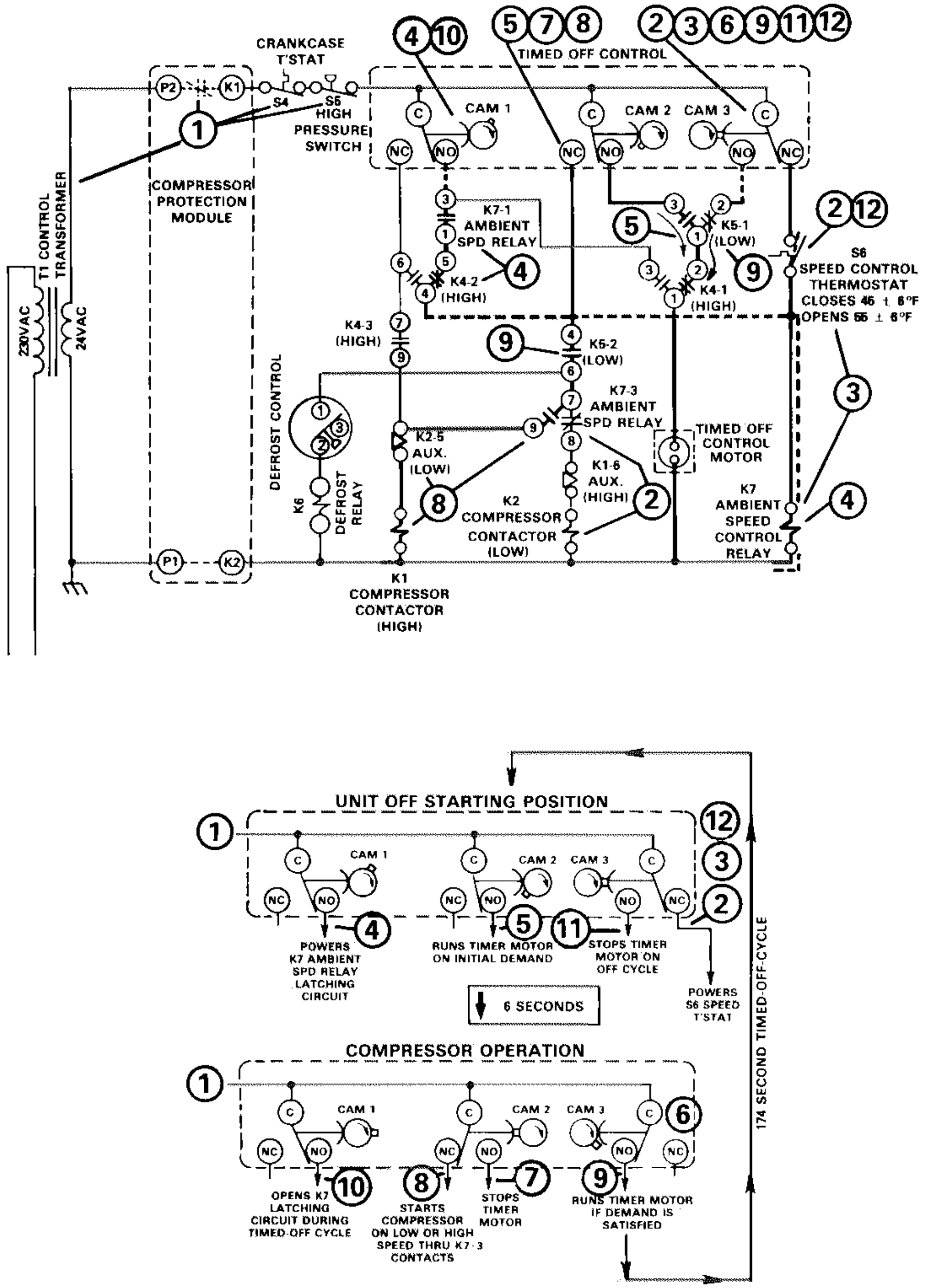
10 - At 1.5 minutes into the timed-off-cycle Cam 1 - N.O. contacts open for approximately 4 seconds and re-close. When open they break the circuit latching on K7 ambient speed control relay. K7 is de-energized.

11 - Following the complete timed-off-cycle of 174 seconds (2.9 minutes) Cam 3 switch changes position. Cam 3 - N.O. contacts open breaking circuit to timer motor and motor stops. The timer is set for the next demand cycle.

12 - Cam 3 - N.C. contacts are now closed again providing power to S6 speed control thermostat. It is now again in the circuit to "look" at the outdoor temperature prior to the next cycle to determine compressor speed for the cycle as in steps 2 & 3. Note that if a cycle was just completed on high speed, the outdoor temperature will have to rise above 55°F to open S6 for low speed operation. S6 has a 10°F differential. Due to the latching feature of K7, once the compressor starts up on one speed it remains in that mode *until* demand is satisfied regardless of the status of S6.

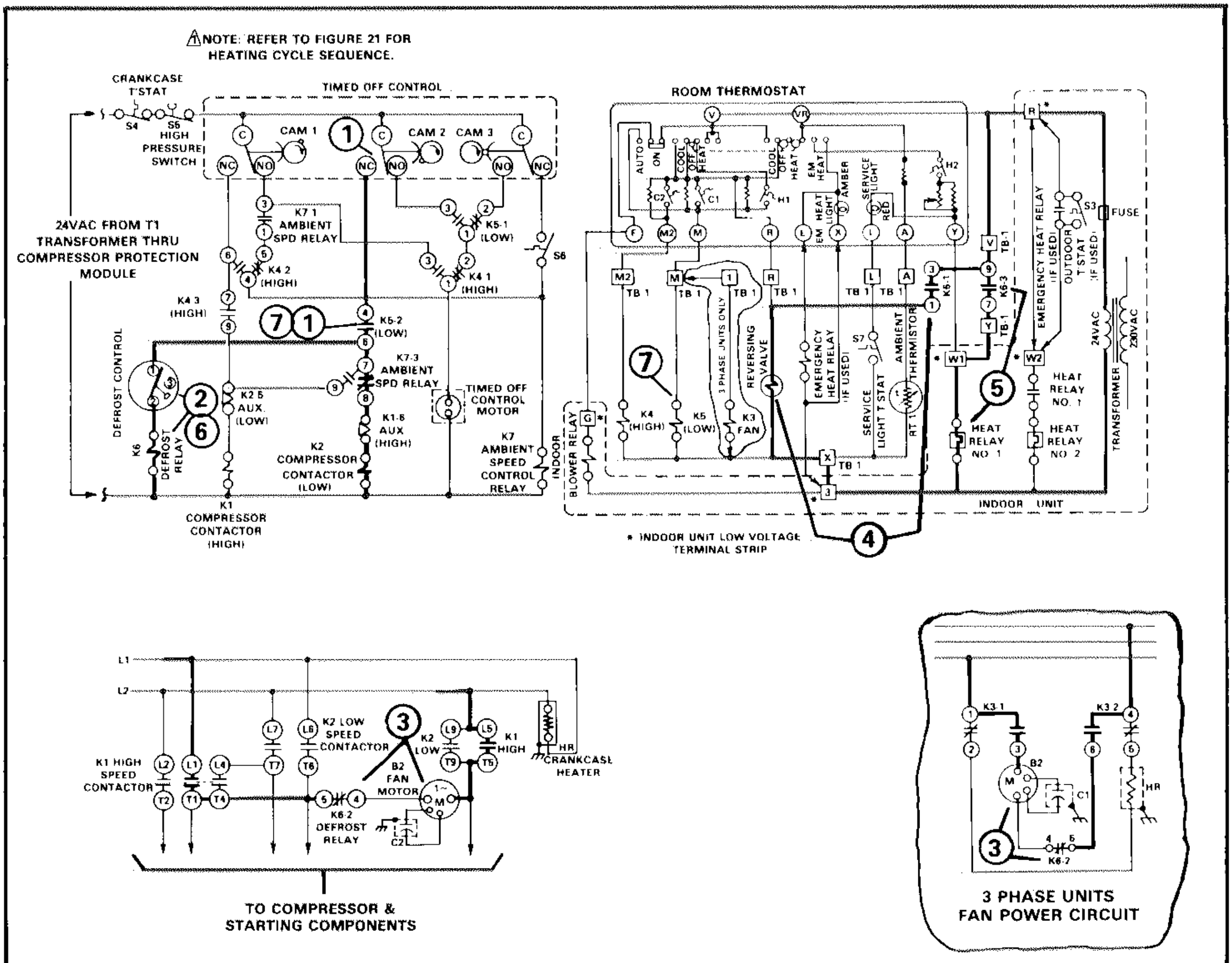
TIMED OFF CONTROL SEQUENCE





HEATING CYCLE TIMED OFF CONTROL SEQUENCE

FIGURE 22



DEFROST CYCLE CONTROL CIRCUIT

FIGURE 23

D - Defrost Cycle Control Circuit (Figure 23)

1 - During a heating cycle the Defrost Control Pressure Switch senses an increase in static pressure in the outdoor coil compartment caused by ice buildup on the outdoor coil. The Defrost Control is powered thru Cam 2 N.C. contacts and K5-2 N.O. contacts only during the heating cycle. (Refer to Figure 21 for heating cycle sequence)

2 - The Defrost Control closes contacts 2 to 1 energizing K6 Defrost Relay.

3 - Defrost relay N.C. contacts K6-2 open de-energizing the outdoor fan motor.

4 - Defrost relay N.O. contacts K6-1 close to energize the reversing valve.

5 - Defrost relay N.O. contacts K6-3 close to energize Heat relay No. 1. Heat relay No. 1 in turn energizes the auxiliary electric heat to compensate for the temporary cooling during the defrost cycle.

6 - The Defrost Control senses the liquid line temperature for termination of the defrost cycle at approximately 65°F. The Defrost Control opens contacts 2 to 1 de-energizing K6 Defrost Relay returning the unit to normal heat pump operation; K6-2 recloses starting outdoor fan, K6-1 opens de-energizing reversing valve and K6-3 opens de-energizing auxiliary Heat Relay No. 1.

7 - The Defrost cycle may also be terminated if the heating demand is satisifed; K5 Control Relay is de-energized by the room thermostat to de-energize the compressor circuitry.

E - Compressor Starting Circuit - Single Phase Low Speed (Figure 24)

1 - K2 Low Speed Compressor Contactor is energized by the timed off control circuit closing contacts L6-T6, L7-T7, L8-T8 and L9-T9.

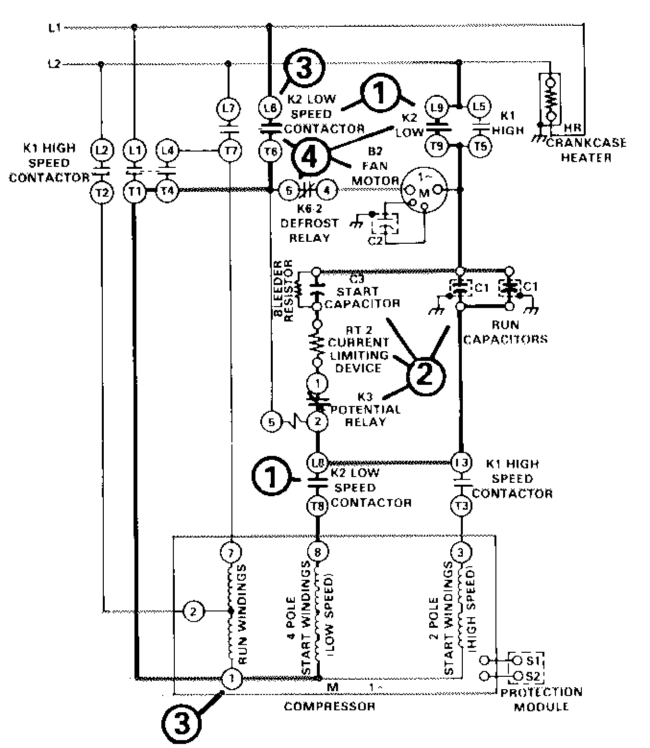
2 - To energize the start windings the start and run capacitors are in parallel for maximum starting capacitance.

L2 Thru: K2 - Low Speed Capacitor L9-T9 contacts
C1 - Run Capacitor(s)
C3 - Start Capacitor
RT-2 - Current Limiting Device
K3 - Potential Relay N.C. contacts
K2 - Low Speed Contactor L8 - T8 contacts

The low speed start windings are energized at compressor terminal 8.

3 - The start winding connects to common terminal 1 and completes the circuit to L1 thru K2 low speed contactor L6-T6 contacts.

4 - The fan motor is also energized from L1 thru K2 contacts L6-T6, K6-2 N.C. defrost relay contacts and K2 contacts L9-T9 to L2.



COMPRESSOR STARTING CIRCUIT
1Ø LOW SPEED

FIGURE 24

F - Compressor Run Circuit - Single Phase Low Speed (Figure 25)

1 - At the same time the start windings are energized the compressor run windings (in series) are powered thru K2 low speed contactor (contacts L6-T6 & L7-T7).

2 - As the compressor comes up to speed K3 potential relay coil is energized by the voltage from the motor windings thru K2 contacts L8-T8. This voltage will usually be in the range or above the pickup voltage of the potential relay. It varies with each compressor.

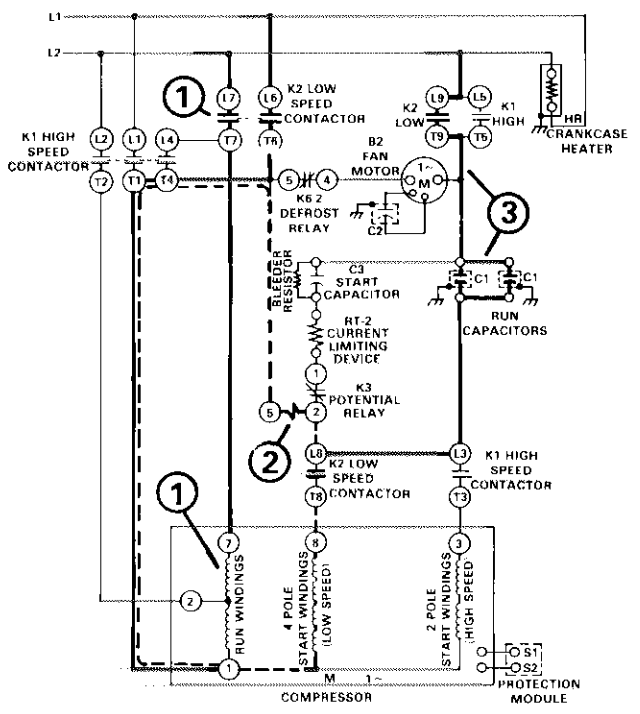
K3 - N.C. contacts open taking the start capacitor out of the circuit.

3 - The run capacitor(s) remain connected to the start winding thru K2 contacts L9-T9 & L8-T8. The run capacitors create the proper amount of voltage phase shift to improve power factor and increase torque.

Note - If the run capacitor(s) fail the compressor may not start and if it does it will run with a very poor power factor creating high electric bills. The run capacitor(s) provide 2 functions:

1 - Increasing starting capacitance when in parallel with start capacitor.

2 - Improving power factor and torque characteristics during run.



COMPRESSOR RUN CIRCUIT
1Ø LOW SPEED

FIGURE 25

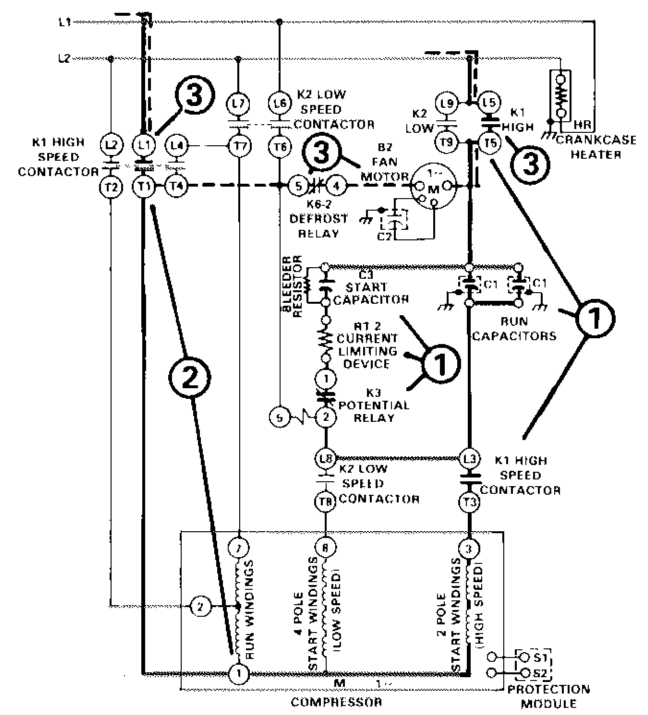
G - Compressor Starting Circuit - Single Phase High Speed (Figure 26)

1 - L2 Thru: K1 - High Speed Contactor L5-T5 contacts
C1 - Run Capacitor(s)
C3 - Start Capacitor
RT-2 - Current Limiting Device
K3 - Potential Relay N.C. contacts
K1 - High Speed Contactor L3-T3 contacts.

The high speed start windings are energized at terminal 3.

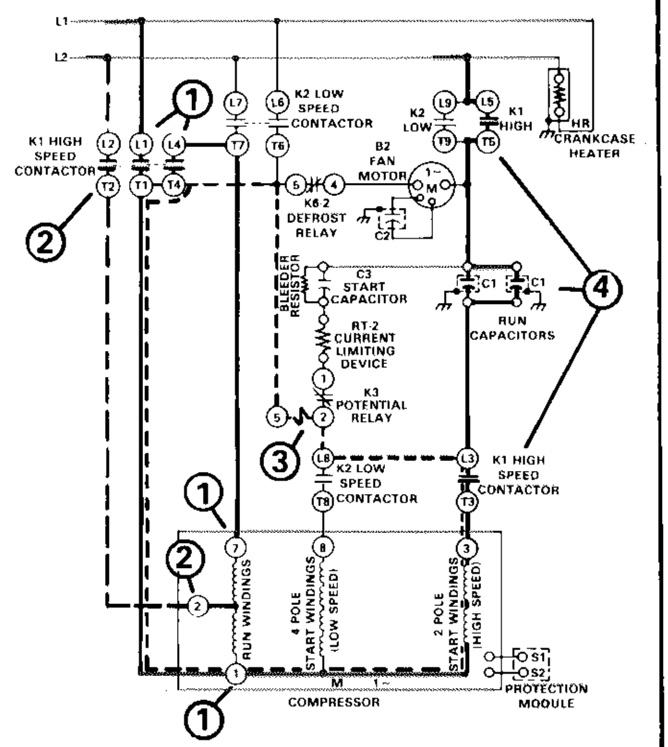
2 - The start winding connects to common terminal 1 and completes the circuit to L1 thru K1 high speed contactor L1-T1 contacts.

3 - The fan motor is also energized from L1 thru K1 contacts L1-T1, K6-2 N.C. defrost relay contacts and K1 contacts L5-T5.



COMPRESSOR STARTING CIRCUIT
1Ø HIGH SPEED

FIGURE 26



COMPRESSOR RUN CIRCUIT
1Ø HIGH SPEED

FIGURE 27

H - Compressor Run Circuit - Single Phase High Speed (Figure 27)

At the same time the start windings are energized the compressor run windings (in parallel) are powered thru K1 high speed contactor as follows:

1 - L1 power thru K1 contacts L1-T1 & L4-T4 to compressor terminals 1 & 7.

2 - L2 power thru K1 contacts L2-T2 to compressor terminal 2.

3 - As the compressor comes up to speed, K3 potential relay coil is energized by the voltage from the motor windings thru K1 contacts L3-T3.

4 - The run capacitor(s) remain connected to the start windings thru K1 contacts L5-T5 & L3-T3.

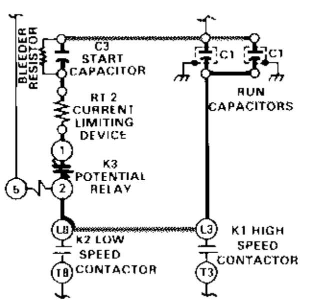
I - Current Limiting Device Function (Figure 28)

The current limiting device (RT-2) is a NTC thermistor (increase in temperature equals decrease in resistance).

It is used in the compressor starting circuit in series between the potential relay contacts and the start capacitor.

1 - As the compressor is started RT-2 heats fast lowering its resistance due to the high initial starting current.
2 - When the compressor is up to speed, K3 potential relay contacts open breaking the circuit to RT-2 (& the start capacitor). RT-2 cools down during the compressor run cycle - increasing its resistance again. The start capacitor is discharged by the bleeder resistor across it.
3 - When the compressor is cycled off and the compressor contactor opens, the potential relay K3 drops out immediately. This is when RT-2 provides its function.
4 - When the potential relay contacts close, RT-2 is in series with the contacts, start capacitor and the fully charged run capacitor(s). The resistance of RT-2 absorbs the current surge created as the run capacitor(s) are discharged, dissipating it as heat.

This protects the potential relay contacts from welding when they close and discharge the run capacitor(s).



CURRENT LIMITING DEVICE FUNCTION

FIGURE 28

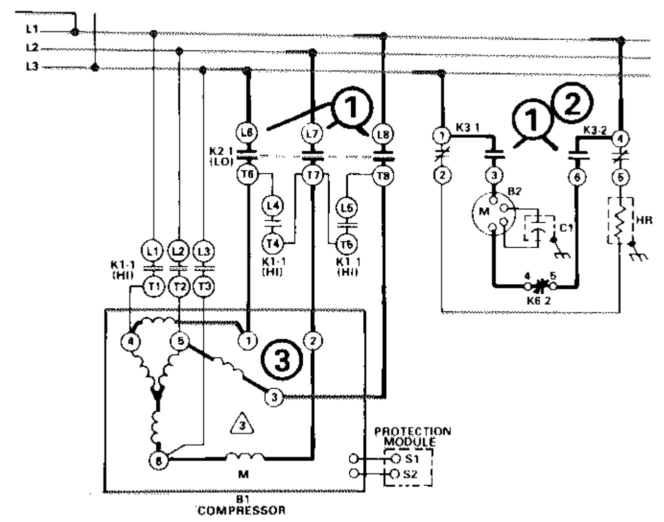
THREE PHASE OPERATION

The three phase unit low voltage circuits to energize K1 or K2 compressor contactors operate the same as in the single phase units (Refer to Figures 18 & 19).

No starting components or run capacitors are required on three phase motors.

J - Compressor Circuit - Three Phase - Low Speed "Series Y" (Figure 29)

1 - K2-1 low speed compressor contactor and K3 fan relay are energized by low voltage circuit.
2 - The fan motor B2 is energized from L1 thru K3-2 N.O. contacts, K6-2 N.C. defrost relay contacts and K3-1 N.O. contacts to L3. At the same time K3-1/-2 N.C. contacts open de-energizing the crankcase heater.
3 - Compressor terminals 1, 2 & 3 are energized thru K2-1 contacts L6-T6, L7-T7 & L8-T8 to form a series Y connection to the motor windings for low speed.

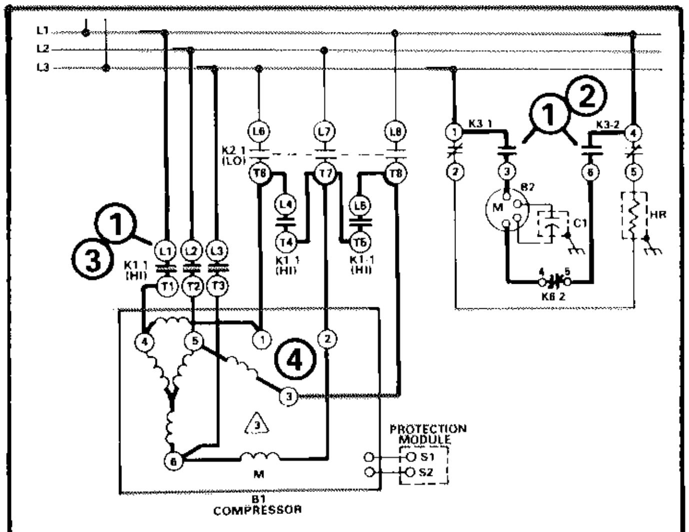


COMPRESSOR CIRCUIT - 3Ø LOW SPEED (SERIES "Y" MOTOR CIRCUIT)

FIGURE 29

K - Compressor Circuit - Three Phase - High Speed "Parallel Y" (Figure 30)

1 - K1-1 high speed compressor contactor and K3 fan relay are energized by low voltage circuit.
2 - The fan motor B2 is energized from L1 thru K3-2 N.O. contacts, K6-2 N.C. defrost relay contacts and K3-1 N.O. contacts to L3. At the same time K3-1/-2 N.C. contacts open de-energizing the crankcase heater.
3 - Compressor terminals 4, 5 & 6 are energized thru K1-1 contacts L1-T1, L2-T2 & L3-T3.
4 - And compressor winding terminals 1, 2 & 3 are connected together by K1-1 contacts L4-T4 & L5-T5 to complete the parallel Y connection to the motor for high speed.



COMPRESSOR CIRCUIT - 3Ø HIGH SPEED (PARALLEL "Y" MOTOR CIRCUIT)

FIGURE 30

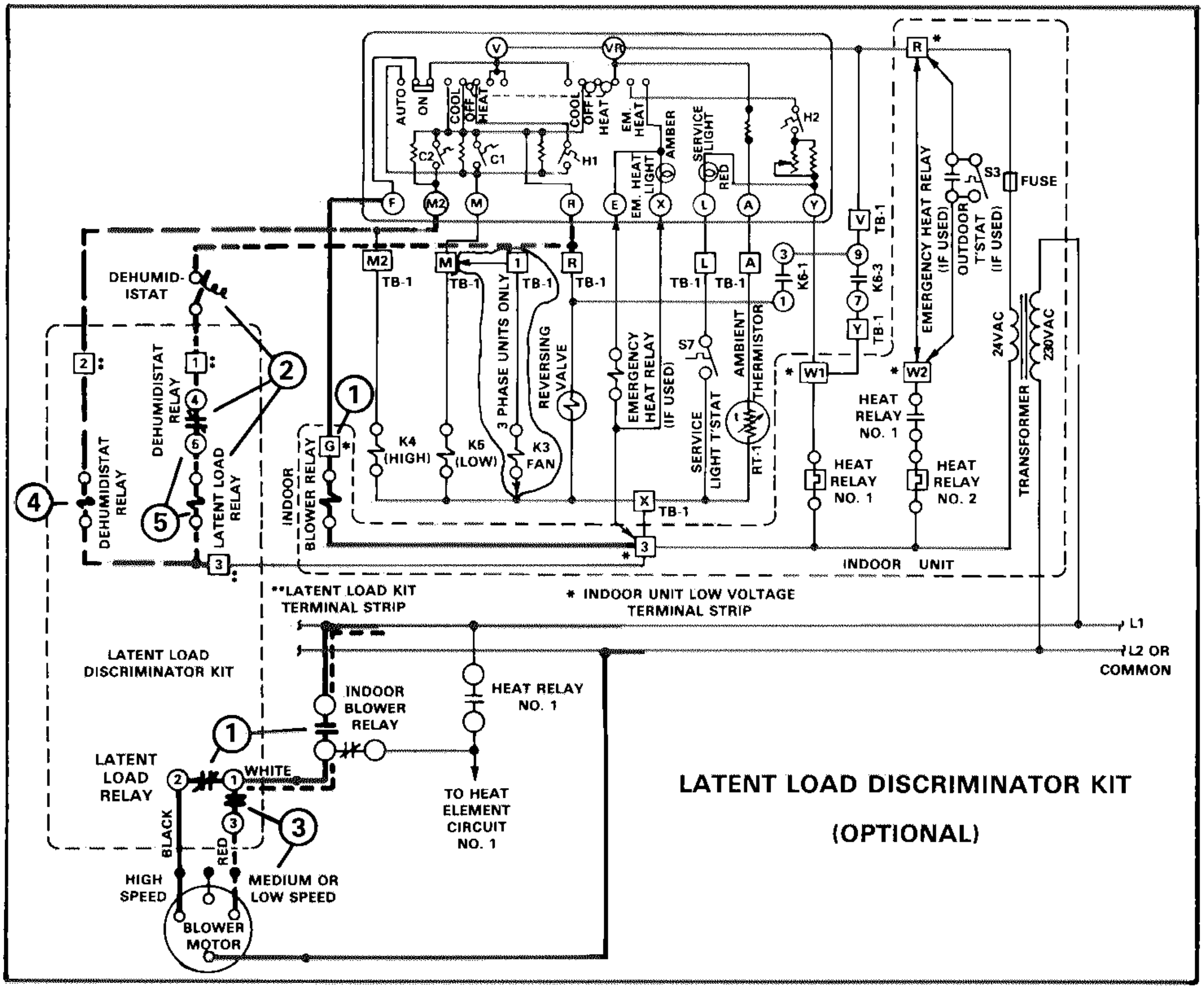


FIGURE 31

ACCESSORY SEQUENCE

L - Latent Load Discriminator Kit (Figure 31)

The latent load kit functions during cooling low speed compressor operation to lower the indoor blower motor speed for increased dehumidification when needed.

1 - Blower operation during cooling or continuous operation (indoor blower relay energized from thermostat terminal F) is thru the blower relay N.O. contacts and latent load relay N.C. contacts to the high speed tap.

2 - During first stage cooling (M & R terminals powered at thermostat) the latent load relay coil is energized from R terminal thru dehumidistat and dehumidistat relay N.C. contacts, if the humidity rises sufficiently.

3 - The latent load relay N.C. contacts open de-energizing high blower speed and the N.O. contacts close energizing low speed.

4 - During second stage cooling (R, M & M2 terminals powered at thermostat) the dehumidistat relay coil is energized from terminal M2.

5 - The dehumidistat relay N.C. contacts open preventing the latent load relay from operating - the blower runs on high speed only.

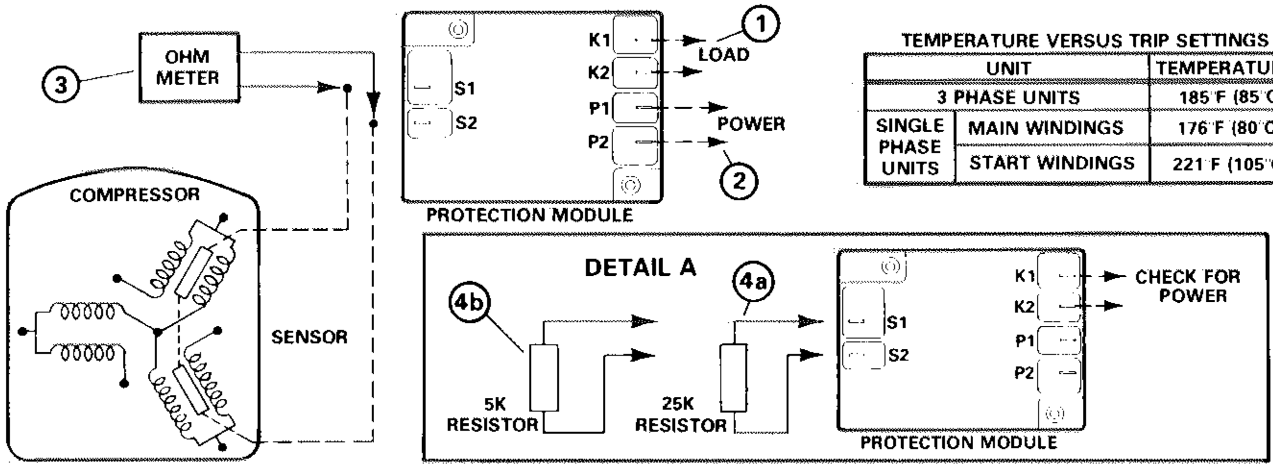
VIII - TROUBLESHOOTING

Other than the timed off control and switching required for speed changes, the other HP14 components are standard and should not present particular troubleshooting problems.

When servicing the HP14 it is necessary to be familiar with the timing sequence of operation to determine if the unit is operating normally.

Checking for 24VAC at control relay coils K5 & K4 will determine thermostat circuits complete for first & second stage cooling. Remember that in the heating mode only M terminal at the thermostat is energized by the H1 heating bulb and K5 control relay only is energized (K4 not energized in heating mode).

TEXAS INSTRUMENTS SOLID STATE COMPRESSOR PROTECTION



TEMPERATURE VERSUS TRIP SETTINGS

UNIT		TEMPERATURE
3 PHASE UNITS		185°F (85°C)
SINGLE PHASE UNITS	MAIN WINDINGS	176°F (80°C)
	START WINDINGS	221°F (105°C)

1 - Provide a cooling demand and check the voltage at K1 and K2. Power (24 volts) indicates that the module is O.K. and there is another component open in the control circuit.
2 - Check for 24 volts at P1 & P2. If there is no voltage, check the unit transformer and power supply to unit.
3 - Checking Thermal Sensors
   a - Remove thermal sensor leads from S1 and S2 therminals and check the resistance.
   b - The trip setting ranges from 16K to 24K.
   c - The reset setting ranges from 5.5K to 6.9K.
   d - If an open circuit is indicated the compressor must be replaced.
   e - If a shorted circuit is indicated, the compressor must be replaced.
4 - Checking Module (Detail "A")
   a - Remove thermal sensor leads and place a 25K resistor across terminals. There should be no voltage at K1 and K2 terminals.
   b - Substitute a 5K resistor and recheck K1 and K2 terminals. The module should reset and provide 24 volts.
   c - If module doesn't function properly, replace.

FIGURE 32

A - Compressor Protection Module Checkout

Provide a cooling demand and check K1 and K2. Power indicates another component is open. Check power to module. Remove thermal sensor leads and check their resistance. Use resistors to check module operation. Refer to Figure 32.

Thermal sensors embedded within the compressor windings change resistance in direct relationship to temperature change. The trip setting ranges from 16K to 24K while reset settings range from 5.5K to 6.9K.

Figure 33 shows the protection module internal circuitry. Note that the Triac (T1C 216A) is the component used to break the circuit between terminals P2 and K1. This is illustrated on the unit schematics as a N.C. contact between P2 and K1.

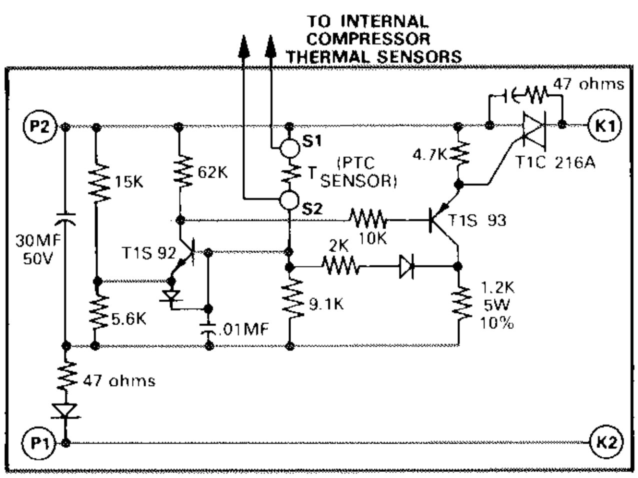
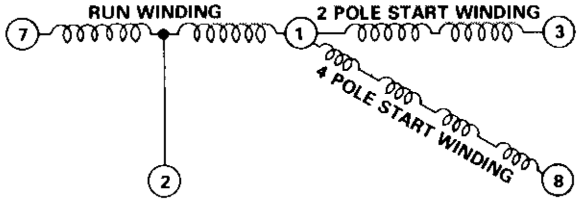


FIGURE 33

B- Checking Two Speed Compressor Windings

Turn off power to unit and remove all wiring from compressor terminals. Using an ohm meter set on scale R x 10K, check windings for grounds and open circuits. Refer to Figure 34 & 35 .

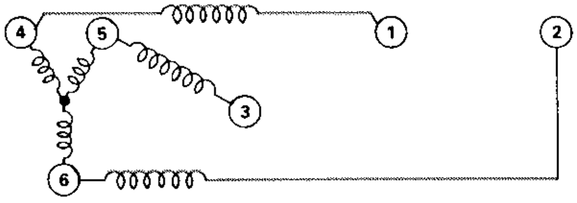
CHECKING MOTOR WINDINGS ON A TWO SPEED SINGLE PHASE COMPRESSOR



1 — Disconnect wiring from compressor terminals.
2 — Check for continuity from each terminal to ground. Continuity indicates a shorted winding and a defective compressor.
3 — Check for continuity from 7 to 3, 7 to 8 and 7 to 2. No continuity indicates an open winding and a defective compressor.

FIGURE 34

CHECKING MOTOR WINDINGS ON A TWO SPEED THREE PHASE COMPRESSOR



1 — Disconnect wiring from compressor terminals.
2 — Check for continuity from each terminal to ground. Continuity indictes a shorted winding and a defective compressor.
3 — Check for continuity from 1 to 3 and 1 to 2. No continuity indicates an open winding and a defective compressor.

FIGURE 35