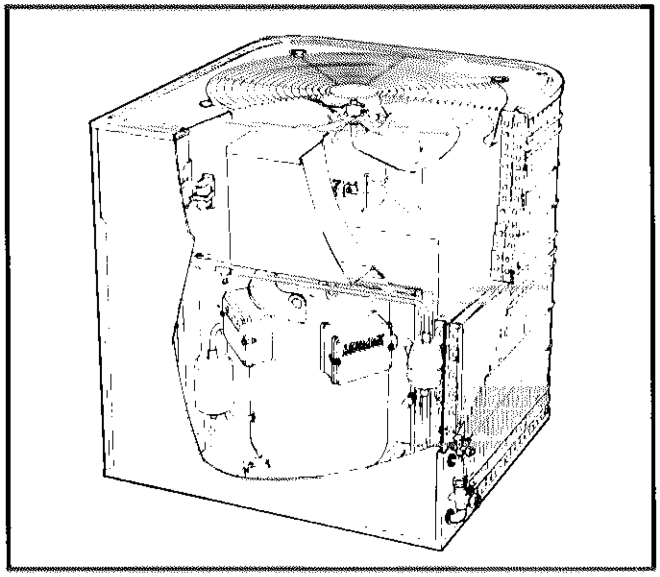
SERVICE UNIT INFORMATION HS14
LENNOX Industries Inc.
Corp. 8711-L12
Litho U.S.A.

HS14 SERIES UNITS WITH TSC SOLID STATE TWO SPEED CONTROL

The HS14 is a residential condensing unit which features a two speed compressor. The two speed operation was initially controlled by electromechanical timers and switches. Beginning with HS14-5 and -6 series units, two speed operation will be controlled by the new Lennox TSC solid state two speed control. HS14-5 series units utilize a Lennox two speed compressor and a TSC-1 two speed control. HS14-6 series units utilize a Bristol two speed compressor and a TSC-2 two speed control.

The first part of this manual describes the components used in HS14's. The latter part of this manual describes the sequence of operation for units using the TSC. A troubleshooting flowchart has been included at the end of the sequence section to help diagnose unit problems.

Units not using the TSC will have a slightly different sequence of operation from units which are equipped with the TSC.



SPECIFICATIONS

Model Number		HS14-411V-413V	HS14-511V-513V	HS14-651V-653V
Condenser Coil	Net face area (sq. ft.)	18.5 outer/17.6 inner	18.5 outer/17.6 inner	21.3 outer/ 20.3 inner
	Tube dia. (in.)/No.of rows	3/8 - 2	3/8 - 2	3/8 - 2
	Fins per inch	20	20	20
Condenser Fan	Dia. (in.)/No.of blades	24 - 3	24 - 3	24 - 4
	Motor hp	1/10	1/6	1/4
	Cfm (factory setting)	2800	3200	4200
	RPM (factory setting)	830	830	815
	Watts (factory setting)	150	210	310
Refrigerant 22 (charge furnished)	-5 series units	10 lbs. 4 oz.	10 lbs. 0 oz.	14 lbs. 0 oz.
	-6 series units	10 lbs. 11 oz.	10 lbs. 10 oz.	12 lbs. 7 oz.
Liquid Line Connection (o.d. in.)		3/8 (compression)	3/8 (compression)	3/8 (compression)
Suction Line Connection (o.d. in.)		7/8 (compression)	1-1/8 (sweat)	1-1/8 (sweat)

ELECTRICAL DATA

Model Number		HS14-411V	HS14-413V	HS14-511V	HS14-513V	HS14-651V	HS14-653V
Line voltage data		208/230v/1ph	208/230v/3ph	208/230v/1ph	208/230v/3ph	208/230v/1ph	208/230v/3ph
Compressor (Lennox) -5 series units	RLA	14.8	11.1	21.6	15.7	32.1	17.2
	Power factor	.98	.88	.97	.88	.97	.88
	LRA	90.0	70.0	133.0	90.0	163.0	115.0
Compressor (Bristol) -6 series units	RLA	17.3	10.9	24.4	14.1	30.8	19.2
	Power factor	.97	.90	.97	.90	.97	.90
	LRA	90.0	70.0	135.0	90.0	162.0	122.0
Condenser Coil Fan Motor	FLA	0.7	0.7	1.0	1.0	1.7	1.7
	LRA	1.2	1.2	1.9	1.9	2.9	2.9
Maximum fuse size	-5 series units	30	25	45	35	60	40
	-6 series units	35	25	50	30	60	40
*Minimum circuit ampacity	-5 series units	19.2	14.6	28.0	20.6	41.8	23.2
	-6 series units	22.3	14.3	31.5	18.6	40.2	25.7

*Refer to National Electrical Code Manual to determine wire, fuse and disconnect size requirements.
NOTE - Extremes of operating range are plus 10% and minus 5% of line voltage.

I-INTRODUCTION

The HS14 incorporates a two speed compressor which shifts speeds to match load requirements. The compressor automatically shifts to low speed when thermostat demand is low and shifts to high speed when thermostat demand is high. The heat transfer surfaces are oversized increasing the capacity and efficiency. See table 1.

TABLE 1

Unit	Tonnage at Low Speed	Tonnage at High Speed
HS14 - 410	2	3
HS14 - 510	2-1/2	4
HS14 - 650	3	5

A-Approved Matchups

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.

Refer to the Lennox Engineering Handbook for the correct expansion valve kit. Table 2 lists the line sets for the HS14. The 410 units use compression connections at the unit. The 510 and 650 units use a compression connection for the liquid line and a sweat connection for the suction line.

TABLE 2

Unit Model No.	Line Set Model No.	Length of Lines (ft.)	Liquid Line (o.d. in.)	Line (o.d. in.) Suction
HS14-410V	L10-65-30	30	3/8	7/8
	L10-65-40	40		
	L10-65-50	50		
HS14-510V HS14-650V	field fabricate	---	3/8	1-1/8

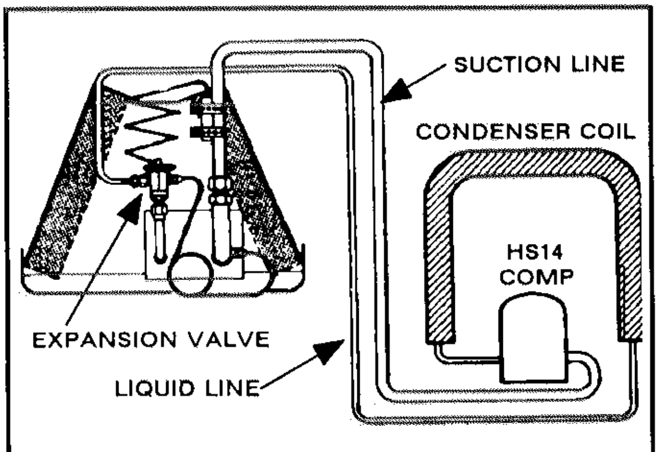
The HS14 is for use with single circuit coils and expansion valves only. However, the HS14 is applicable to the Zonemaster and new Zonemaster II systems. The Zonemaster is a direct expansion valve system using multiple evaporators, thermostats and an RTM1-65 Tank Module. The Zonemaster II is a direct expansion valve system using two evaporators which are controlled individually by separate thermostats without a tank module. Refer to the Zonemaster and Zonemaster II literature for further details.

II-REFRIGERANT SYSTEM

Figure 1 shows the typical piping in a HS14 system. The 410, 510 and 650 liquid line service valves are located outside the unit cabinet. They have side gauge ports. The liquid line valves require a 3/16 in. allen wrench and the suction line valves require a 5/16 in. allen wrench. The side gauge port is not shut off when the valve is backseated.

The suction line service valve on the 510 and 650 units is located inside the unit cabinet. A 3/16 in. hex socket wrench is required for the valve. This valve closes the gauge port when backseated.

A port for the addition of a pressure switch is provided in the liquid line between the condenser coil and the filter drier. The port allows for easy installation of a low ambient kit if needed. This kit may also be used to monitor high pressure during a system pumpdown for repairs on low side. The high pressure during pumpdown *must not* exceed 410 psig.



STANDARD DX REFRIGERANT CIRCUIT

FIGURE 1

HS14 SINGLE/THREE PHASE CONTROL BOX

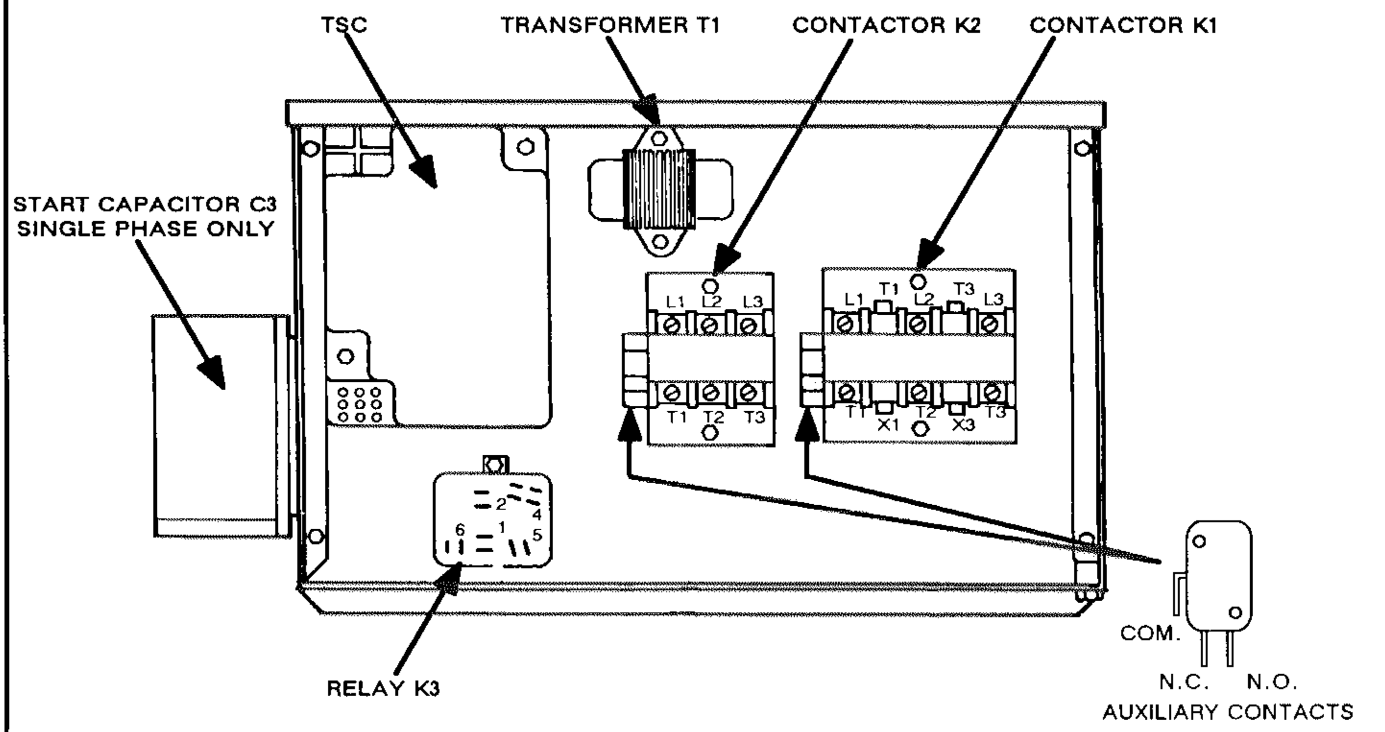


FIGURE 2

III–UNIT COMPONENTS

A–Control Box Components (Figure 2)

1– Transformer (T1)

All HS14's use a single 24VAC transformer (T1) to power all controls in the outdoor unit. A separate indoor transformer provides 24VAC power to the indoor thermostat and indoor unit.

2– TSC Two Speed Control

To control compressor speed, the TSC first determines if all safety circuits are o.k. The control then responds to 1st stage or 2nd stage accordingly. The control also initiates time delays to prevent short cycling between thermostat demands and between speed changes. The timed off delay between thermostat demands is approximately 5 minutes. The speed change delay is approximately 60 seconds.

3– Contactor (K2)

Contactor K2 energizes low speed compressor operation in single phase units. In three phase units, K2 energizes high speed compressor operation. See Table 3.

In single phase units, K2 also de-energizes the crankcase heater during compressor operation. In three phase units, K2 prevents both high speed and low speed from energizing at the same time by 'locking out' contactor K1.

TABLE 3

Speed	Single Phase	Three Phase
Low	K2	K1
High	K1 & K2	K2

4–Contactor (K1)

In single phase units, K1 and K2 are both energized to bring on high speed operation. Three phase units bring on only K1 for low speed operation. See Table 3.

In single phase units, K1 is energized with K2 to redirect voltage to the compressor terminals for high speed operation. K1 also de-energizes the low speed start windings while energizing the high speed start windings. K1 auxiliary contacts switch whenever K1 is energized to ensure that K2 is energized with K1 during high speed operation.

In three phase units, high speed demand de-energizes K1 and energizes K2. However, K1 is wired so that when de-energized, the contactor forms a parallel wiring connection to the motor windings. Low speed demand de-energizes K2 and energizes K1. When K1 is energized, the contactor changes back to a series connection to the motor windings.

5- Relay (K3)

In single phase units, K3 is a potential relay which controls the operation of the starting circuit. The relay is normally closed when K2 is de-energized. When K2 energizes, the compressor immediately begins start-up. K3 remains closed during the voltage drop due to compressor startup and the start capacitor remains in the circuit. As the compressor gains speed and voltage is restored, K3 is energized. When K3 energizes, the contacts open and the start capacitor is taken out of the circuit.

In three phase units, K3 controls the operation of the condenser fan and crankcase heater. The relay energizes the condenser fan and de-energizes the crankcase heater during any cooling demand.

6- Start Capacitor (C2)

All single phase units use a start capacitor connected in parallel with the run capacitor. This capacitor is switched off by potential relay K3 when the compressor nears full speed. Table 4 shows start capacitor ratings for single phase HS14's. Three phase HS14's do not use start capacitors.

TABLE 4

Unit	MFD*	VAC
411V-5P	145-175	330
511V-5P	145-175	
651V-5P	176-216	320 or 330
411V-6P	145-175	330
511V-6P	145-175	
651V-6P	176-216	320 or 330

*These are current values and are subject to change.

7- Run Capacitor (C3)

All single phase units use run capacitors to maximize compressor efficiency. Model HS14 651-P uses multiple run capacitors connected in parallel with the start capacitor. Table 5 shows run capacitor ratings for single phase HS14's.

TABLE 5

Unit	Number of Capacitors	MFD	VAC
411V-5P	1	35	440
511V-5P	1	45	
651V-5P	2	30	
		25	
411V-6P	1	35	
511V-6P	1	45	
651V-6P	2	30	
		25	

8- Fan Capacitor (C1)

All HS14's use single phase condenser fans which require run capacitors to maximize efficiency. Table 6 shows fan run capacitor ratings for HS14's.

TABLE 6

Unit	MFD	VAC
411V	3.75	370
413V	3.75	
511V	5	
513V	5	
651V	10	
653V	10	

B-Unit Parts (Figure 3)

1- Compressor (B1)

Table 7 shows the specifications of two speed compressors used in HS14's. All compressors are rated at 208/230 VAC and may be single phase or three phase. Lennox compressors are equipped with 40 watt internal crankcase heaters and Bristol compressors are equipped with 30 watt internal crankcase heaters. Crankcase heaters in all units are regulated by HS14 circuitry. The compressors are also equipped with PTC (positive temperature coefficient) type thermistors used by the TSC in monitoring the temperature of the motor windings.

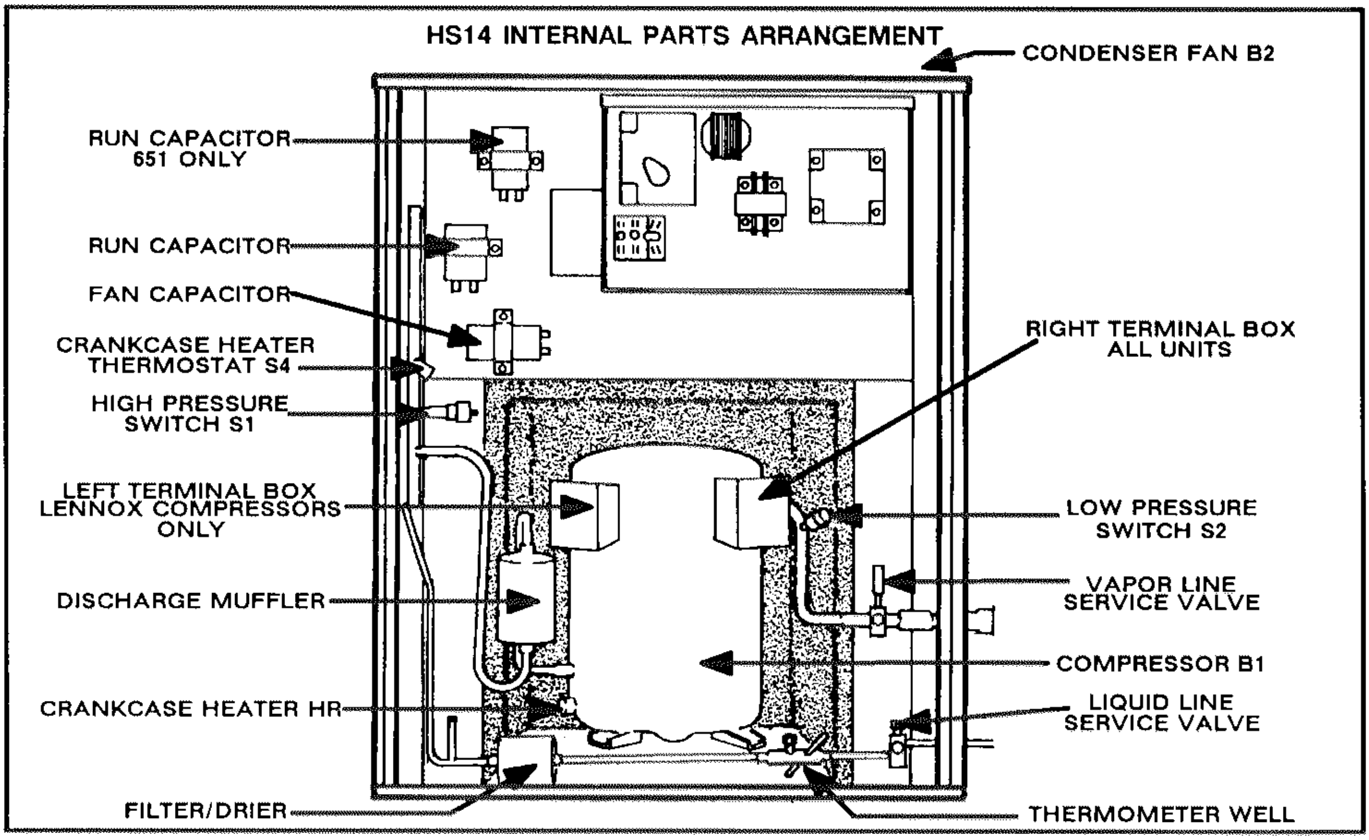


FIGURE 3

TABLE 7

Unit	Phase	Capacity Btuh		LRA		RLA	Oil
		Low	High	Low	High		
411V-5P	1	15,500	34,400	38	90	14.8	65 fl. oz. ZEROL 150 SUS
511V-5P	1	23,100	48,500	49	133	21.6	
651V-5P	1	29,300	61,500	54	163	32.1	
413V-5Y	3	15,500	34,400	40	70	11.1	
513V-5Y	3	23,100	48,200	50	90	15.7	
653V-5Y	3	29,300	61,600	65	115	17.2	
411V-6P	1	16,600	34,900	39	90	17.3	50 fl. oz. BRISTOL SP581007 150 SUS
511V-6P	1	22,600	46,400	53	135	24.4	
651V-6P	1	29,700	61,400	56	162	30.8	
413V-6Y	3	16,600	34,900	40	70	10.9	
513V-6Y	3	22,600	46,400	50	90	14.1	
653V-6Y	3	29,700	61,400	72	122	19.2	

2- Condenser Fan (B2)

The specifications table on page 1 shows the specifications of condenser fans used in HS14's. In single phase units, B2 is controlled by K2. In three phase units, B2 is controlled by K3.

3- Crankcase Heater (HR)

See compressor section on previous page.

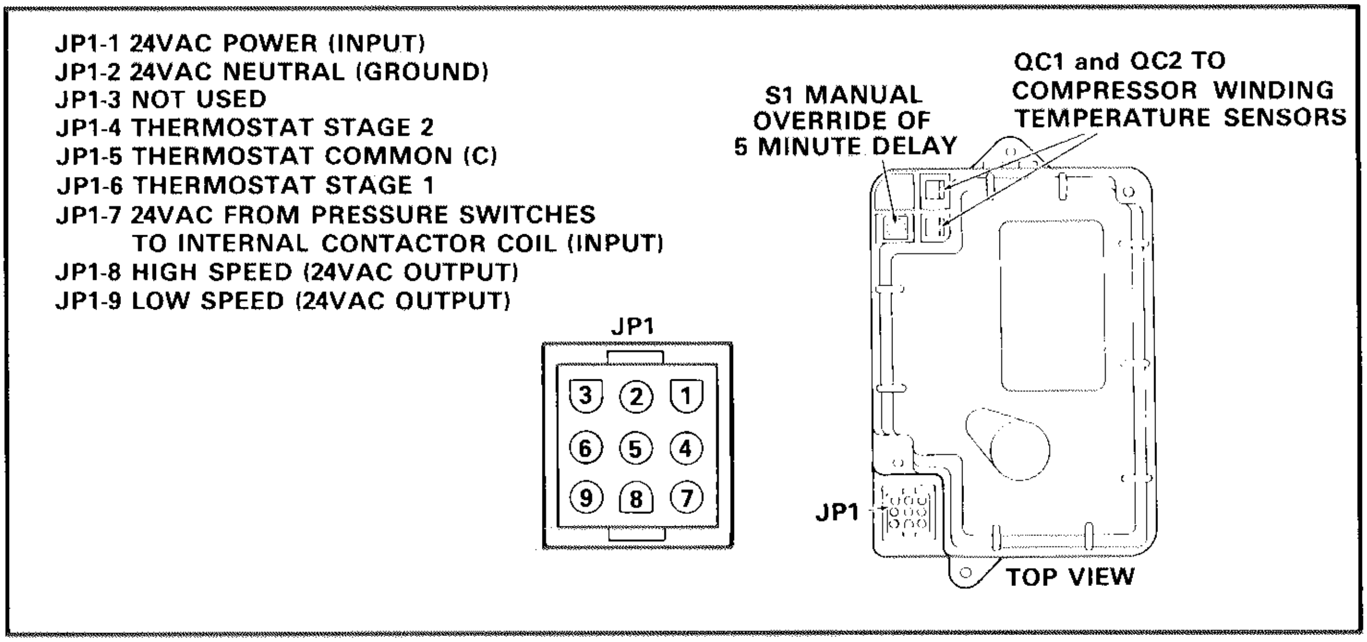


FIGURE 4

4- High Pressure Switch (S1)

All units are equipped with a high pressure switch mounted on the compressor discharge line. The manually reset high pressure switch has a 'cut-out' point of 410±10 psig. The switch is connected in series with the low pressure switch (S2) to the TSC.

5- Low Pressure Switch (S2)

All units are equipped with a low pressure switch (auto reset type) mounted on the compressor suction line. The low pressure switch has a 'cut-out' point of 25±5 psig and automatically resets when suction line pressure increases above 55 ± 5 psig. The switch is connected in series with the high pressure switch (S1).

6- Crankcase Heater Thermostat (S4)

All HS14's are equipped with a crankcase heater thermostat which is mounted on the coil manifold. In three phase units, relay K3 must be de-energized for the crankcase heater to operate (no cooling demand). In single phase units, relay K2 must be de-energized for the crankcase heater to operate (no cooling demand). S4 de-energizes the crankcase heater when coil manifold temperature increases above 94±5°F. S4 closes and brings on the crankcase heater when the compressor stops and coil manifold temperature drops below 74±5°F.

7- TSC-1 & TSC-2 Two Speed Control

The TSC two speed control (figure 4) is a Lennox built control designed for use with two speed condensing units and heat pumps. The control provides automatic switching from low speed to high speed operation and back. The TSC-1 is designed for use with Lennox two speed compressors and will initially be used on HS14-5 series units. The TSC-2 is designed for use with Bristol two speed compressors and will initially be used on HS14-6 series units. The control replaces electromechanical timers and relays used in earlier units.

The TSC two speed control contains relays which energize low speed or high speed compressor operation in response to thermostat demand. High speed operation can be energized and de-energized without passing through low speed. The control also contains safety timed off delays and compressor over-temperature sensing which help protect the compressor.

A timed-off delay in the control delays compressor operation for 5 minutes after the end of each thermostat demand or after a power failure to prevent short cycling (see Miscellaneous section). The control also counts unit fault conditions. Whenever the compressor stops due to a safety limit trip or if the compressor winding temperature becomes too hot, the control's internal cycle counter accumulates 1 fault. If three unit faults are accumulated during the same thermostat demand, the control 'locks-out' and stops all unit operation. The control can be reset by 'breaking and remaking' thermostat demand. Also, unit faults are erased when power is interrupted. Whenever thermostat demand changes stages, compressor operation stops for approximately 1 minute to allow refrigerant pressure to equalize in the system.

In order to aid in servicing and troubleshooting, a manual override button has been placed on the control. The manual override button, when pressed and then released, bypasses the 5 minute delay so low speed or high speed operation can be directly energized.

Normal Operation Sequence

1- General Operation

On power-up, the control begins a 10 second initial power-up delay.

2-The control then begins a 5 minute time delay during which the unit is not operational (control and outdoor unit do not respond to thermostat demand). Once the 5 minute delay is complete, the control waits in 'OFF' mode for thermostat demand.

3- After receiving a new thermostat demand, the two speed control delays 3 seconds before responding.

4- Low speed demand (JP1-6) energizes low speed operation (JP1-9) OR high speed demand (JP1-4) energizes high speed operation (JP1-8).

5- If thermostat demand stops during low speed or high speed operation, all unit operation stops after a 3 second delay (control de-energizes JP1-8 and JP1-9), the control resets (see Unit Fault Conditions Section) and the control returns to step 2 above.

6- During unit operation, if low speed demand changes to high speed or if high speed demand changes to low speed, the control delays 3 seconds before responding. Then, all unit operation stops for 60$\pm$5 seconds (control de-energizes JP1-8 and JP1-9). This allows refrigerant pressure to equalize in the system. At the end of the 60$\pm$5 second delay, the control responds to whatever thermostat demand is present. If no thermostat demand is present, the control resets (see Unit Fault Conditions Section) and the control returns to step 2.

Two Speed Control Unit Fault Conditions

If the control is in low speed operation, high speed operation, 'OFF' mode or speed change delay, the control will 'count' or accumulate unit faults on a internal cycle counter. Only faults which occur during compressor operation and cause the compressor to shut off are counted. After each fault is counted, the control stops all unit operation, resets and begins the 5 minute time delay (step 2, sequence of operation). If the control continues to sense a fault at the end of the 5 minute delay, the unit will not restart. If the control 'counts' 3 unit faults during the same thermostat demand, the control 'locks-out' all unit operation.

NOTE-If the control 'locks-out', it can be reset by breaking thermostat demand for about 5 seconds then remaking thermostat demand. Also, anytime thermostat demand is removed or power is interrupted, the control resets to zero faults.

A Unit Fault Occurs When:

A- On condensing units, compressor operation is controlled by the high pressure switch and the low pressure switch. These controls are wired in series. If either one trips, compressor operation is interrupted and 1 fault is accumulated. Note that in most cases, the high pressure switch must be reset manually while the low pressure switch resets automatically. It is likely that the control could accumulate 3 unit faults from the low pressure switch during the same thermostat demand. However, the control only accumulates unit faults from the high pressure switch if the reset button is pushed *without* breaking and remaking thermostat demand.

B- On all units using the TSC two speed control, terminals QC1 and QC2 on the control are connected to temperature sensors (thermistors) which monitor the temperature of the compressor motor windings. The two speed control measures the resistance through the sensors. The sensor wires are not polarity sensitive. The sensors increase their resistance as temperature increases. When the resistance through the sensors increases above a preset limit, the control stops compressor operation. As the compressor windings cool, the resistance through the sensors drops. When the resistance through the sensors drops below the reset limit, the control resets automatically and 1 fault is accumulated. Table 8 shows the resistance values for winding temperature sensors in different compressors.

IMPORTANT–If the cycle counter accumulates three faults during the same thermostat demand, the control 'locks–out'. The outdoor unit remains inoperable until thermostat demand is broken. This indicates further troubleshooting is needed. Though the control can be reset by breaking thermostat demand, the outdoor unit may remain inoperable. The high pressure or high temperature condition may still exist and must be located and corrected before the unit can be placed back in service.

TABLE 8

Compressor Winding Temperature Sensor	Trip Ohms Temp. Rise	Reset Ohms Temp. Fall
TSC-1 Lennox Compressor	16K to 24K	5.5K to 6.9K
TSC-2 Bristol Compressor	25K to 35K	8.4K to 10K

Two Speed Control Manual Override

The manual override button is designed to be an aid in servicing and troubleshooting the control or the unit. When the button is pressed and released, the control bypasses the 5 minute override delay. This is not a reset button.

If the button is pushed and released *during the initial 10 second power–up delay*, the button has no effect. The control completes the 5 minute delay as in normal operation. *Do not use the button for at least 11 seconds after power–up.*

If the override button is pushed and released *during the 5 minute delay,* the control bypasses the time delay and goes directly to 'OFF' mode where it waits for thermostat demand.

For override, the button must be pushed and released after the 5 minute delay has begun.

The manual override button has no effect during the 60 second speed change delay.

Miscellaneous

A– The control delays approximately 3 seconds before responding to any new command. The control responds 3 seconds after a new thermostat demand and releases 3 seconds after the end of a thermostat demand. See *IMPORTANT* below.

IMPORTANT–THE CONTROL RESPONDS TO THE MANUAL OVERRIDE BUTTON 3 SECONDS AFTER THE BUTTON IS RELEASED TO PROVIDE TIME TO MOVE HANDS AND FINGERS AWAY FROM THE CONTROL BOX AREA.

B– To prevent compressor short cycling, the control immediately returns to step 2 of the operation sequence if any of the following occur:
1– A safety circuit shutdown (pressure or temperature sensors).
2– Breaking and remaking thermostat demand.
3– power failure followed immediately by power–up.

NOTE–If the control will not reset after 'locking–out', check the manually reset controls. A fault condition may still exist.

DANGER–DO NOT ATTEMPT TO REPAIR THE CONTROL. UNSAFE OPERATION MAY RESULT. USE THE SEQUENCE OF OPERATION ONLY AS A GUIDE FOR DIAGNOSING PROBLEMS. IF THE CONTROL IS FOUND TO BE FAULTY, SIMPLY REPLACE THE ENTIRE CONTROL.

CAUTION– THE INTERNAL CIRCUITRY IS SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGE. TO PREVENT THIS TYPE OF DAMAGE, DO NOT REMOVE THE CONTROL'S COVER.

C–Charging Procedure

This charging procedure is intended as a guide. It is intended for use on expansion valve systems only. For best results, indoor temperature should be 70°F (21°C) and 80°F (27°C). Be sure to monitor system pressures while charging.

It is not recommended that the system be charged below 60°F. If charging below 60°F is required, the most reliable method is to weigh in the charge listed on the unit nameplate. This amount will be correct for a system with a line set length of of 25 feet. If line set length is greater than 25 feet, add one ounce of refrigerant per foot in excess of 25 feet. If line set is shorter than 25 feet, subtract one ounce of refrigerant for every foot less than 25 feet.

1- Turn indoor thermostat to 'OFF' position.

2- Indoor temperature should be between 70°F (21°C) and 80°F (27°C).

3- Fill thermometer well with oil (to assure accurate reading). Do not insert thermometer in well now.

4- Install high pressure gauge to the liquid line service port *(do not use the compressor discharge port)*. Connect the low pressure gauge to the compressor suction line service port.

5-Turn indoor thermostat to 'COOL' mode and adjust to lowest temperature setting (call for both stages of cooling so compressor is energized on high speed).

6-If power to outdoor unit has been off, allow 10 seconds for two speed control to power-up. Press and release manual override button on two speed control. Compressor should energize on high speed within 3 seconds. Allow unit to operate and system to stabilize before and after each charge adjustment.

7- Check outdoor temperature.

8- Insert thermometer in well and check liquid line temperature.

9-Approach temperature = liquid temperature minus ambient temperature. Approach temperature should approximate the values given in table 9.

TABLE 9

Unit	Approach Temperature (°F)
411V-5P, 413V-5Y	3.0 ± 1.0
511V-5P, 513V-5Y	4.0 ± 1.0
651V-5P, 653V-5Y	5.0 ± 1.0
411V-6P, 413V-6Y	8.0 ± 1.0
511V-6P, 513V-6Y	6.0 + 1.0
651V-6P, 653V-6Y	5.0 ± 1.0

10-An approach temperature greater than the value shown in table 9 indicates an undercharge. Add refrigerant slowly and continue to watch liquid line temperature (thermometer well) until approach temperature approximates the value given in table 9.

An approach temperature less than the value shown indicates an overcharge. Do not vent refrigerant into atmosphere. Use only approved refrigerant reclaiming methods.

When the unit is properly charged, the system pressure should approximate the pressure given in the Normal Operating Pressure Table (table 10).

Use table 10 only as a general guide in performing maintenance checks. Table 10 is not a procedure for charging the unit. Minor variations in these pressures may be expected due to the differences in installations. Significant deviations could mean that the system is not properly charged or that a problem exists with some component in the system. Used properly, this table could serve as a useful service guide.

TABLE 10

Normal Operating* Pressure Table	HS14-411V-5P HS14-413V-5Y		HS14-511V-5P HS14-513V-5Y		HS14-651V-5P HS14-653V-5Y		HS14-411V-6P HS14-413V-6Y		HS14-511V-6P HS14-513V-6Y		HS14-651V-6P HS14-653V-6Y	
Outdoor Coil Entering Air Temp.	Liquid ±10 psig	Suction ±5 psig	Liquid ±10 psig	Suction ±5 psig	Liquid ±10 psig	Suction ±5 psig	Liquid ±10 psig	Suction ±5 psig	Liquid ±10 psig	Suction ±5 psig	Liquid ±10 psig	Suction ±5 psig
65°F	150	66	158	66	148	61	149	66	158	66	157	61
75°F	173	71	186	68	170	66	172	71	179	68	182	66
85°F	193	73	205	71	198	69	205	73	215	71	213	69
95°F	230	76	245	73	224	70	238	76	247	73	247	70
105°F	264	78	280	75	264	72	270	78	280	75	279	72

*Unit operating on high speed, indoor return air at 80°F.

IV-UNIT DIAGRAMS AND

SEQUENCE OF OPERATION

A-Compressor Startup

Single Phase Compressor Startup

Figure 5 shows single phase compressor windings. This 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 compressor comes up to speed. The run capacitor remains connected to the start winding and the motor runs as a two phase induction motor with improved power factor and torque characteristics provided by the capacitor.

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

High speed compressor operation is provided when the run windings are connected in parallel; terminals 1 (common) and 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) and 3.

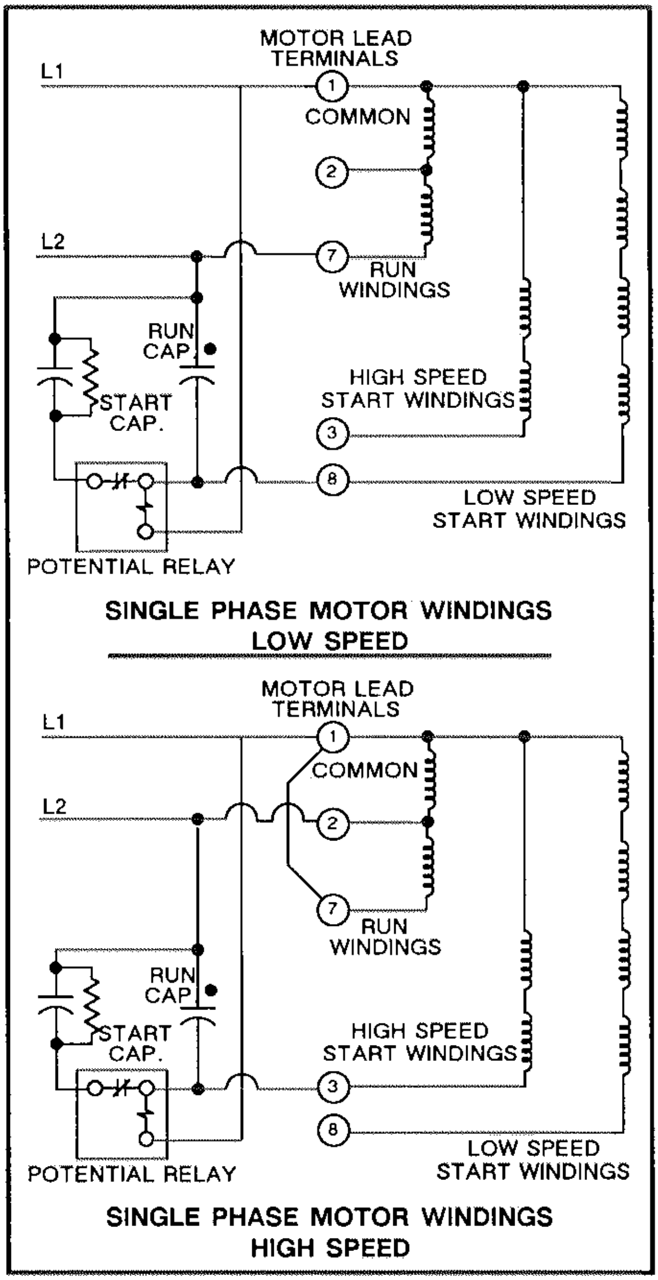


FIGURE 5

Three Phase Compressor Startup

Figure 6 shows windings of three phase two speed compressors. These compressors have two speed, three phase induction motors. Capacitors are not needed to provide the proper phase and torque characteristics.

Low speed operation is provided when the motor windings are connected in a series circuit. The motor operates at 1800 RPM. Lennox compressors are connected in a series 'Y' circuit. Bristol compressors are connected in a series 'Delta' circuit.

High speed operation is provided when the motor windings are connected in a parallel circuit. Auxiliary contacts on the low speed contactor provide this connection. Lennox compressors are connected in a parallel 'Y' circuit. Bristol compressors are connected in a parallel 'Delta' circuit.

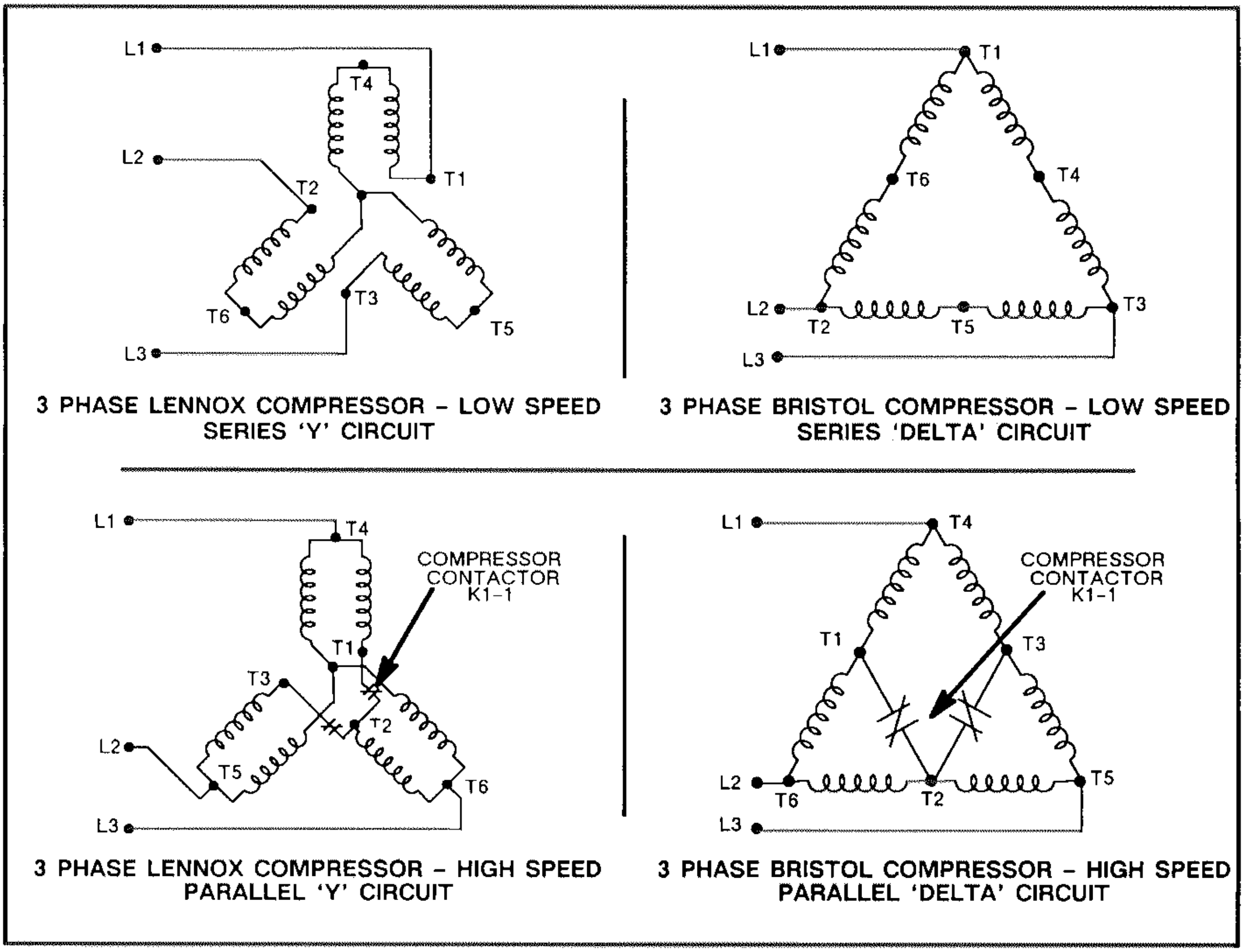
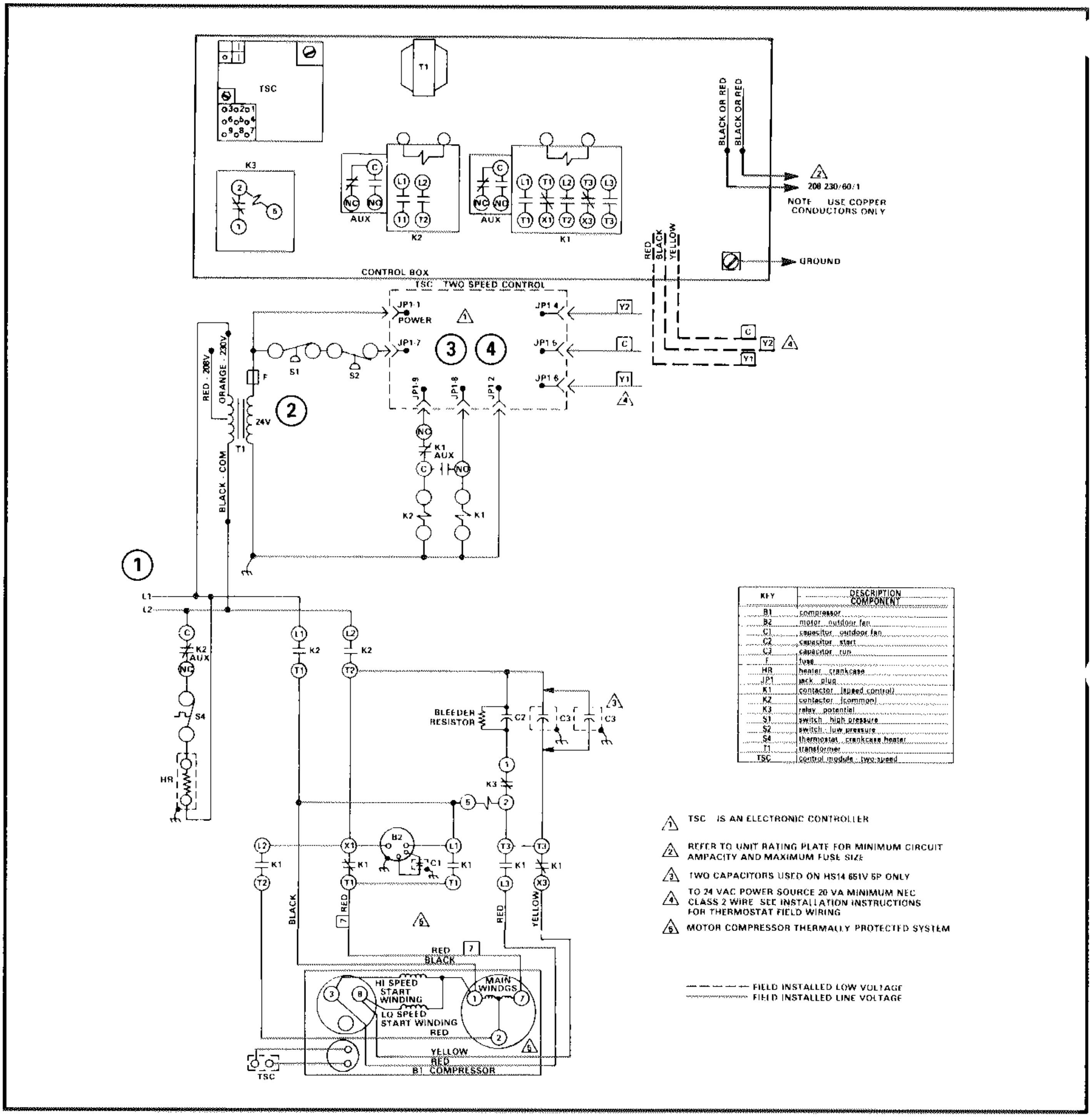


FIGURE 6



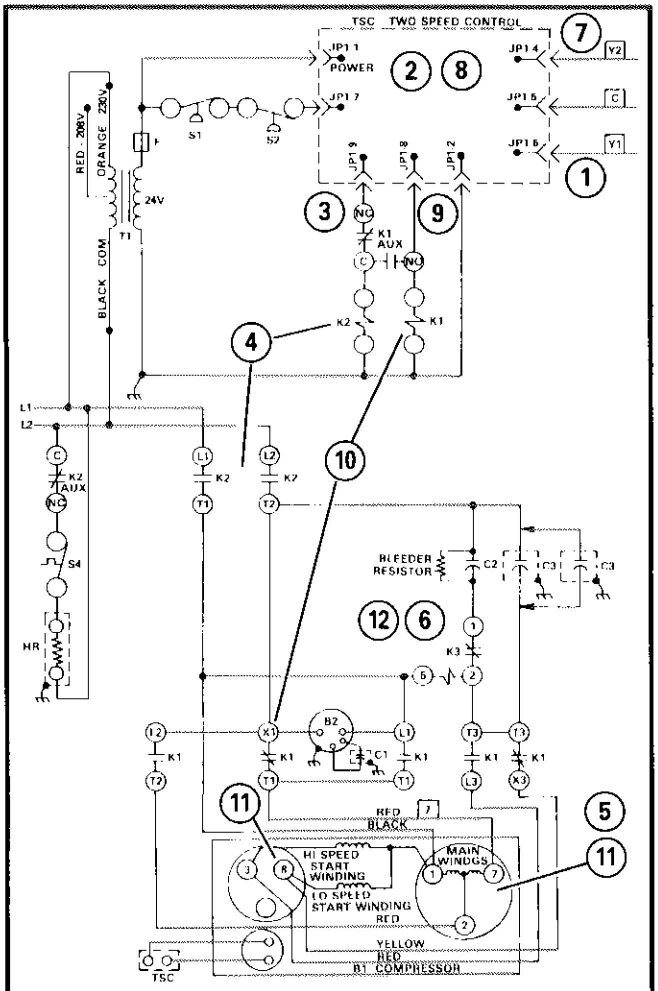
B–SINGLE PHASE STARTING SEQUENCE

1– Line voltage feeds through L1 and L2 to energize transformer T1 and the unit. Crankcase heater HR is energized through relay K2 N.C. auxiliary contacts and crankcase heater thermostat S4.

2– Transformer T1 provides 24VAC power to the control circuit.

3– On power–up, 24VAC power is fed through JP1–1 and JP1–7 to the two speed control. TSC begins an initial 10 second power–up delay.

4– TSC then begins a 5 minute delay during which the unit is not operational. After the 5 minute delay, TSC waits in 'OFF' mode for 1st stage or 2nd stage demand. After the delay, thermostat demand is allowed to energize the unit.



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor outdoor fan
C1	capacitor outdoor fan
C2	capacitor start
C3	capacitor run
F	fuse
HR	heater crankcase
JP1	jack plug
K1	contactor (speed control)
K2	contactor (common)
K3	relay potential
S1	switch high pressure
S2	switch low pressure
S4	thermostat crankcase heater
T1	transformer
TSC	control module two speed

C-SINGLE PHASE OPERATION

LOW SPEED:

1- 1st stage demand energizes Y1 in the unit. Y1 energizes JP1-6 on the TSC. TSC delays 3 seconds before responding to the new command.

2- If the unit is changing from 2nd stage to 1st stage demand, TSC initiates speed change delay and de-energizes JP1-8 and JP1-9 to stop all unit operation for 60$\pm$5 seconds. After the TSC completes the 60$\pm$5 second speed change delay, or if the unit is starting up in 1st stage directly from 'OFF' mode, TSC checks safety circuits by looking for 24$\pm$6 VAC at JP1-7 and by checking resistance through wires connected to QC1 and QC2.

3- If all safety circuits are alright, TSC energizes JP1-9 and compressor begins low speed startup.

4- Contactor K2 is energized through contactor K1 N.C. auxiliary contacts. K2 N.C. auxiliary contacts open to de-energize the crankcase heater. All other K2 contacts close to begin low speed startup.

5- Compressor B1 terminal 1 and the condenser fan circuit are energized by K2 contacts L1-T1 and L2-T2. Compressor terminal 7 and the condenser fan are both energized by contactor K2 terminal L2-T2 through contactor K1 terminal T1-X1. Compressor terminal 8 (start winding) is energized by contactor K2 terminal L2-T2 through the start (C2) and run (C3) capacitors and contactor K1 terminal T3-X3.

6- As the compressor nears full speed, potential relay K3 energizes and K3 contacts 1-2 open to de-energize the start capacitor.

HIGH SPEED:

7- 2nd stage demand energizes Y2 in the unit. Y2 energizes JP1-4 on the TSC. TSC delays 3 seconds before responding to the new command.

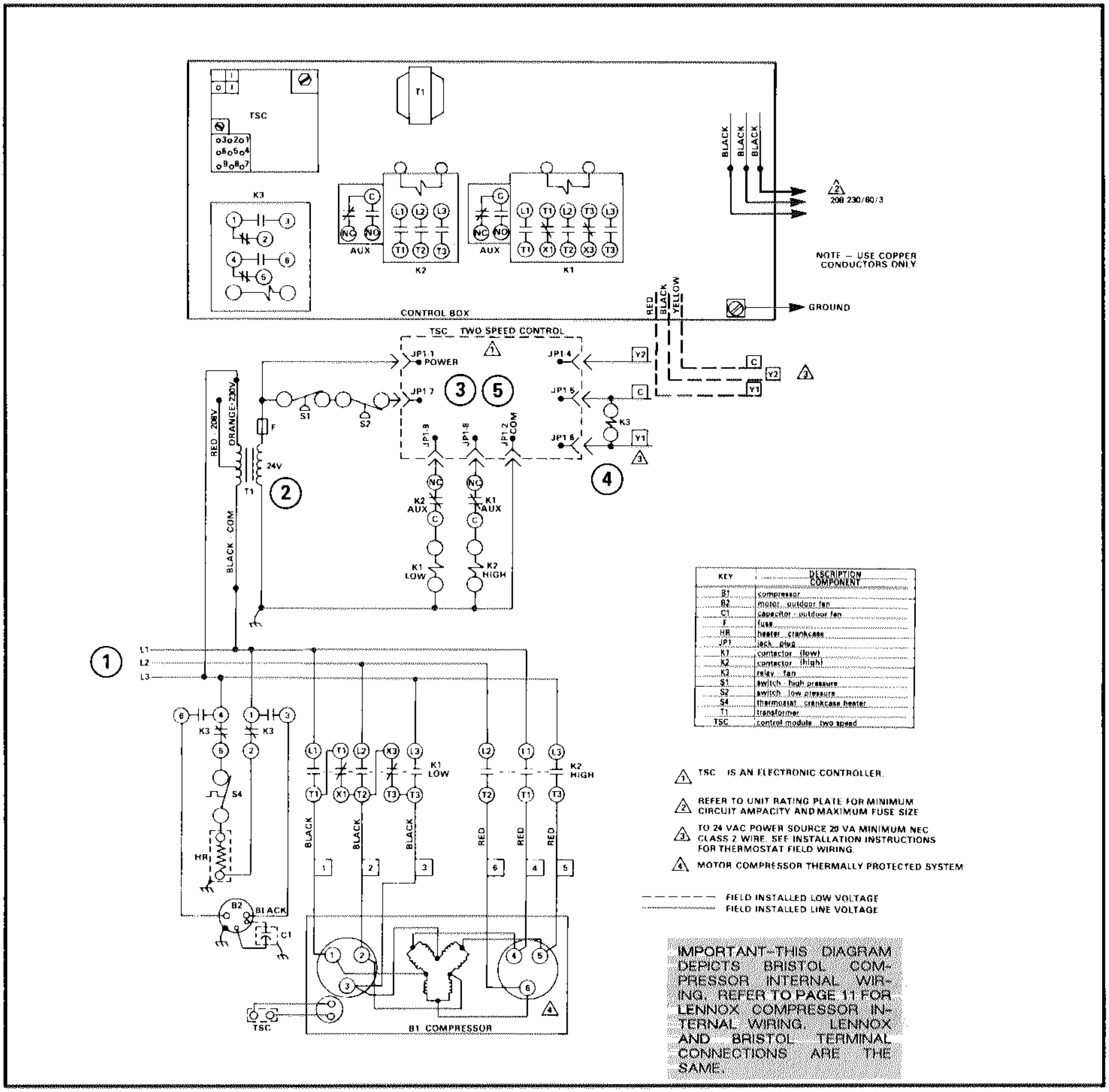
8- If the unit is changing from 1st stage to 2nd stage demand, the TSC initiates speed change delay and de-energizes JP1-8 and JP1-9 to stop all unit operation for 60$\pm$5 seconds. After TSC completes the 60$\pm$5 second speed change delay, or if the unit is starting up in 2nd stage directly from 'OFF' mode, TSC checks safety circuits by looking for 24$\pm$6 VAC at JP1-7 and by checking resistance through wires connected to QC1 and QC2.

9- If all safety circuits are alright, TSC energizes JP1-8.

10- Contactor K1 energizes and K1 N.O. auxiliary contacts close to energize contactor K2. K2 auxiliary contacts open to de-energize the crankcase heater. All other K2 contacts close. K1 contacts L1-T1, L2-T2 and L3-T3 close while contacts T1-X1 and T3-X3 open.

11- Compressor B1 terminal 3 (start winding) is energized by contactor K2 terminal L2-T2 through the start (C2) and run (C3) capacitors and through contactor K1 terminal L3-T3. Compressor terminal 2 is energized by contactor K2 terminal L2-T2 through contactor K1 and terminal L2-T2. Compressor terminal 1 is energized directly by contactor K2 terminal L1-T1. Compressor terminal 7 is energized by contactor K2 terminal L1-T1 through contactor K1 terminal L1-T1.

12- As the compressor nears full speed, potential relay K3 energizes and K3 contacts 1-2 open to de-energize the start capacitor (C2).



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor - outdoor fan
C1	capacitor - outdoor fan
F	fuse
HR	heater - crankcase
JP1	jack - plug
K1	contactor (low)
K2	contactor (high)
K3	relay - fan
S1	switch - high pressure
S2	switch - low pressure
S4	thermostat - crankcase heater
T1	transformer
TSC	control module - two speed

D–THREE PHASE STARTING SEQUENCE

1– Line voltage feeds through L1, L2 and L3 to energize transformer T1 and the unit. Crankcase heater HR is energized through relay K3 N.C. contacts and crankcase heater thermostat S4.

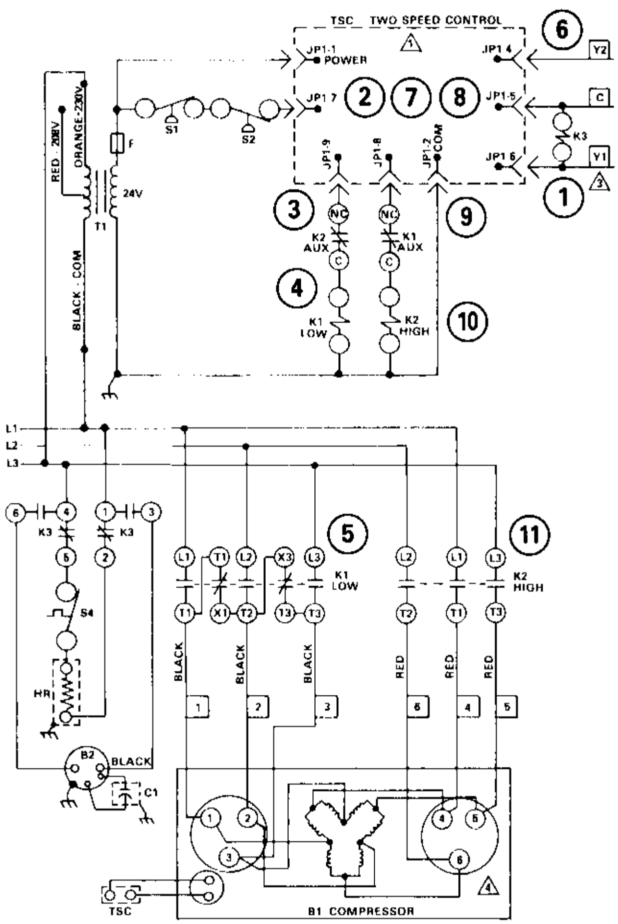
2– Transformer T1 provides 24VAC power to the TSC and contactors K1 and K2.

3– On power-up, 24VAC power is fed through JP1-1 and JP1-7 to the two speed control. TSC begins an initial 10 second power-up delay.

4– TSC then begins a 5 minute timed off delay during which the unit is not operational.

NOTE–If thermostat demand is present during this delay, the condenser fan will be energized. See operation sequence on next page.

5– After the 5 minute timed off delay, TSC waits in 'OFF' mode for 1st stage or 2nd stage demand and thermostat demand is allowed to energize the compressor.



IMPORTANT-THIS DIAGRAM DEPICTS BRISTOL COMPRESSOR INTERNAL WIRING. REFER TO PAGE 11 FOR LENNOX COMPRESSOR INTERNAL WIRING. LENNOX AND BRISTOL TERMINAL CONNECTIONS ARE THE SAME.

KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor · outdoor fan
C1	capacitor outdoor fan
F	fuse
HR	heater crankcase
JP1	jack plug
K1	contactor (low)
K2	contactor (high)
K3	relay · fan
S1	switch high pressure
S2	switch low pressure
S4	thermostat · crankcase heater
T1	transformer
TSC	control module · two-speed

E-THREE PHASE OPERATION

LOW SPEED:

1- 1st stage demand energizes Y1 in the unit. Y1 energizes JP1-6 on the TSC and relay K3. Relay K3 immediately energizes and contacts 4-5 and 1-2 open to de-energize the crankcase heater while contacts 4-6 and 1-3 close to energize the condenser fan. The condenser fan begins operating. The TSC delays 3 seconds before responding to the new command.

2- If the unit is changing from 2nd stage to 1st stage demand, TSC initiates speed change delay and de-energizes JP1-8 and JP1-9 to stop all unit operation for 60±5 seconds. After the TSC completes the 60±5 second speed change delay, or if the unit is starting up in 1st stage directly from 'OFF' mode, TSC checks safety circuits by looking for 24±6 VAC at JP1-7 and by checking resistance through wires connected to QC1 and QC2.

3- If all safety circuits are alright, TSC energizes JP1-9 and compressor begins low speed startup.

4- Contactor K1 is energized through K2 N.C. auxiliary contacts. K1 N.C. auxiliary contacts open to prevent contactor K2 from being energized.

5- K1 contacts L1-T1, L2-T2 and L3-T3 close to begin low speed startup. Contacts T1-X1 and T3-X3 open to disconnect the high speed wiring circuit. This arrangement forms a series connection to the motor windings for low speed.

HIGH SPEED:

6- 2nd stage demand energizes Y1 and Y2 in the unit. Y2 energizes JP1-4 on the TSC. TSC delays 3 seconds before responding to the new command.

7- If the unit is changing from 1st stage to 2nd stage demand, TSC initiates a speed change delay and de-energizes JP1-8 and JP1-9 to stop all unit operation for 60±5 seconds. *The condenser fan continues to operate.* If the unit is starting up in 2nd stage directly from 'OFF' mode, the condenser fan is immediately energized when thermostat demand is present and the TSC responds to thermostat demand 3 seconds later.

8- After the TSC completes the 60±5 seconds speed change delay or if the unit is starting up in 2nd stage directly from 'OFF' mode, TSC checks safety circuits by looking for 24±6 VAC at JP1-7 and by checking resistance through wires connected to QC1 and QC2.

9- If all safety circuits are alright, TSC energizes JP1-8 and compressor begins high speed startup.

10- Contactor K2 is energized through K1 N.C. auxiliary contacts, K2 N.C. auxiliary contacts open to prevent K1 from being energized.

11- K2 contacts L1-T1, L2-T2 and L3-T3 close to begin high speed startup. K1 contacts T1-X1 and T3-X3 are closed to form a parallel circuit to the motor windings for high speed.

TSC TWO SPEED CONTROL
HS14 SERIES UNITS
TROUBLESHOOTING FLOWCHART