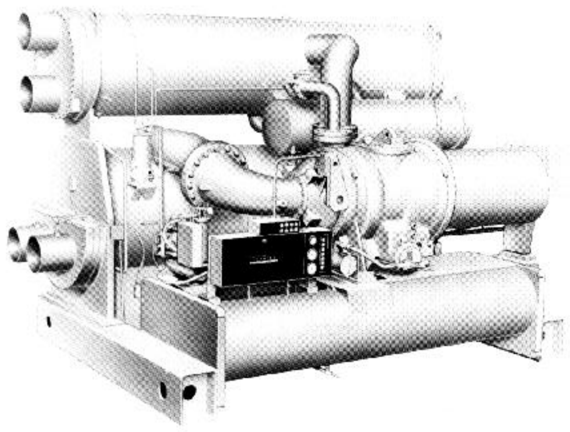
Number One Air Conditioning Maker

Carrier

Start-Up, Operation and Maintenance Instructions

19FA

Hermetic Centrifugal Liquid Chillers



Form 19FA-2SS

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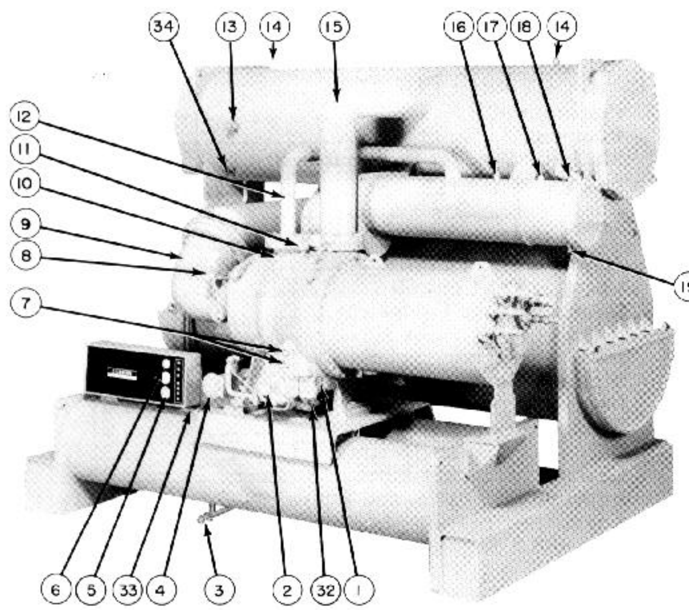
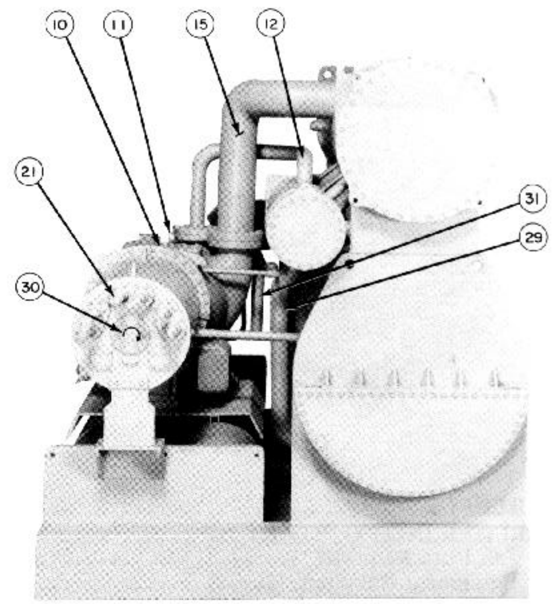


FRONT VIEW



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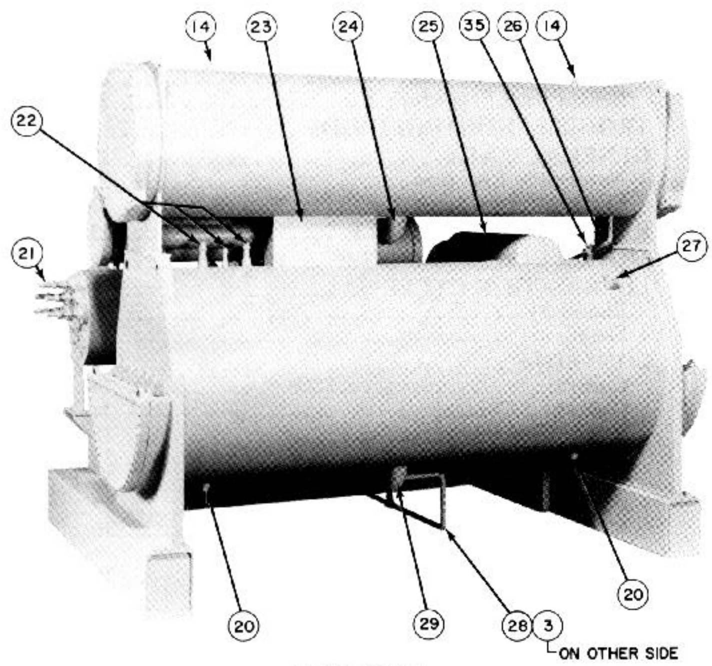

REAR VIEW

1 – Oil Heater and Thermostat
2 – Oil Pump Terminal Box
3 – Refrigerant Charging Valve (Valve 10)
4 – Oil Cooler
5 – Cooler Pressure Gage
6 – Oil Pressure Gage
7 – Oil Level Sight Glass
8 – Guide Vane Actuator
9 – Compressor Suction Elbow
10 – Gear Rotation Sight Glass and Inspection Cover
11 – Thrust Bearing Temperature Gage
12 – Economizer Gas Line to Compressor
13 – Sight Glass or Level Control Connection
14 – Condenser Vent Connection (Valve 11)
15 – Compressor Discharge Pipe
16 – Control Connection
17 – Vent Connection (Flash Gas Chamber)
18 – Vent Connection (Cond Float Valve Chamber)
19 – Economizer High Side Drain
20 – Cooler Drain Connection
21 – Compressor Motor Terminal
22 – Cooler Relief Valves
23 – Vessel Support Plate
24 – Refrigerant Liquid Outlet
25 – Cooler Suction Pipe
26 – Motor Cooling Liquid Supply Line
27 – Pumpout Connection
28 – Refrigerant Transfer Pipe
29 – Cooler Liquid Inlet from Economizer
30 – Motor Rotation Arrow
31 – Oil Filter
32 – Oil Drain and Charging Valve
33 – Storage Tank Vent Valve (Valve 9)
34 – Condenser Liquid Temperature Well
35 – Service Valve 1

Fig. 1 — 19FA Machine Components

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Contents

PREFACE

Thoroughly review these instructions and all necessary job data before operating this machine. Instructions are arranged in the proper sequence for machine start-up and operation.

MACHINES WITH SPECIAL COMPONENTS OR CONTROLS MAY REQUIRE SPECIAL START-UP ADJUSTMENTS AND PROCEDURES. CHECK YOUR INDIVIDUAL JOB REQUIREMENTS.

BEFORE INITIAL START-UP

Job Data Required

1. List of applicable design temperatures and pressures.
2. Machine assembly, wiring and piping prints.
3. Prints and instructions for special controls.
4. Starter details and wiring diagrams.
5. 19FA Installation Instructions.
6. Pumpout Unit Instructions – 06D, 07D Installation, Start-Up and Service.

Equipment Required

1. Mechanic's tools.
2. Clamp-on ammeter and volt-ohmmeter.
3. Leak detector, electronic or halide.
4. Absolute pressure manometer or vacuum indicator.
5. Portable vacuum pump, 5 to 7.5 cfm or larger.

Using the Pumpout Unit – Refer to Pumpout Procedures, page 17 for pumpout unit preparation, refrigerant transfer and machine evacuation.

Check Machine Tightness – The 19FA machine is shipped with a full refrigerant charge in the integral storage tank and a holding charge of approximately 10 psig in the refrigeration machine (cooler, condenser, economizer and compressor). Several levels of leak testing may be required, depending upon the condition of the machine on arrival and at time of initial start-up.

Check storage tank tightness first and then check machine proper. In some instances, the storage tank will have to be rechecked following the machine tests. The proper sequence and procedures for leak testing are outlined in Fig. 3. Instructions for standing vacuum test and dehydration may be found on page 4; instructions for refrigerant transfer and vessel evacuation on pages 18 and 19.

→ *Retighten all gasketed joints after leak testing.*

→ If the machine is spring-isolated, keep springs blocked in both directions to prevent possible piping stress and damage when refrigerant is transferred from vessel to vessel during the leak testing process. Adjust springs when refrigerant is in operating condition and water circuits are full.

CHECK CONDITION OF STORAGE TANKS AND MACHINE – Attach an accurate 30"-0-200 psi gage to vent valve 9 on the storage tank (item 33, Fig. 1). Valve connection size is 1/2-in. male flare.

→ Machine pressure is indicated on the cooler pressure gage in the control center (item 5, Fig. 1). Compare cooler gage reading with the reading taken at the time of machine installation. Allow for any change in ambient temperature. Pressure will increase or decrease about 0.5 psig for every 10 F change in temperature.

All leak testing should be made with a halide or electronic leak detector.

WARNING: Never charge liquid refrigerant into the machine if the pressure is less than the values listed in Table 1. Charge as a gas only, with cooler and condenser water pumps running. Flashing of liquid refrigerant at low pressures can cause tube freeze-up and considerable damage.

When performing the standing vacuum test or machine dehydration, use a manometer or wet-bulb vacuum indicator; dial gages cannot indicate the small amount of leakage acceptable during a short period of time.

→ CHECK SAFETY CONTROL SETTINGS – If machine pressure is reduced to atmospheric (0 psig) for repair during the leak testing process, this may be a convenient time to check the oil low-pressure cutout and the condenser high-pressure cutout as described in Table 4. *Be sure to tag each control with the setting values and the checking date.*

LEAK TEST STORAGE TANKS AND MACHINE – Follow the sequence and procedures given in Fig. 3. Valve numbers and locations are shown in Fig. 1 and Fig. 16. Procedures A and B listed in Fig. 3 are as follows:

Procedure A – Test Machine Side

1. Raise machine pressure to 45 psig, following Pumpout Procedure, steps 1-a thru 1-e of TRANSFER REFRIGERANT FROM STORAGE TANK TO MACHINE.
2. Check machine components and piping for leaks with halide or electronic leak detector.
3. If no leak is found, complete the transfer of refrigerant gas from storage tank to machine (Step 1-f). Retest.
4. If leak is found, pump refrigerant gas back into storage tank as follows:
   a. Turn on pumpout condenser water.
   b. Open valves 1, 3, 4 and 6.

VALVE	1	2	3	4	5	6	7	8
CONDITION		C			C		C	C

   See Fig. 16 for valve location.

   c. Run pumpout compressor until machine pressure is reduced to 0 psig.
5. Repair leak and repeat procedure to ensure repair. (If machine is opened to atmosphere for an extended period, it must be evacuated before repeating procedure.)

Procedure B – Retest Storage Tank

1. Following all steps under Pumpout Procedure, TRANSFER REFRIGERANT FROM STORAGE TANK TO MACHINE, reduce storage tank pressure to 0 psig.
2. Repair storage tank leak. (If tank is opened for an extended period, it must be evacuated before proceeding.)
3. Valve refrigerant gas back into storage tank as follows:
   a. Open valves 1, 2 and 6.
   b. Slowly open valve 4.

VALVE	1	2	3	4	5	6	7	8
CONDITION			C		C		C	C

4. When tank pressure reaches 45 psig, close valve 4 and check for leak with halide or electronic leak detector.
5. If leak persists, repeat procedure. If leak has been repaired, pump refrigerant from storage tank to machine, following steps 2-g thru 2-m of TRANSFER REFRIGERANT FROM STORAGE TANK TO MACHINE.

Table 1 – Pressures Corresponding to 32 F Saturation Temperature

REFRIG	PRESSURE (psig)	CHARGE AS GAS UP TO
R-500	38.04	45 psig
R-12	30.06	35 psig

Table 2 – Refrigerant Temperature vs Pressure (Saturated)

TEMP (F)	REFRIG (psig) R-500	R-12	R-114	TEMP (F)	REFRIG (psig) R-500	R-12	R-114
0	13.26	9.15	17.79*	70	85.81	70.19	12.87
2	14.48	10.18	17.15*	72	89.01	72.86	13.91
4	15.73	11.24	16.48*	74	92.27	75.60	14.97
6	17.03	12.34	15.78*	76	95.59	78.39	16.06
8	18.36	13.47	15.06*	78	99.0	81.25	17.18
10	19.75	14.64	14.31*	80	102.5	84.17	18.34
12	21.18	15.84	13.52*	82	106.1	87.16	19.52
14	22.65	17.08	12.71*	84	109.7	90.22	20.74
16	24.16	18.36	11.86*	86	113.4	93.34	21.99
18	25.72	19.68	10.98*	88	117.3	96.53	23.27
20	27.33	21.04	10.07*	90	121.2	99.79	24.59
22	28.99	22.44	9.12*	92	125.1	103.12	25.94
24	30.70	23.88	8.14*	94	129.2	106.52	27.32
26	32.45	25.36	7.12*	96	133.3	110.00	28.74
28	34.26	24.88	6.07*	98	137.6	113.54	30.19
30	36.12	28.45	4.99*	100	141.9	117.16	31.69
32	38.04	30.06	3.85*	102	146.3	120.9	33.22
34	40.01	31.72	2.69*	104	150.9	124.6	34.78
36	42.02	33.42	1.47*	106	155.4	128.5	36.39
38	44.10	35.17	0.22*	108	160.1	132.4	38.03
40	46.24	36.97	0.55	110	164.9	136.4	39.71
42	48.44	38.82	1.18	112	169.8	140.5	41.44
44	50.69	40.71	1.86	114	174.8	144.7	43.20
46	53.01	42.66	2.56	116	179.9	148.9	45.00
48	55.39	44.65	3.28	118	185.0	153.2	46.85
50	57.82	46.70	4.03	120	190.3	157.6	48.74
52	60.32	48.80	4.80	122	195.7	162.2	50.67
54	62.87	50.95	5.59	124	201.2	166.7	52.65
56	65.52	53.16	6.41	126	206.7	171.4	54.67
58	68.21	55.42	7.26	128	212.4	176.2	56.73
60	70.96	57.74	8.13	130	218.2	181.0	58.84
62	73.79	60.11	9.02	132	224.1	185.9	60.99
64	76.69	62.54	9.94	134	230.1	191.0	63.20
66	79.67	65.03	10.89	136	236.3	196.1	65.45
68	82.71	67.58	11.87	138	242.5	201.3	67.74

*Inches of mercury below one atmosphere.

Standing Vacuum Test

1. Attach an absolute pressure manometer or wet-bulb vacuum indicator to the affected vessel(s) (storage tank or machine proper). Dial gages cannot register the small amount of leakage acceptable during a short period of time.
2. Evacuate the vessel (see Pumpout Procedures) to 22 in. Hg vac, ref 30-in. bar. (4.0 psia), using vacuum pump or pumpout unit.
3. Valve off pump to hold vacuum and record the manometer or indicator reading.
4. If the leakage rate is less than 0.05 in. Hg in 24 hours, the vessel is sufficiently tight.
5. If the leakage rate exceeds 0.05 in. Hg in 24 hours, repressurize the vessel as described below and test for leaks. If refrigerant is available in the other vessel, pressurize by following steps 1 thru 6 of the Pumpout Procedure, RETURN REFRIGERANT TO NORMAL OPERATING CONDITIONS. If not, use nitrogen and refrigerant tracer. Raise the vessel pressure in increments until leak is detected. If refrigerant is used, the maximum gas pressure is approximately 70 psig at normal ambient temperature; with nitrogen, limit the leak test pressure to 140 psig maximum.
6. Repair leak, retest and then proceed with dehydration.

Dehydration – Dehydration is recommended if the machine has been open for a considerable period of time, machine is known to contain moisture or there has been a complete loss of machine holding charge or storage tank refrigerant charge.

WARNING: Do not start compressor or oil pump even for a rotation check, nor apply test voltage of any kind while machine is under dehydration vacuum. Motor insulation breakdown and serious damage may result.

While dehydration is readily accomplished at normal room temperatures, use of a cold trap (Fig. 2) may substantially reduce the time required. If room temperature is high, dehydration takes place more quickly. At low room temperatures, a very deep vacuum is required for boiling off any water. If low-ambient temperatures are involved, contact a qualified service representative for dehydration techniques.

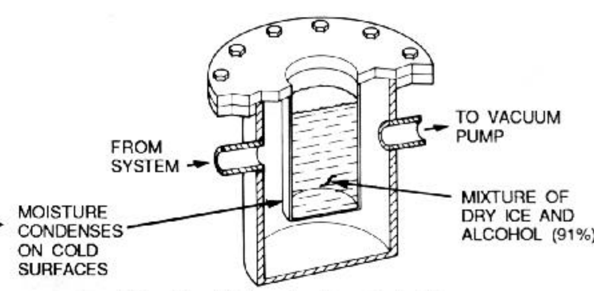
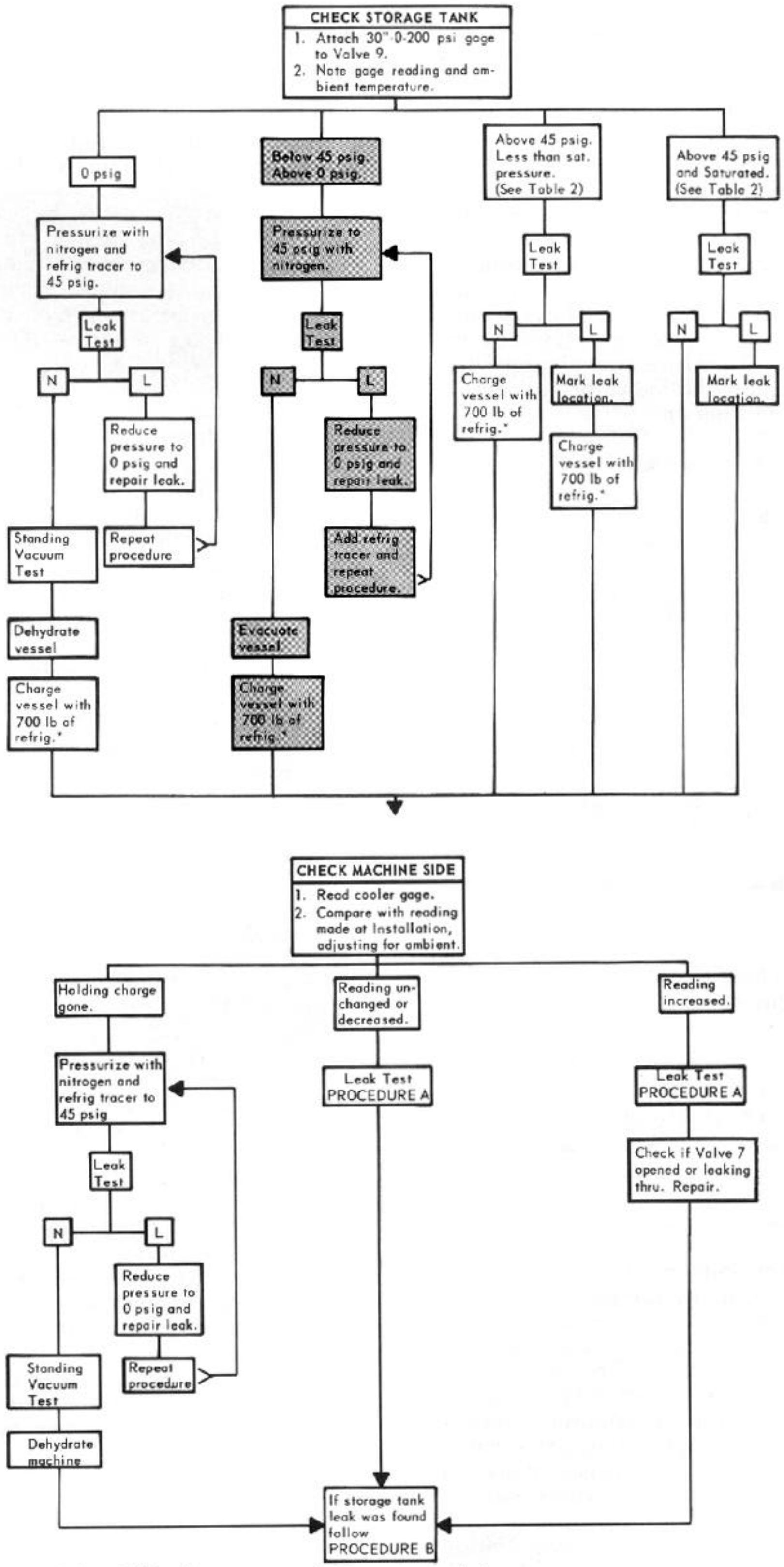


Fig. 2 – Dehydration Cold Trap



At ambient temperatures below 50 F, refrigerant saturation pressure may be less than 45 psig. Do not apply SHADED AREA procedure unless condition (over 0 psig; less than 45 psig) still exists when machine ambient is raised above 50 F.

L — Leak detected N — No leak detected

NOTE: Use halide or electronic leak detector.

*This refrigerant may be used to raise machine side to saturated pressure during machine side leak test.

Fig. 3 — 19FA Leak Test Procedures

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Connect a high capacity vacuum pump (5 - 7 cfm or larger) to valve 10 if storage tank or complete system is to be dehydrated; use charging tee and valve 1 if refrigeration machine only. Tubing from vacuum pump to machine should be as short and as large in diameter as possible to provide the least resistance to gas flow.

Vacuum readings may be made with an absolute pressure manometer or with a wet-bulb vacuum indicator similar to that shown in Fig. 4. Install a shutoff valve on the suction side of both the vacuum pump and the measuring instrument. If a wet-bulb vacuum indicator is used, open its shutoff valve only when taking a reading. Then leave the valve open for 3 minutes or so to allow the indicator vacuum to equalize with machine vacuum.

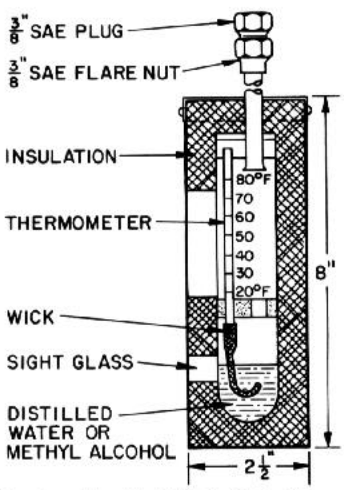

Fig. 4 — Typical Wet-Bulb Type Vacuum Indicator

1. With machine ambient temperature at 60 F or higher, evacuate the desired vessels until the manometer reads 0.20 in. Hg abs (29.8 in. Hg vac ref 30-in. bar.) or the vacuum indicator reads 35 F. The pumpout unit may assist down to 22 in. Hg vac ref 30-in. bar.
2. Continue to operate vacuum pump for 2 more hours.
3. Close valve at pump connection, stop pump and record vacuum reading. *Do not go below 0.18 in. Hg abs (29.82 in. Hg vac ref 30-in. bar.) or 33 F.* Below this temperature/pressure, isolated pockets of moisture can turn into ice. The slow rate of evaporation (sublimation) of ice at low temperature greatly retards the dehydration process.
4. After a 2-hour wait, take another vacuum reading. If vacuum has not decreased, dehydration is complete. If, however, vacuum has decreased, repeat dehydration procedure.
5. If vacuum fails to hold after several dehydration attempts, pressurize vessel(s) to 70 psig with nitrogen and refrigerant tracer. Locate leak; repair at 0 psig. Then repeat dehydration.

Inspect Piping — Refer to the piping diagrams provided in the job data. Inspect piping to cooler, condenser, oil cooler, pumpout system and relief devices. Be sure that flow directions are correct and that all piping specifications are met.

Pipes must be properly vented, with no stress on water box nozzles and covers.

Measure pressure drop across cooler and condenser or across the pumps with accurate gages.

→ CAUTION: Water must be within design flow limits, clean and treated to ensure proper machine performance and reduce the potential of tubing damage due to corrosion, scaling or erosion. Carrier assumes no responsibility for chiller damage resulting from untreated or improperly treated water.

Oil cooler water must meet the specifications for cleanliness, flow rate, pressure and temperature specified in the job data or in the machine Installation Instructions. If city water is used, make sure that drainage is visible. Plug valve (Fig. 13) on oil cooler is adjusted to provide proper oil temperature after compressor start.

Pipe pumpout condenser water to an open sight drain. Check for field-supplied shutoff valves and controls as specified in job data.

Be sure that refrigerant relief valves are piped to the outdoors in compliance with ANSI/ASHRAE 15-1978 Safety Code for Mechanical Refrigeration and applicable local safety codes. Piping connections must allow access to valve mechanism for periodic inspection.

Check that air is properly supplied to pneumatic thermostat (Fig. 5) electro-pneumatic relay (Fig. 11) and pneumatic vane actuator (Fig. 6) on pneumatically controlled machines.

Inspect Wiring

WARNING: Do not check high voltage supply (over 600 v) without proper equipment and precautions. Serious injury may result. Follow power company recommendations.

1. Examine wiring for conformance to job wiring diagrams and to all applicable electrical codes.
2. On low voltage compressors (600 v or less) connect voltmeter across power wires to compressor starter and measure voltage. Compare reading with voltage rating on compressor and starter nameplates.
3. Compare ampere rating on starter nameplate with ampere rating on motor nameplate. Motor overload relay selection must satisfy electrical code requirements.
4. Starter for centrifugal compressor motor must contain the components and terminals required for refrigeration machine control. Check Job Data drawings.
5. Check voltage to the following components and compare to nameplate values: oil pump starter and pumpout compressor motor starter.

WARNING: Do not apply test voltage of any kind, even for a rotation check, if machine is under dehydration vacuum. Insulation breakdown and serious damage may result.

6. Check separate 115-volt supply to oil heater.

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7. Be sure that fused disconnects have been supplied for oil pump, oil heater and pumpout unit.
8. Check that electrical equipment and controls are properly grounded in accordance with job drawings and all applicable electrical codes.
9. Check that customer-contractor has verified proper operation of water pumps and cooling tower fan.
10. Test machine compressor motor and its power lead insulation resistance with a 500-volt insulation tester such as a megohmmeter.
    a. *Open starter main disconnect switch.*
    b. With tester connected to the motor side of the starter contactor in the starter, take 10-second and 60-second megohm readings as follows:

       Six-lead motor – Tie all 6 terminals together and test between terminal group and ground. Next, tie terminals in pairs, 1 and 4, 2 and 5, 3 and 6. Test between each pair while grounding the third pair.

       Three-lead motor – Tie terminals, 1, 2 and 3 together and test between group and ground.
    c. Divide the 60-second resistance reading by the 10-second reading. The ratio, or polarization index, must be 1.5 to 1 or higher. Both the 10-second and the 60-second reading must be at least 50 megohms.

       If the readings are unsatisfactory, repeat the test at the motor with the power leads disconnected. Satisfactory readings in this second test indicate that the fault is in the power leads.

Check Starter – *Open the main disconnect* and check starter.

1. Remove contactor arc chutes. Be sure that contactors move freely and that shipping string has been removed. Replace arc chutes.
2. Check contactors for dirt and rust. Clean contact magnet surfaces lightly with sandpaper. *Do not sandpaper or file silverplated contacts.* Apply a very thin coat of petroleum jelly to magnet surfaces and then wipe it off. If starter has been in a dusty atmosphere, vacuum clean the cabinet and wipe with lint-free cloth.
3. Remove fluid cups from magnetic overload relays. Add dashpot oil to cups per instructions on relay nameplate. Oil is shipped in small vials usually attached to starter frame near relays. Use only dashpot oil supplied with starter. *Do not substitute.* Overload relays are factory set for 108% of motor full load amperage. Resetting is not normally required, nor is it recommended except by a qualified electrical shop.
4. Check transfer timer for proper setting. Starter timers have adjustable range of 10 seconds to 1 minute and are factory set at 30 seconds.
5. With main disconnect open, manually open and close the main control relay (1CR) to be sure that it operates freely.

Lubrication – Size 4 compressors are charged with approximately 15 gallons of oil, and size 5 compressors with approximately 20 gallons. The oil should be visible in the lower sight glass (item 7, Fig. 1). If additional oil is required, it must meet Carrier's specification for centrifugal compressor usage as described in the section, Change Oil and Oil Filter.

Charge the oil thru the oil charging valve on the compressor (item 32, Fig. 1).

Be sure that the hand valve on the oil line near the oil filter(s) (item 31, Fig. 1) is fully open before operating the compressor.

Oil Heater – Energize the oil heater some hours before start-up to minimize oil-refrigerant absorption. The light on the heater cover indicates whether the heater is energized. The oil heater thermostat is set to maintain a temperature of 140-145 F at shutdown. Adjust if required.

Refrigerant Charging – The full refrigerant charge is shipped in the 19FA integral storage tank. The exact charge varies with machine components and design conditions and must therefore be found in the individual job specifications. An approximate charge may be determined by adding the cooler charge to the condenser-economizer charge listed in Table 3.

To prepare the machine for operation, the charge must be transferred from the storage tank to the machine. Refer to Pumpout Procedures for transfer method.

Refrigerant may be added at the storage tank thru valve 10 (item 3, Fig. 1). In this case, the added refrigerant must be pumped into the machine thru the pumpout unit.

Refrigerant may also be added directly into the cooler thru the 3/8-in. FPT tee at valve 1, if desired. In this case, carefully observe the warning below.

WARNING: At pressures below those listed in Table 1, liquid refrigerant flashes into gas and may cause tube freeze-up. Run water pumps and charge refrigerant as a gas until cooler pressure rises above the Table 1 value.

NOTE: Service valve 9 (item 33, Fig. 1) is equipped with a dip tube for checking refrigerant level. Liquid blowoff when valve is opened indicates that storage tank contains more than permissible amount of refrigerant.

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→ **Table 3 — Typical Refrigerant Charges**

COOLER SIZE 17FA*	CHARGE (lb)† R-500	CHARGE (lb)† R-12	COND-ECON ASSEMBLY 17FA*	CHARGE (lb)† R-500	CHARGE (lb)† R-12
10	360	385	**10**	730	815
11	430	460	**11**	730	815
12	450	480	**12**	725	810
14	590	630	**14**	835	935
15	620	660	**15**	830	930
16	650	695	**16**	830	925
18	735	785	**18**	975	1085
19	815	870	**19**	965	1080
20	975	1035	**20**	1170	1305
21	995	1060	**21**	1160	1295
22	1100	1175	**22**	1155	1290
24	1260	1340	**24**	1300	1450
25	1295	1375	**25**	1290	1440
26	1330	1415	**26**	1285	1435
27	1575	1675	**27**	1490	1665
28	1620	1725	**28**	1485	1660
29	1675	1780	**29**	1480	1650
40	500				
41	595				
42	625				
44	820				
45	860				
46	905				
48	1025				
49	1135				
50	1350				
51	1380				
52	1530				
54	1750				
55	1795				
56	1845				
57	2185				
58	2250				
59	2325				

*Identify Cooler and Condenser-Economizer size by first 6 digits of vessel assembly number on Machine Identification Plate e.g. 17FA103-404

†Complete machine charge is the sum of cooler charge plus condenser-economizer charge.

Check Safety Control Operation — See wiring label on control center door for location of electrical terminals. As the following checks are made, control panel lights should appear as indicated.

□ – OFF ■ – ON

1. Open main disconnect (all power off to starter and controls). Disconnect main motor leads in starter.

   □ ON-STOP
   □ START
   □ OIL PUMP
   □ POWER
   □ SAFETY CIRCUIT
   □ LOAD RECYCLE
   □ PROGRAM TIMER

2. Provide control circuit power from separate 115-volt source.

   □ ON STOP
   □ START
   □ OIL PUMP
   ■ POWER
   □ SAFETY CIRCUIT
   □ LOAD RECYCLE
   □ PROGRAM TIMER

3. Press ON-STOP button (light goes on). If SAFETY CIRCUIT light does not go on, check resets on condenser high-pressure safety, low-refrigerant temperature safety, bearing and motor high-temperature circuit breakers (on some machines), and compressor overloads in starter. Check 3-amp fuse in control center.

   ■ ON-STOP
   □ START
   □ OIL PUMP
   ■ POWER
   ■ SAFETY CIRCUIT
   ■ LOAD RECYCLE
   □ PROGRAM TIMER

   If SAFETY CIRCUIT light goes on but LOAD RECYCLE light stays off, check the chilled water recycle switch (auto.-reset).

   If both lights go on, manually trip and reset motor and bearing high-temperature circuit breakers (Control Design 1, Fig. 7), compressor motor overloads in starter, and low-refrigerant temperature cutout to be sure they cut off the safety light. Tripping the chilled water recycle switch cuts off the LOAD RECYCLE light only.

4. Press ON-STOP button (light goes out). Detach and tag end of brown striped wire running from control center terminal (17) to terminal [17].

   □ ON-STOP
   □ START
   □ OIL PUMP
   ■ POWER
   □ SAFETY CIRCUIT
   □ LOAD RECYCLE
   □ PROGRAM TIMER

5. Start chilled water and condenser water pumps. Press ON-STOP button (light goes on).

   ■ ON-STOP
   □ START
   □ OIL PUMP
   ■ POWER
   □ SAFETY CIRCUIT
   □ LOAD RECYCLE
   □ PROGRAM TIMER

6. Press OIL PUMP button for several seconds. Pump should raise oil pressure to 25-30 psi differential on oil pressure gage on machine control panel. SAFETY CIRCUIT and LOAD RECYCLE lights should go on. If pump starts but there is no pressure, reverse any 2 of 3 power leads to change pump rotation.

   ■ ON-STOP
   □ START
   ■ OIL PUMP
   ■ POWER
   ■ SAFETY CIRCUIT
   ■ LOAD RECYCLE
   □ PROGRAM TIMER

7. Release OIL PUMP button. SAFETY CIRCUIT light and LOAD RECYCLE light should go out.

   ■ ON-STOP
   □ START
   □ OIL PUMP
   ■ POWER
   □ SAFETY CIRCUIT
   □ LOAD RECYCLE
   □ PROGRAM TIMER

8. With OIL PUMP button depressed, alternately stop and restart chilled water and condenser water pumps. SAFETY CIRCUIT and LOAD RECYCLE lights should go out as each pump stops. Continuous operation of oil pump is unnecessary.

   ■ ON-STOP
   □ START
   ■ OIL PUMP
   ■ POWER
   □ SAFETY CIRCUIT
   □ LOAD RECYCLE
   □ PROGRAM TIMER

9. Shut off water pumps. Release OIL PUMP button. Press ON-STOP button (light goes out). Replace tagged wire on terminal (17).

   □ ON-STOP
   □ START
   □ OIL PUMP
   ■ POWER
   □ SAFETY CIRCUIT
   □ LOAD RECYCLE
   □ PROGRAM TIMER

10. Start cooler and condenser water pumps.

11. Press ON-STOP button (light goes on).

   ■ ON-STOP
   □ START
   □ OIL PUMP
   ■ POWER
   ■ SAFETY CIRCUIT
   ■ LOAD RECYCLE
   □ PROGRAM TIMER

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12. Press machine START button (motor leads disconnected).

■	ON-STOP
■	START
□	OIL PUMP
■	POWER
■	SAFETY CIRCUIT
■	LOAD RECYCLE
■	PROGRAM TIMER

13. Oil pump starts within 30 seconds.

■	ON-STOP
■	START
■	OIL PUMP
■	POWER
■	SAFETY CIRCUIT
■	LOAD RECYCLE
■	PROGRAM TIMER

14. Compressor motor start contacts close 30 seconds later. Starter transfers to its run condition 30 to 60 seconds after starter is energized.

■	ON-STOP
■	START
■	OIL PUMP
■	POWER
■	SAFETY CIRCUIT
■	LOAD RECYCLE
□	PROGRAM TIMER

15. Open oil pump main disconnect. Compressor motor starter must de-energize. OIL PUMP light remains on for approximately 30 seconds.

■	ON-STOP
□	START
■	OIL PUMP
■	POWER
□	SAFETY CIRCUIT
□	LOAD RECYCLE
■	PROGRAM TIMER

16. OIL PUMP light goes out.

■	ON-STOP
□	START
□	OIL PUMP
■	POWER
□	SAFETY CIRCUIT
□	LOAD RECYCLE
■	PROGRAM TIMER

17. Close oil pump disconnect. In approximately 15 minutes the program timer completes the antirecycle portion of its cycle and machine is ready to restart.

■	ON-STOP
□	START
□	OIL PUMP
■	POWER
■	SAFETY CIRCUIT
■	LOAD RECYCLE
□	PROGRAM TIMER

18. Remove all power. Reconnect motor leads. Restore power.

→ **Check Air Supply (Pneumatic Controls Only)** — Be sure that pneumatic temperature controller on cooler end flange (Fig. 5) and electro-pneumatic relay in machine control center (Fig. 11) are supplied with 25 psi clean dry air.

The guide vane actuator air supply (Fig. 6) should be within a 35 - 90 psi range. Optional controls such as a hot gas bypass may also require air; check your job data.

→ **Check Safety Control Settings (Table 4)** — With the exception of the chilled water low temperature cutout and recycle switch (item 1, Table 4) these controls are most conveniently checked with machine off and unishell pressure at 0 psig. If switches are checked some time before machine initial start up; e.g., during leak test, be sure to tag each switch with temperature or pressure setting and date.

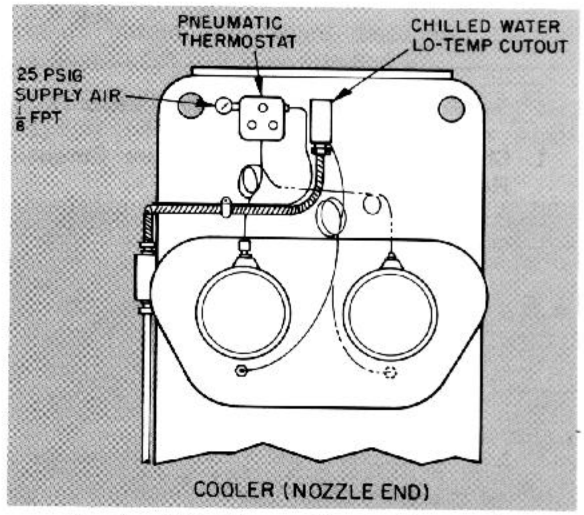
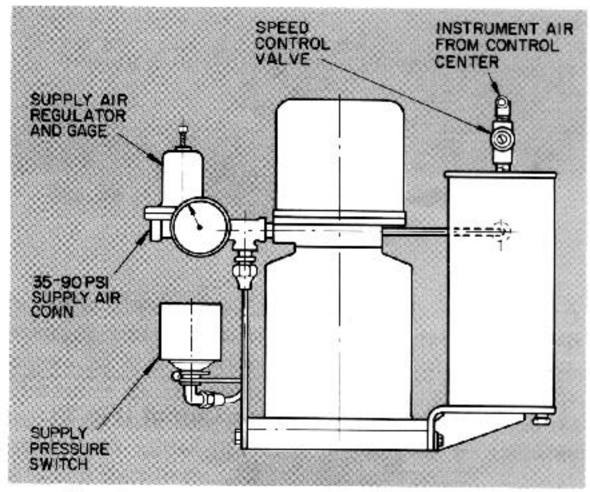


Fig. 5 — Field Connection to Pneumatic Thermostat

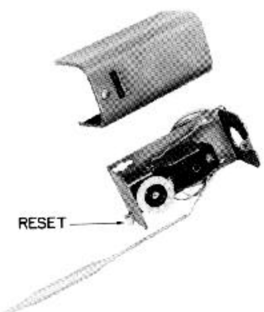
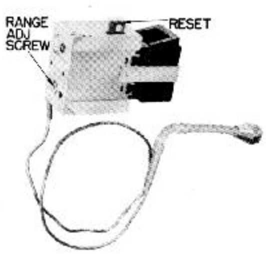
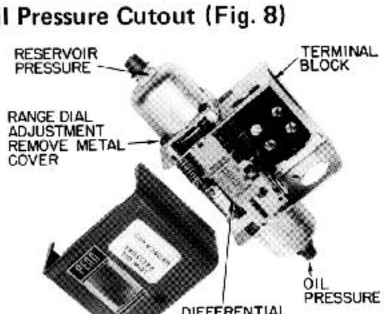


→ **Fig. 6 — Pneumatic Connections to Guide Vane Actuator**

If machine is operated before safety check is complete, carefully monitor chilled water temperature to prevent tube freeze-up. Protection by safety controls cannot be assumed until all control settings have been confirmed.

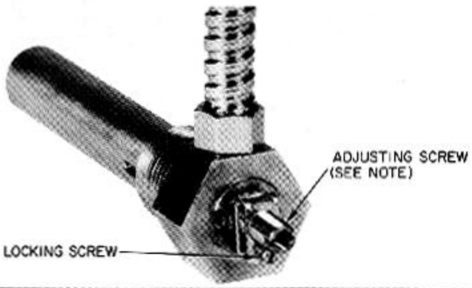
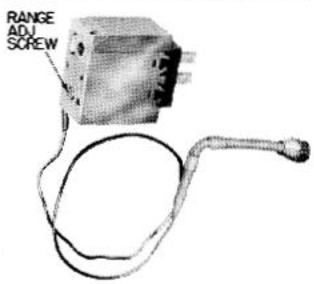
Follow the procedures given in Table 4.

Table 4 — Setting Safety Controls

SAFETY OR CONTROL DEVICE	RECOMMENDED SETTING
1. Chilled Water Low-Temperature Cutout and Recycle Switch (Fig. 5) 	This switch must break ahead of the refrigerant low-temperature cutout or machine will not recycle automatically. Water Chilling Duty – Set switch at 5 degrees below design leaving water temperature or 37 F, whichever is higher. Brine Chilling Duty – Set switch to open at 5 degrees below leaving brine temperature. Switch should reclose automatically at 10 F above selected cutout point.
2. Refrigerant Low-Temperature Cutout 	Switch is located on cooler support plate near thermowell. Water Chilling Duty – Set switch to cut out at 33 F or one degree below design refrigerant temperature, whichever is lower. *Do not permit chilled water temperature to drop below 33 F.* Brine Chilling Duty – Set switch to cut out at brine freezing temperature or 5 degrees below suction temperature, whichever is higher.
3. Condenser High-Pressure Cutout (Fig. 8) 	Condenser high-pressure cutout should shut down machine when condenser pressure exceeds 220 ± 5 psig. Switch can be manually reset at approximately 185 – 192 psig. Isolate switch and check with metered supply of air.
4. Low Oil Pressure Cutout (Fig. 8) 	Low oil differential pressure switch should open when pressure difference between oil supply and oil reservoir becomes less than 13 ± 1 psi. Switch should close when pressure difference reaches 17 ± 1 psi. Isolate switch and check with metered supply of air.

Contents

Table 4 — Setting Safety Controls (cont)

SAFETY OR CONTROL DEVICE	RECOMMENDED SETTING
→ 5. **Oil Heater Thermostat (Fig. 1)** 	Set thermostat to maintain minimum oil reservoir temperature of 140-145 F at machine shutdown. NOTE: When altering set point, turn adjusting screw in small increments; a half turn changes set point by 50 F.
6. **Pumpout Compressor Hi-Pressurestat (Fig. 19)** 	Switch located in pumpout control box. Pumpout compressor hi-pressurestat should shut off pumpout compressor when compressor discharge pressure exceeds 161 ± 5 psi. Reset is automatic at $130 \pm {}^{7}_{0}$ psi.

INITIAL START-UP

Prepare Machine for Initial Start-Up — Follow procedures described in the Operating Instructions section under Prepare Machine for Start-Up, page 15.

Initial Start-Up — Before operating the machine for any length of time, check compressor rotation and operation as follows:

On machine with electronic capacity control, set the capacity control switch (item 2, Fig. 8) at HOLD position.

On machine with pneumatic control, turn off supply air to chilled water temperature controller and guide vane actuator.

Follow the Start Machine procedures on page 16. As the compressor motor shaft begins to turn, check for clockwise rotation (Fig. 7) at transmission cover or motor end bell sight glass. Let compressor come up to speed and note oil differential pressure on control center gage; differential should be 20 -30 psi.

Press machine ON-STOP button after compressor has reached operating speed. Listen for any unusual sounds from compressor as it coasts to a stop. Confirm clockwise rotation as compressor coasts to a stop.

If rotation is not clockwise, correct the condition. Electric motor rotation can be reversed by reversing any 2 of the 3 power leads entering the starter. Recheck rotation after taking corrective action.

The program timer prevents rapid recycling of the compressor and allows restart 15 minutes after stop.

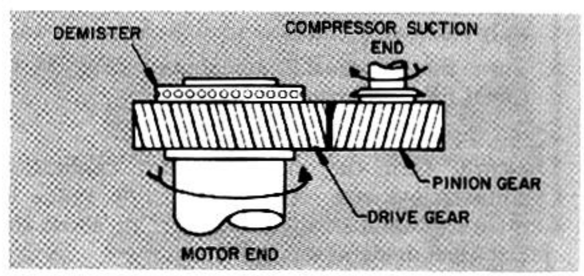


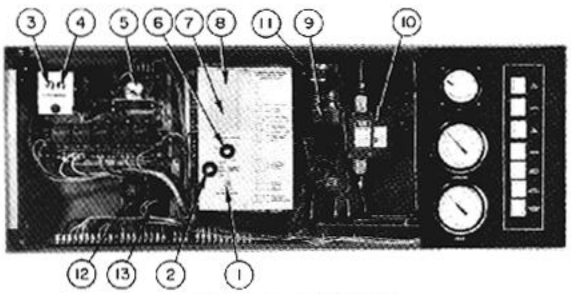
Fig. 7 — Checking Compressor Rotation

Set Operating Controls — Electronic

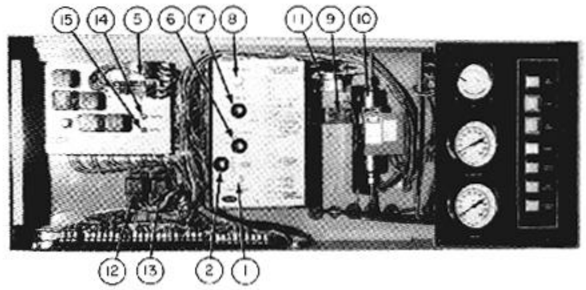
MOTOR CURRENT CALIBRATION (Electronic Capacity Control)

1. Establish a steady motor current value for this calibration. Open guide vanes manually (capacity control at INC) until full load current is reached. Motor current calibration (Fig. 9) may need to be turned counterclockwise to permit vanes to open further. *Do not exceed 105% of nameplate full load amperes.*

Contents



CONTROL DESIGN 1



CONTROL DESIGN 2

1 – Motor Current Calibration
2 – Capacity Control Switch
3 – Bearing High-Temp Cutout
4 – Motor High-Temp Cutout
5 – Program Timer
6 – Electrical Demand Control
7 – Thermostat (Chilled Water)
8 – Throttle Range Adjustment
9 – Cond High-Pressure Cutout
10 – Low Oil Pressure Cutout
11 – Cycling Timer
12 – Motor Temp Sensor Module
13 – Bearing Temp Sensor Module
14 – Bearing Overtemperature Indicator
15 – Motor Overtemperature Indicator

→ **Fig. 8 – Typical 19FA Electronic Control Centers**

If system load is sufficient to maintain full load current for a period of time, calibrate at this condition. With small loads, pull down to and maintain design leaving chilled water temperature (capacity control at HOLD) and calibrate at this condition.

2. Measure motor current at selected condition. Determine its percentage of full load motor current.
3. Use this percentage figure to set the electrical demand adjustment (Fig. 9) per the following table:

Percent of Full Load Motor Current	Electrical Demand Adjustment Setting
105	100%
85 or above	80%
65 to 84	60%
45 to 64	40%
below 45	Control cannot be calibrated

4. Turn the motor current calibration adjustment fully clockwise. Guide vanes will close part way.
5. Turn the thermostat adjustment (Fig. 9) to COOLER (fully counterclockwise).
6. Set capacity control at INC position.
7. Slowly turn the motor current calibration counterclockwise. Allow the guide vanes to open until motor current reaches 5% above the electrical demand setting.

   NOTE: There is a time lag of several seconds due to feedback capacitance in the motor current circuit. When the motor current calibration setting is adjusted, allow for this time lag.
8. Check the foregoing motor current calibrations with machine under automatic control as follows:
   a. Close vanes manually (capacity control to DEC).
   b. Turn capacity control to AUTO. Vanes should stop opening at electrical demand setting.
9. If control was calibrated at less than 100% load, turn electrical demand adjustment setting to 100%. Control is now automatically calibrated for 100% full load current.
10. If control cannot be calibrated with above procedure, check voltage signal from signal resistor in starter. At 100% full load current, voltage between terminals 23 and 24 inside control center must be 0.5 ± 0.1 volts. If not in this range, check sizing of resistor in starter.

Both excess motor current and chilled water temperatures below the thermostat set point (Fig. 9) override the capacity control setting. If the capacity control knob is in the INC position, the guide vanes will stop opening. With the knob in any of the other positions, the vanes will close as needed.

The motor current limiting circuit operates in 2 steps.

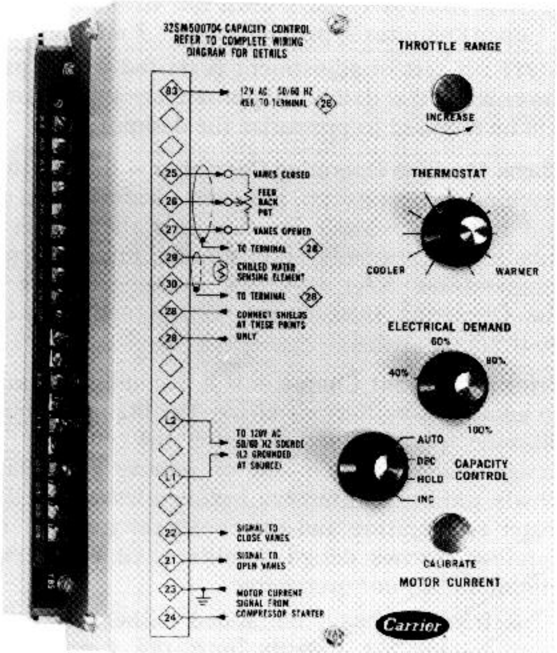
At 100% full load motor current, the vanes stop opening further. If the motor current should increase to 105% due to some change in load conditions, the vanes close until the motor current is reduced to about 102%.

If the motor current is reduced to 98% or below, control again operates in response to chilled water temperature.

The electrical demand adjustment permits the operator to set the maximum current drawn by the motor and thus minimize the electrical demand rate during off-season operation.

CHILLED WATER CALIBRATION (Electronic Controls)

1. Turn throttle range adjustment (Fig. 9) fully clockwise.
2. Turn chilled water thermostat until design chilled water temperature is maintained. Mark thermostat at this position. If capacity control vanes hunt, turn throttle range adjustment counterclockwise in small increments until hunting ceases. Chilled water thermostat may require resetting.

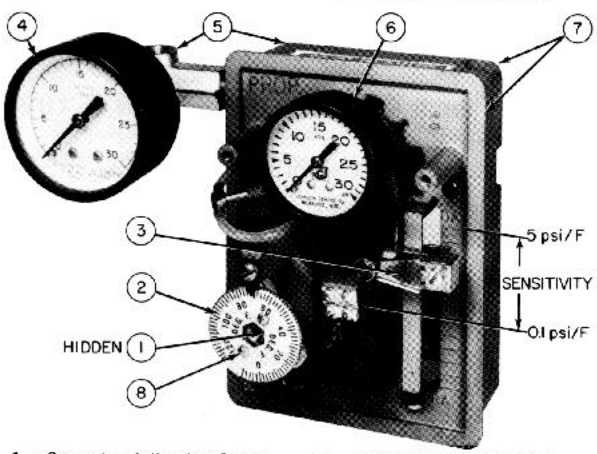


→ **Fig. 9 — Capacity Control Module (Electronic Control)**

Set Operating Controls — Pneumatic

NOTE: If machine has special pneumatic controls, follow the instructions supplied in the Job Data for their setting and adjustment.

CHILLED WATER THERMOSTAT (Pneumatic)



1 — Set-point Adjusting Screw	5 — Supply Air Connections
2 — Thermostat Dial	6 — Control Air Pressure Gage
3 — Sensitivity Slider	7 — Control Air Connections
4 — Supply Air Pressure Gage	8 — Dial Retaining Screw (2)

→ **Fig. 10 — Pneumatic Thermostat, Less Cover**

Preparation:

1. Provide 25 psi supply air for thermostat.
2. Loosen Allen setscrew in sensitivity slider and move slider halfway between midpoint and DA. Retighten screw.

Calibration:

1. Turn thermostat dial until control air registers 15 psi.
2. Operate machine to reach design chilled water temperature at design load. Maintain 15 psi control air during pulldown by adjusting thermostat dial as required.
3. On reaching design chilled water temperature, turn dial until control air pressure holds machine at design conditions.
4. → Hold set-point adjusting screw stationary within the dial post, loosen dial retaining screws and set the thermostat dial at design chilled water temperature. Retighten dial retaining screws.

Completion:

If vane hunting occurs, move sensitivity slider away from DA. Sensitivity decreases as slider is moved from 5 psi/F to the lower limit of 0.1 psi/F.

ELECTRO-PNEUMATIC RELAY

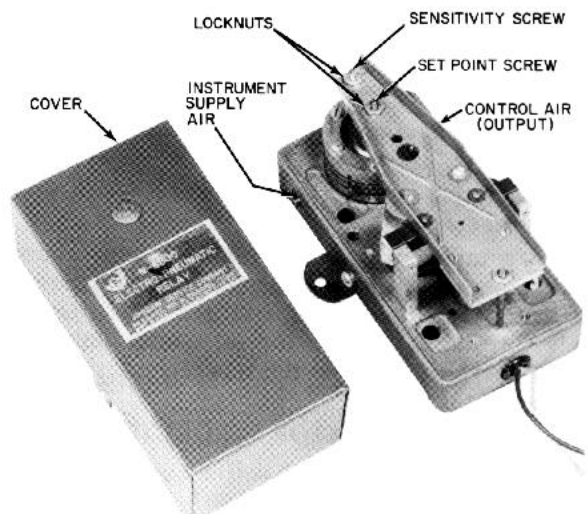


Fig. 11 — Electro-Pneumatic Relay

This control is factory calibrated to provide a linear output signal of 3 psi at 6 volts d-c to 18 psi at 15 volts d-c. Field recalibration should not be necessary.

If calibration is required:

1. Establish 15 volt d-c input with 25 psi supply air.
2. Turn sensitivity screw to obtain 18 psi or higher output.
3. Adjust setpoint screw, if required, to set output at 18 ± ¼ psi.
4. Reduce input to 6 volts. Output should be 3 ± ¼ psi. If low, turn sensitivity screw carefully clockwise. If high, turn screw counterclockwise.
5. Recheck output at 15 volts. Repeat steps 3 and 4 if necessary.

DEMAND LIMIT CONTROLLER

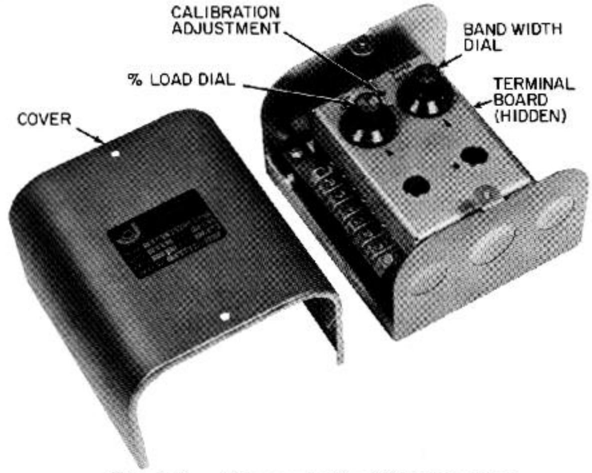


Fig. 12 — Demand Limit Controller

1. Set % load dial at 100%.
2. Set band width dial at 3.
3. Turn calibration adjustment screw fully clockwise.
4. Operate machine at 100% FLA by adjusting dial on chilled water thermostat.
5. Turn calibration adjustment screw counterclockwise until guide vanes just begin to close.
6. If hunting occurs, increase band width and repeat steps 4 and 5.

If control cannot be calibrated with above procedure, check voltage signal from resistor in starter. At 100% full load, voltage between terminals 23 and 24 inside control center must be 3.0 ± 0.1 volts. If not in this range, check sizing of resistor in starter.

→ GUIDE VANE ACTUATOR STROKE (Pneumatic) (Fig. 6)

Supply:

1. 115 volt control power to control center terminal 74.
2. Clean dry air at 35 - 90 psi to supply air regulator. Supply air regulator is factory set at 35 psi. If required, adjust to maintain 35 ± 1 psi.

For test purposes, increase the rate of actuator stroke by turning the speed control adjusting screw fully counterclockwise. Then vary the instrument air pressure from the pneumatic thermostat (Fig. 10). Guide vanes should begin to open at 3 ±½ psig and should be fully open at 15 ±½ psig. Actuator should stroke smoothly without binding. Refer also to the section Checking Guide Vane Linkage.

After checking the stroke, reset the speed control as follows:

1. Set instrument air at 3 psi to close vanes.
2. Turn speed control adjusting screw clockwise in increments while applying 15 psi instrument air.
3. Repeat steps 1 and 2 until full stroke (close to open) requires approximately 2 - 3 minutes.

NOTE: If test or adjustment is started with 0 psig pressure in the dashpot, approximately 2 minutes will be required to pressurize the dashpot.

Check Machine Operating Condition — Be sure that machine temperatures, pressures, water flow, oil and refrigerant levels indicate that the system is functioning normally. For specific pressures and temperatures, refer to Check Running System in the Operating Instructions section and examine your job data.

→ **Trim Refrigerant Charge** — If it becomes necessary to adjust the refrigerant charge to obtain optimum machine performance, operate the machine at design load and then add or remove refrigerant slowly until the difference between leaving chilled water temperature and the cooler refrigerant temperature reaches design conditions or becomes a minimum. *Do not overcharge.*

Refrigerant may be added either thru the storage tank or directly into the machine as described in the section entitled, Refrigerant Charging.

To remove any excess refrigerant, follow Pumpout Procedure, steps 1-a thru 1-d of TRANSFER REFRIGERANT FROM MACHINE TO STORAGE TANK (page 18).

CALIBRATE OPTIONAL CONTROLS (If Supplied)

→ **Lead-Lag Control Calibration** — Establish a steady cooling load for this operation.

1. Supply main and control power to each chiller and energize lead-lag separate source.
2. Place all lead-lag ON-OFF switches in OFF position (light out).
3. Set lead chiller selector switch at MAN.
4. Energize each chiller control circuit by pressing ON-STOP and START buttons at each control center.
5. Press chiller no. 1 ON-OFF switch (light goes on) on lead-lag panel; chiller no. 1 starts.
6. Operate chiller no. 1 manually by means of the capacity control module in machine control center. Calibrate the module as described in the previous section, Set Operating Controls. Adjust as required to obtain design leaving *system* temperature.
7. Press chiller no. 1 ON-OFF switch at lead-lag panel (light goes out); chiller no. 1 stops.
8. Press chiller no. 2 ON-OFF switch (light goes on); chiller starts.
9. Repeat step 6 with chiller no. 2.

Procedure is now complete for parallel machines or series machines with a common control point.

For series machines with a split control point, continue calibration as follows (at least 75% of system load must be available):

10. Press chiller no. 1 ON-OFF switch at lead-lag panel (light goes on); chiller no. 1 starts.
11. After chiller no. 1 starts, press chiller no. 2 ON-OFF switch (light goes on); chiller no. 2 starts.
12. Remove plug button on lead-lag panel and adjust set-point potentiometer until chiller no. 2 operates at the selected intermachine temperature for series operation. A clockwise turn raises set point temperature; counter-clockwise turn lowers set point.
13. Shut down machines by pressing ON-OFF switches on lead-lag panel. Subsequent start or stop can be made by pressing the single ON-OFF switch on the left side of the lead-lag panel.

Remote Thermostat Calibration

1. Turn throttle range adjustment in machine control center fully clockwise. (Fig. 9)
2. Turn remote thermostat knob fully counter-clockwise (maximum COOLER position).
3. Start machine.
4. Turn machine thermostat knob in control center to minimum chilled water set point per job requirements.
5. Adjust remote thermostat for desired chilled water temperature. If guide vanes hunt, turn throttle range adjustment counterclockwise in small increments until hunting ceases. Remote thermostat may require resetting.

INSTRUCT THE CUSTOMER OPERATOR

Be sure the operator understands all operating and maintenance procedures. Point out the various machine parts and explain their function as part of the complete system.

Cooler-Condenser-Economizer — float chambers, sight glasses or level controls, thermowells, relief valves, refrigerant charging valve, safety switch locations, gage and control connections, water boxes and tubes.

Storage Tank — transfer valves and pumpout system, refrigerant charging procedure, relief valves.

Motor-Compressor Assembly — guide vane actuator, transmission, motor cooling system, inspection covers, terminal boxes.

Motor-Compressor Lubrication System — Oil pump, coolers, filters, oil cooler solenoid valve, plug valve, oil heater, thermostat, temperature gages, oil charge and specification, oil level, temperature and pressure, oil fill connections.

Control System — indicator lights, gages, adjustment of operating and safety controls (manual reset and auto.), auxiliary and special controls, safety precautions with electrical equipment.

Auxiliary Equipment — starters, pumps, cooling tower, water valves, vents and drains.

Review Maintenance Procedures — scheduled, extended shutdown, importance of log sheet, importance of water treatment.

Check Operator Knowledge — start-stop procedures, safety and operating controls, trouble-shooting.

→ **Safety Devices and Procedures** — electrical disconnects, relief valve maintenance, handling of refrigerant.

OPERATING INSTRUCTIONS

Operator Duties

1. Become familiar with refrigeration machine and related equipment before operating.
2. Prepare system for start-up; start and stop machine; place system in shutdown condition.
3. Maintain log of operating conditions and recognize abnormal readings.
4. Inspect equipment; make routine adjustments, maintain proper levels of refrigerant, oil and water.
5. Protect system from damage during shutdown.

Prepare Machine for Start-Up — Before starting machine, be sure that:

1. Power is on to main starter, oil pump starter, water pumps and tower fan, oil heater and machine control circuit.
2. Cooling tower water is at proper level.
3. Machine is charged with refrigerant.
4. Oil is visible in reservoir sight glass.
5. Oil reservoir temperature is 140 - 150 F, with oil heater energized.
6. Oil cooler plug valve (Fig. 13) is partially open.
7. Valves in chilled water and condenser water circuits are open and water is circulating properly. *Do not run water having temperature over 100 F thru cooler. Refrigerant over-pressure may result, with loss of refrigerant thru the relief valves.*
8. Air supply to pneumatic controls is adequate.
9. Valve in oil filter line (item 1, Fig. 17) is fully open.

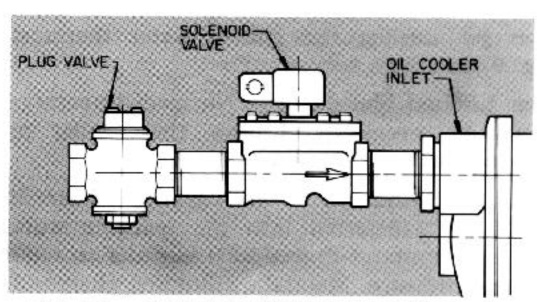


Fig. 13 — Oil Cooler Water-Flow Control

Contents

Start Machine

1. Energize main circuit breaker.
2. Start water pumps and cooling tower fan (if not automatic).
3. Press ON-STOP switch at machine control center.
4. Press machine START switch.
   a. Oil pump starts within 30 seconds. If PROGRAM TIMER light is on, oil pump will start within 15 minutes.
   b. Compressor starts approximately 30 seconds after oil pump; program timer stops (light goes out).

Check Running System — After compressor reaches stable operation, operator should observe the following conditions of normal operation:

Oil reservoir temperature	140 - 150 F
Bearing oil return temperature	170 F max
Oil level	Visible at lower sight glass
Oil cooler water	Visible at open drain
Condenser leaving water	Over 55 F
Cooler temperature Condenser temperature	Refer to selected design conditions

NOTE: The compressor may operate at full capacity for a short time during pulldown even though the building cooling load is small. The electrical demand control (Fig. 9 and 12) can be adjusted to avoid a high demand charge for the short period of full capacity operation.

Stop Machine

1. Press ON-STOP switch (compressor stops).
2. Stop water pumps and cooling tower fan (if not automatic).
3. Oil pump stops in approximately 40 seconds.
4. Machine may be restarted in approximately 15 minutes.

Should machine fail to stop, first close the guide vanes; then pull main circuit breaker. Do not attempt to stop machine by opening an isolating knife switch. Electrical arcing and serious injury may result. DO NOT restart machine until malfunction is located and corrected.

On machines with electronic capacity control, close the guide vanes by turning capacity control switch (Fig. 8) to DEC (decrease).

On machines with pneumatic control, close the vanes by turning the chilled water thermostat (Fig. 9) to a high setting.

After Limited Shutdown — No special operations should be necessary. Follow the regular preliminary checks and starting procedures.

Extended Shutdown — Refrigerant 12 or 500 should be transferred into the machine storage tank (see Pumpout Procedures) in order to reduce machine pressure. Maintain a holding charge of 5 to 10 lbs to prevent air leakage into the machine.

If freezing temperatures are likely to occur in the machine area, drain the chilled water, condenser water, oil cooler and pumpout condenser water circuits to avoid freeze-up. Clear the oil cooler lines with air after removing drain plug. Keep water box drains open.

Leave the oil charge in the machine, with the oil heater (item 1, Fig. 1) energized to maintain a minimum oil temperature of 140 F.

After Extended Shutdown — Be sure that water system drains are closed. It may be advisable to flush water circuits to remove any soft rust which may have formed.

Check cooler gage. If (after adjusting for changes in ambient temperature) any loss in holding charge is indicated, check for refrigerant leakage. See Check Machine Tightness, page 3.

Recharge machine by transferring refrigerant charge from the storage tank as described in Pumpout Procedures, page 17. *Observe freeze-up precautions.*

Carefully make all regular preliminary and running system checks.

Cold Weather Operation — When entering condenser water temperature drops very low (55 F minimum), cycle the cooling tower fans off to keep the temperature up. Piping may also be arranged to automatically or manually bypass the cooling tower.

Manual Operation — The capacity control switch (Fig. 9) allows the operator to change leaving chilled water temperature without altering the automatic temperature control settings.

Manual control is useful in checking control operation and safety cutout points, overcooling the building prior to a heavy load, or for controlling the machine in an emergency.

ELECTRONIC CONTROL — Turn the capacity control switch to DEC (decrease) to close the guide vanes, decrease machine capacity and *increase* water temperature. The HOLD position maintains guide vane position. INC (increase) opens the guide vanes, increases machine capacity and *lowers* chilled water temperature.

NOTE: Motor current above the electrical demand control setting or above motor full load amperage, and chilled water temperature below the thermostat set point prevent the machine from responding to an INC signal.

PNEUMATIC CONTROL — Pneumatically controlled machines normally have no method for independent manual control. However, similar effects are obtained by manually resetting the air-operated chilled water thermostat to a new control point.

Refrigeration Log — The Carrier log for 19FA hermetic centrifugal machines provides a convenient check list for routine inspection and

Contents

Carrier Air Conditioning Company

DATE ______________

REFRIGERATION LOG CARRIER 19E/F HERMETIC CENTRIFUGAL REFRIGERATION MACHINE

PLANT ______________ MACHINE SERIAL NO ______________ MACHINE SIZE ______________ REFRIGERANT TYPE ______________

	COOLER				CONDENSER				COMPRESSOR					DEHYDRATOR				
	H_2O Press In ______ GPM ______ H_2O Press Out ______				H_2O Press In ______ GPM ______ H_2O Press Out ______					Oil			F.L.A. ______					
			Water Temperature				Water Temperature											
Time	Shut-down Refrigerant Level	Refrigerant Pressure	IN	OUT	Refrigerant Pressure	Refrigerant Temperature	IN	OUT	Bearing Temperature	Level	Temperature (reservoir)	Pressure (differential)	Motor Amps or Vane Position	Refrigerant Level	Condenser Pressure	Operator's Initials		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

REMARKS: Indicate shut-downs on safety controls, repairs made, oil or refrigerant added or removed, air exhausted and water drained from dehydrator. Include amounts.

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Fig. 14 — Refrigeration Log

maintenance, and forms a continuing record of machine performance. It is an aid in scheduling routine maintenance and in diagnosing machine problems.

Keep a record of machine pressures, temperatures and liquid levels on a sheet similar to that shown, reduced in size, in Fig. 14. Full size (8½ x 11 in.) sheets can be obtained thru your Carrier representative. Specify the form number in the lower left corner of the sheet.

PUMPOUT PROCEDURES

Preparation — If the machine is equipped with a pumpout unit, use the following procedures for refrigerant transfer or machine evacuation. Valves are identified by the item numbers shown in Fig. 1 and 16. The letter C in the valve condition diagrams indicates a closed valve.

OPERATING THE PUMPOUT COMPRESSOR — Be sure that both the suction and the discharge service valves are open (backseated) during operation. Rotate the valve stem fully counterclockwise to open. Frontseating the valve closes off the refrigerant line and opens the gage port to compressor pressure.

Loosen the compressor hold-down bolts to allow free spring travel.

Open the refrigerant inlet valve (Fig. 15) on the pumpout condenser.

Oil should be visible in the compressor sight glass under all conditions of operation and at shutdown. If oil is low, add as described under Pumpout System Maintenance.

Pumpout control wiring is shown schematically in the Pumpout Unit Controls section.

→ To read refrigerant pressure during pumpout or leak testing:

1. The cooler gage on the machine control center is suitable for determining refrigerant-side pressure or low (soft) vacuum. *For evacuation or dehydration, however, use a high quality vacuum gage or manometer to ensure the desired range and accuracy.*
2. To determine storage tank pressure, attach an accurate gage (30″-0-200 psi range recommended) to the 1/2-in. flare connection on vent valve 9 (Fig. 16).
3. If only machine pressure (cooler, condenser, economizer and compressor) is desired, attach gage or manometer to the tee at valve 1 (Fig. 16).

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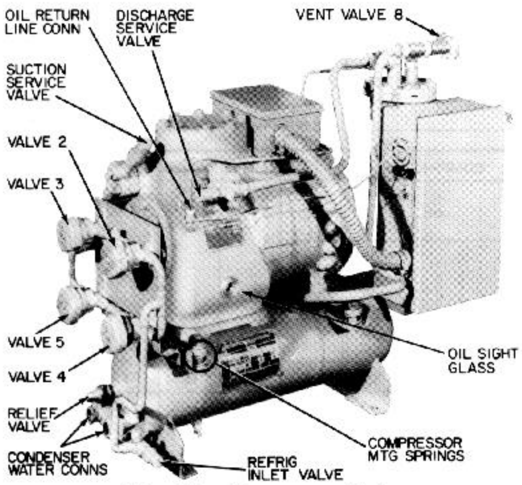

Fig. 15 — Pumpout Unit

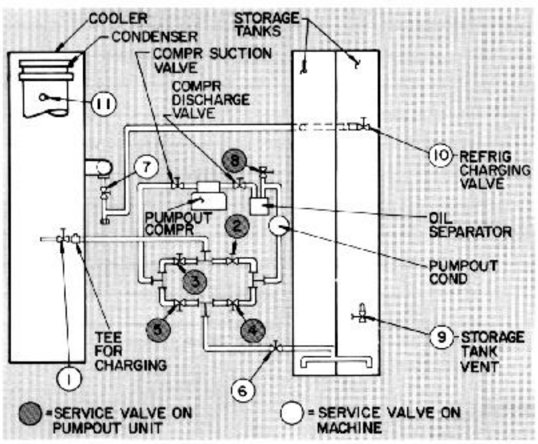

Fig. 16 — Pumpout System Piping Schematic

Pumpout Operation

WARNING: Transfer, addition or removal of large quantities of refrigerant in spring-isolated machines may place severe stress on external piping if springs are not properly blocked in both directions.

→ CAUTION: This pumpout procedure is written for R-12. A minimum pressure must be maintained to prevent tube freeze-up. Appropriate pressures for R-500 and R-114 are shown in Table 2.

TRANSFER REFRIGERANT FROM STORAGE TANK TO MACHINE (Fig. 16)

1. Equalize refrigerant pressure:
   a. Be sure that pumpout vent valve 8 is closed.
   b. Close valves 2, 4 and 5.
   c. Open valves 1, 3 and 6.

VALVE	1	2	3	4	5	6	7	8
CONDITION		C		C	C		C	C

   d. Turn on machine water pumps.
   e. Crack open valve 5, gradually increasing machine pressure to 45 psig. *Feed refrigerant slowly to prevent tube freeze-up.*
   f. Open valve 5 fully and open liquid line valve 7 until refrigerant pressure equalizes.

VALVE	1	2	3	4	5	6	7	8
CONDITION		C		C				C

2. Transfer remaining refrigerant:
   a. Close valve 5.
   b. Open valve 4.

VALVE	1	2	3	4	5	6	7	8
CONDITION		C			C			C

   c. Turn off machine water pumps and be sure that pumpout condenser water is off.
   d. Turn on pumpout compressor to push liquid out of storage tanks.
   e. Close liquid line valve 7.
   f. Turn off pumpout compressor.

VALVE	1	2	3	4	5	6	7	8
CONDITION		C			C		C	C

   g. Close valves 3 and 4.
   h. Open valves 2 and 5.

VALVE	1	2	3	4	5	6	7	8
CONDITION			C	C			C	C

   i. Turn on pumpout condenser water.
   j. Run pumpout compressor until storage tank pressure reaches 5 psig (0 psig if repairing).
   k. Turn off pumpout compressor.
   l. Close valves 1, 2, 5 and 6.
   m. Turn off pumpout condenser water.

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C	C	C	C	C	C	C

TRANSFER REFRIGERANT FROM MACHINE TO STORAGE TANK (Fig. 16).

1. Equalize refrigerant pressure:
   a. Be sure that vent valves 8 and 9, charging valve 10 and transfer valve 7 are closed.
   b. Close valves 2, 4 and 5.
   c. Open valves 1, 3 and 6.

VALVE	1	2	3	4	5	6	7	8
CONDITION		C		C	C		C	C

   d. Open valve 5 and liquid line valve 7 to allow liquid refrigerant to drain by gravity into storage tank.

VALVE	1	2	3	4	5	6	7	8
CONDITION		C		C				C

2. Transfer remaining liquid:
   a. Be sure that pumpout condenser water is off.
   b. Close valve 3.
   c. Open valve 2.

VALVE	1	2	3	4	5	6	7	8
CONDITION			C	C				C

Contents

d. Run pumpout compressor for 30 minutes; then close valve 7.

VALVE	1	2	3	4	5	6	7	8
CONDITION			C	C			C	C

e. Turn off pumpout condenser.

3. Remove any entrapped refrigerant:

a. Run cooler and condenser water pumps.

b. Close valves 2 and 5.

c. Turn on pumpout condenser water (machine water pumps also running).

d. Open valves 3 and 4.

VALVE	1	2	3	4	5	6	7	8
CONDITION		C			C		C	C

e. Run pumpout compressor until machine pressure reaches 35 psig, then shut it off. Warm condenser water will boil off any entrapped liquid refrigerant and machine pressure will rise.

f. When pressure rises 5 psi, turn on pumpout compressor until machine pressure drops to 35 psig. Turn off compressor and allow pressure to rise again 5 psi. Repeat until pressure no longer increases; then pump out until machine reaches 0 psig.

g. Close valves 1, 3, 4 and 6.

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C	C	C	C	C	C	C

h. Turn off pumpout condenser water and machine water pumps.

4. Establish vacuum for service:

Machine may be opened for service at 0 psig (condition at step 3-h above). To conserve refrigerant, it may be desirable to operate pumpout compressor until machine pressure is reduced to 22 in. Hg vac, ref 30-in. bar. (4 psia) in step 3-f.

EVACUATE REFRIGERATION MACHINE

1. Vent pressurizing gas (nitrogen or dry air) to atmosphere thru valve 11 on condenser (Fig. 16) until machine pressure reaches approximately 0 psig. Then close valve 11.

2. With pumpout condenser water running, remove flare cap and crack open valve 8. *Vent refrigerant slowly to avoid freeze-up of pumpout condenser water.*

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C	C	C	C	C	C	

3. Turn off pumpout condenser water.

4. Open valve 3.

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C		C	C	C	C	

5. Operate pumpout compressor until manometer reads 26 in. Hg vac, ref 30-in. bar. (2 psia).

6. Close valve 3.

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C	C	C	C	C	C	

7. Shut off pumpout compressor.

8. Close vent valve 8 and replace flare cap.

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C	C	C	C	C	C	C

EVACUATE STORAGE TANK

1. If tank is under pressure, vent pressurizing gas (nitrogen or dry air) to atmosphere thru valve 9 until tank pressure reaches approximately 0 psig. Close valve 9.

2. Turn on pumpout condenser water.

3. Remove flare cap and crack open valve 8. *Vent refrigerant slowly to avoid freeze-up of condenser water.*

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C	C	C	C	C	C	

4. Turn off pumpout condenser water.

5. Open valves 5 and 6.

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C	C	C			C	

6. Turn on pumpout compressor and operate until manometer (attached to valve 9 or 10) reads 26 in. Hg vac, ref 30-in. bar. (2 psia).

7. Close valves 5 and 6.

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C	C	C	C	C	C	

8. Shut off pumpout compressor.

9. Close vent valve 8 and replace flare cap.

VALVE	1	2	3	4	5	6	7	8
CONDITION	C	C	C	C	C	C	C	C

RETURN REFRIGERANT TO NORMAL OPERATION CONDITION – The full refrigerant charge necessary for maintaining machine design conditions is placed in the machine proper (cooler, condenser, economizer and compressor). Any excess refrigerant is stored in the storage tank. Sufficient refrigerant should be kept in the tank to ensure a positive pressure of at least 3 to 5 psig.

→ **Machines Without Pumpout Systems** — Do not use nitrogen to transfer liquid refrigerant from one vessel to another. Use of nitrogen when transferring liquid refrigerant will result in a significant refrigerant loss. Use a portable pumpout unit when transferring refrigerant.

Nitrogen or air may be evacuated from the chiller with a vacuum pump as discussed in the following Vessel Evacuation Procedure.

VESSEL EVACUATION PROCEDURE (See Fig. 16 for valve location.)

1. Connect vacuum pump and indicator as required.
2. Open valves to pump and indicator.
3. Reduce vessel pressure to 26 in. Hg vac, ref 30-in. bar. (2 psia)
4. Close valves to pump and indicator.
5. Shut off vacuum pump.

WEEKLY MAINTENANCE

Check Lubrication System — While the machine is off, compare the oil level to that marked on the sight glass (item 7, Fig. 1) at time of initial start-up. If additional oil is required, add it thru the charging valve on the oil reservoir wall (item 32, Fig. 1). A pump is required for adding oil against refrigerant pressure. Oil charge is approximately 15 gal. for a 19FA4 size compressor; 20 gal. for a 19FA5 size compressor. *Added oil must meet Carrier's specifications for centrifugal compressor usage. Refer to Change Oil and Oil Filters.*

A 1000-watt oil heater and thermostat (item 1, Fig. 1) maintain oil reservoir temperature at 140 - 150 F during shutdown. A pilot light on the heater indicates whether it is on. If the pilot light is out but the reservoir remains warm at machine shutdown, check the bulb and replace if necessary. If the pilot light is out and the reservoir is colder than normal, the thermostat may be set too low, thermostat may be faulty or power may be off. Check the power source, reset the thermostat or replace if necessary. *Do not operate the machine with oil temperature less than 135 F.*

SCHEDULED MAINTENANCE

Establish a regular maintenance schedule based on actual machine requirements such as machine load, hours of operation and water quality. The time intervals listed in this section are offered as guides.

Inspect Control Center — Maintenance is normally limited to general cleaning, tightening of connections and replacement of components. In the event of machine control malfunction, refer to the Troubleshooting Guide in this publication for control checks and adjustment procedures.

Be sure power is off when making checks and adjustments inside the control center.

Check Safety Controls — To ensure machine protection, check safety controls at least once during the operating season, or at least once every 6 months if the machine is operated continuously. See Table 4 for control settings.

Inspect Starting Equipment — Before working on starter:

1. Shut off machine.
2. Open disconnect switch ahead of starter.

Confirm that circuit is de-energized. Put safety tag on disconnect to prevent tampering; lock open if possible. If work is interrupted, confirm that disconnect is open before resuming.

WARNING: Do not open isolating knife switches while machine is running. High intensity arcing may cause serious injury.

Inspect the contact surfaces of the starter contactors for wear or pitting. Do not sandpaper or file silverplated contacts.

Follow starter manufacturer's instructions for contact replacement, lubrication and other maintenance requirements.

Inspect Cooler Tubes — Examine and clean cooler tubes at the end of the first operating season. Tube condition at this time will establish the required frequency for cleaning and will indicate the level of water treatment needed in the chilled water circuit.

Inspect Condenser Tubes — Since this water circuit is usually an open system, the tubes may be subject to contamination by foreign matter, scale, etc. Clean the condenser tubes at least once a year, or more often if the water is contaminated.

Higher than normal condenser pressure, together with inability to reach full refrigeration load, usually indicates dirty tubes, or air in the machine. When the refrigeration log indicates a rise above normal condenser pressures, check the pressure against actual refrigerant condensing temperature as follows:

1. Install a thermometer in the condenser liquid temperature well (item 34, Fig. 1).
2. If the thermometer reading is more than 2 F below the temperature listed for the existing pressure (Table 2), air is present in the machine.
3. Vent the air thru the condenser purging valve in spurts until condenser pressure is reduced to normal.
4. If the thermometer reading corresponds with the pressure reading (Table 2), the high condenser pressure is due to dirty tubes or to abnormal condensing water conditions such as restricted flow, etc.
5. Check the operation of the condensing water circuit. If water conditions (flow and temperature) are not abnormal, the tubes are dirty and should be cleaned.

Tube cleaning brushes, especially designed to prevent scraping or scratching of tube walls, are available thru your Carrier office. Hard scale may require chemical treatment for its prevention or removal. Consult a water treatment specialist for the proper treatment.

→ **Water Treatment** — Untreated or improperly treated water may result in corrosion, scaling, erosion or algae. The services of a qualified water treatment specialist should be obtained to develop and monitor a treatment program.

CAUTION: Water must be within design flow limits, clean and treated to ensure proper machine performance and reduce the potential of tubing damage due to corrosion, scaling or erosion. Carrier assumes no responsibility for chiller damage resulting from untreated or improperly treated water.

Inspect Refrigerant Float System yearly or if machine is opened for service.

Transfer refrigerant into storage tanks. Remove float chamber access covers on economizer. Clean each chamber and valve assembly thoroughly. Be sure that float valves move freely. See that orifices, vent, drain and control connections are free from obstructions. Examine cover gaskets and replace if necessary.

Change Oil and Oil Filters yearly or if machine is opened for repairs.

1. Transfer refrigerant into storage tanks.
2. Turn off oil heater.
3. When machine pressure is 5 psig or less, drain the oil reservoir by opening the drain valve (item 32, Fig. 1). Open valve slowly against refrigerant pressure.
4. Close the line valve (item 1, Fig. 17) to isolate the oil filter(s).
5. Loosen the filter holding clamp (item 2).
6. Rotate filter nut (item 3) counterclockwise to remove filter housing. Keep the filter housing upright to avoid oil spill.
7. Drain the oil; remove and replace filter cartridges. Do not use any of the extra felt washers supplied with the filters.
8. Bench assemble items A thru D upside down. Then slide filter housing over the stack to ensure that spring (item D) is centered in the bottom of the filter housing as indicated.
9. Charge machine with oil. Approximately 15 gallons for 19FA4 size compressor and 20 gallons for 19FA5 size compressor should bring level up to compressor sight glass (item 7, Fig. 1).
10. Turn on oil heater and warm the oil to 140-145 F. Operate the oil pump for 2 minutes. Add oil if required to keep level up to lower sight glass.

Oil should be visible in the reservoir sight glass during all operating and shutdown conditions.

OIL SPECIFICATION — Use only high grade oil conforming to the following specification:

Viscosity at 100 F, SSU	300 ± 25
Viscosity at 210 F, SSU	50 to 55
Viscosity index (min)	95
Pour point (max)	-5 F
Flash point (min)	400 F

Rust inhibiting characteristics: Material shall pass ASTM Rust Test D665, latest revision. Procedure A will be used with test period of 24 hours. Oxidation Resistance: Material shall pass ASTM Oxidation Test D943, latest revision, for a min of 2000 hours. Acid number at test end shall not exceed 2.0 mg, KOH per gram.

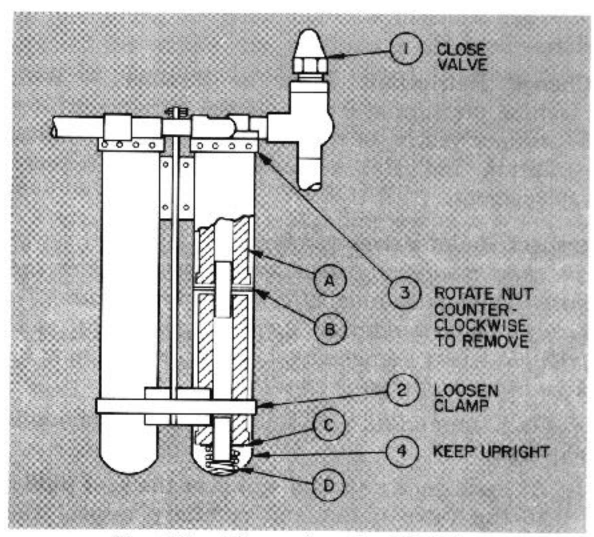

Fig. 17 — Removing the Oil Filter

Check Economizer Damper (Fig. 18) — Check the assembly yearly or when machine is opened for repair.

With machine pressure at 0 psig, remove the spring housing from the damper valve. Exercise care in removing the cover against the force of the valve spring (approximately 50 lb).

Check valve, damper blade and linkage for free travel and clean the assembly thoroughly. Replace the valve packing and housing O-ring gasket if necessary.

The damper valve operates on pressure differential between cooler connections and economizer. Valve starts to open at 8 - 12 psid and is fully open at 17 - 23 psid.

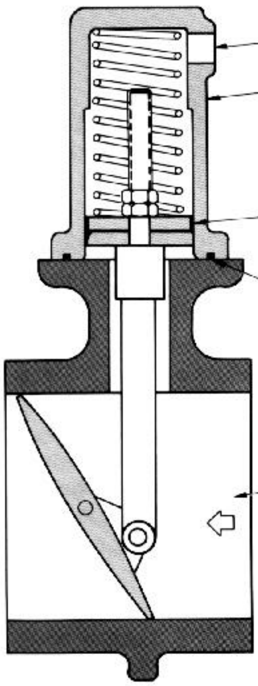

Fig. 18 — Economizer Gas Line Damper

Change Refrigerant Filter or Strainer — With machine pressure at 0 psig, change refrigerant filter or strainer yearly, or more often if filter or strainer condition indicates a need for more frequent replacement.

Inspect Relief Valves and Piping — *The relief valves on this machine protect the system against the potentially dangerous effects of overpressure. To insure against damage to the equipment and possible injury to personnel, these devices must be kept in peak operating condition.*

As a minimum, the following maintenance is required:

1. At least once a year, disconnect the vent piping at the valve outlet and carefully inspect the valve body and mechanism for any evidence of internal corrosion or foreign material (rust, dirt, scale, etc.)
2. If corrosion or foreign material is found, do not attempt repair or reconditioning. Replace the valve.
3. If machine is installed in a corrosive atmosphere or relief valves vent into a corrosive atmosphere, make valve inspection at more frequent intervals.

Compressor Bearing Maintenance — The key to good bearing maintenance is proper lubrication. Use the proper grade of oil, maintained at recommended levels, temperature and pressure. Inspect the lubrication system regularly and thoroughly.

With machine pressure at 0 psig, examine bearings on a scheduled basis for signs of wear. The frequency of examination is determined by the hours of machine operation, type of load on machine and condition of the lubrication system.

The removal and examination of bearings should be done only by a trained service mechanic.

Excessive bearing wear can sometimes be detected thru increased vibration or increased bearing temperature. If either symptom appears, contact an experienced and responsible service organization for assistance.

Pumpout System Maintenance — For compressor maintenance details, refer to the 06D, 07D Installation, Start-Up and Service Instructions.

OIL CHARGE — Use oil conforming to Carrier specification for reciprocating compressor usage. Oil requirements are as follows:

Viscosity at 100 F, SSU	150 ±10
Viscosity at 210 F, SSU	40 - 45
Dielectric, minimum	25 Kv
Floc point, maximum	–60 F
Pour point, maximum	–35 F
Neutralization no., maximum	.05
Flash point, minimum	330 F
Moisture content, maximum	30 ppm

The total charge, 4.5 pints, consists of 3.5 pints for the compressor and an additional pint for the oil separator.

Oil should be visible in the compressor sight glass both during operation and at shutdown. Always check oil level before operating compressor. Before adding or changing oil, relieve refrigerant pressure as follows:

1. Attach a pressure gage to the gage port of the compressor suction service valve (Fig. 15).
2. Close the suction service valve and open the discharge line to storage tank or machine.
3. Operate compressor until crankcase pressure drops to 2 psig.

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4. Stop compressor and isolate system by closing discharge service valve.
5. Slowly remove oil return line connection (Fig. 15). Add oil as required.
6. Replace connection and reopen compressor service valves.

SAFETY CONTROL SETTINGS – The pumpout unit high-pressure switch (Fig. 19) should open at 161 ± 5 psig and should reset automatically on pressure drop to 130 (+7, –0) psig. Switch setting may be checked by operating the pumpout compressor and slowly throttling the pumpout condenser water.

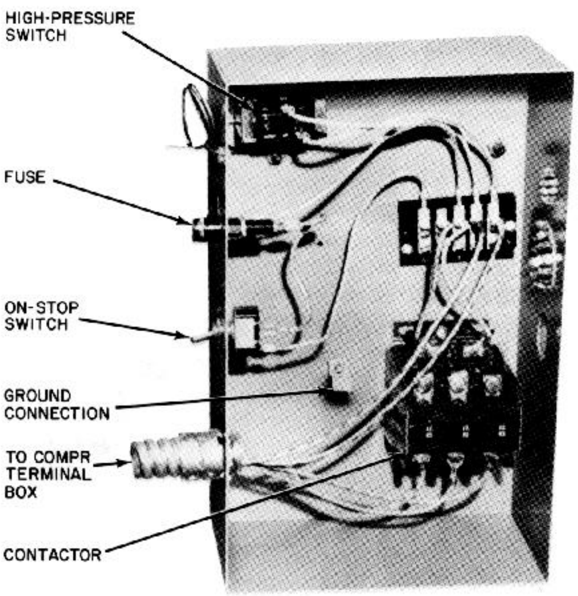

Fig. 19 — Pumpout Unit Controls

GENERAL MAINTENANCE

Refrigerant Properties — Refrigerant 500 or Refrigerant 12 is used in 19FA machines, depending upon machine size and application.

At normal room pressure, both refrigerants boil at approximately 25 degrees below 0° F and must therefore be kept in pressurized containers.

Each refrigerant is practically odorless when mixed with air, and is noncombustible and nontoxic (except in open flame). They do, however, dissolve oil, dry the skin and in heavy concentrations *may displace enough oxygen to cause asphyxiation.* In handling these refrigerants, protect hands and eyes and avoid breathing fumes.

Adding Refrigerant — Follow the procedures described in the section entitled Refrigerant Charging, page 7.

Removing Refrigerant — The 19FA integral storage tank is sufficiently large enough to hold the full charge of refrigerant. Use the Pumpout Procedures for refrigerant transfer when removing refrigerant from storage tank or machine proper.

Adjusting Refrigerant Charge — If addition or removal of refrigerant is required for improvement of machine performance, follow the procedures given under Trim Refrigerant Charge, page 14.

Pressurizing the Machine —Nitrogen is recommended for pressurizing. Dry nitrogen is preferable to air as it ensures that moisture is not introduced into the machine. *Under no circumstances should oxygen be used for pressurizing.*

To pressurize with nitrogen (or bottled dry air):

1. Connect copper tube from pressure cylinder to charging valve 10 or, if pressurizing machine side only, connect to valve 1 or tee adjacent to valve 1. Never apply full cylinder pressure to the pressurizing line. Follow the listed sequence.
2. Open charging valve (or valve 1) fully.
3. Open cylinder regulating valve slowly.
4. Observe pressure gage on machine and close cylinder regulating valve when pressure reaches test level. *Do not exceed 140 psig.*
5. Close valve on machine. Remove copper tube if no longer required.

Refrigerant Leak Testing — Because Refrigerants 12 and 500 are above atmospheric pressure at room temperature, leak testing can be performed with refrigerant in the machine. Use an electronic or halide leak detector. Be sure that the room is well ventilated and free from concentrations of refrigerant.

Before making repairs, however, transfer all refrigerant from the leaking vessel.

TEST AFTER SERVICE OR MAJOR LEAK – If all refrigerant has been lost or if machine has been opened for service, the machine or affected vessels must be pressurized and leak tested. If nitrogen gas and refrigerant tracer are used, follow the procedure described in the section Pressurizing the Machine. Test for leaks with electronic or halide leak detector. Repair and retest.

After repair apply a standing vacuum test, and, if any moisture is suspected of entering the machine, dehydration must also be performed.

Standing Vacuum Test — Refer to Standing Vacuum Test in the Initial Start-Up section.

Dehydration — Refer to Dehydration in the Initial Start-Up section.

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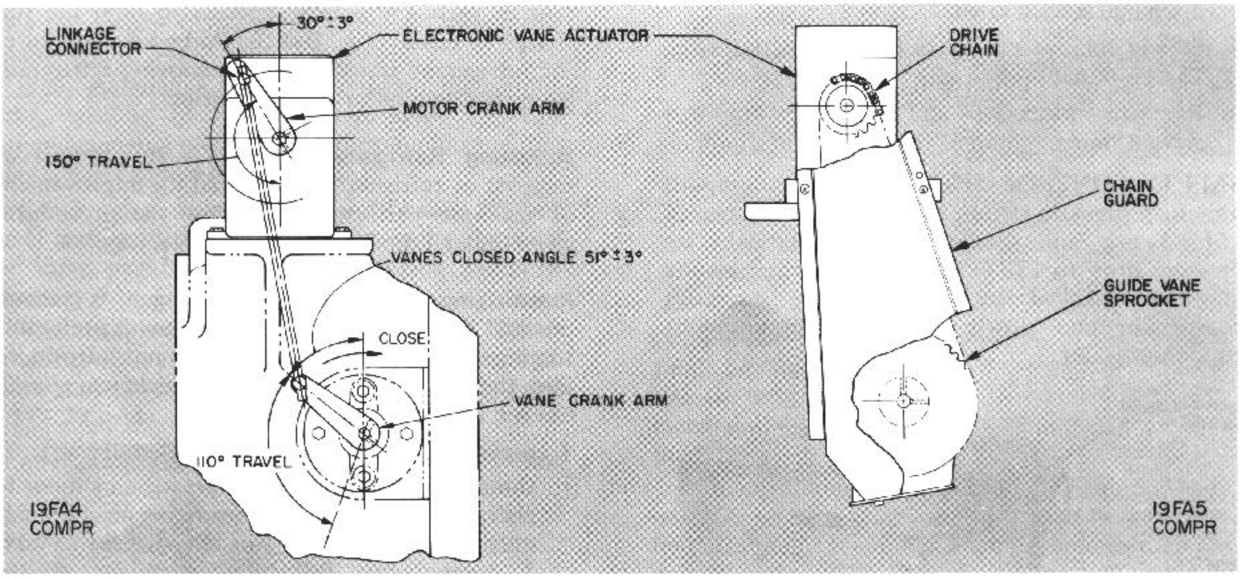


Fig. 20 — Electronic Vane Actuator Linkage

Checking Guide Vane Linkage — When the machine is off, the guide vanes are closed and the actuator mechanism is in the position shown in Fig. 20 or 21.

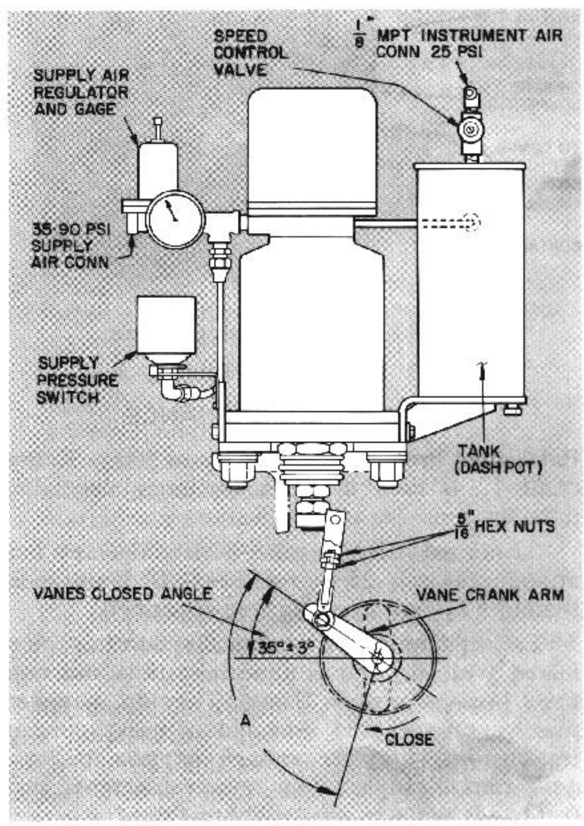
19FA4 ELECTRONIC ACTUATOR (Fig. 20) — If the motor crank arm is in the proper position at machine shutdown but the vane crank arm is not, the vanes are not fully closed. Loosen the vane arm linkage connector, close the vanes firmly by hand and retighten the connector.

If the motor crank arm is not in the proper position, do not attempt adjustment or repair. Contact a qualified service organization for assistance.

19FA5 ELECTRONIC ACTUATOR (Fig. 20) — If slack develops in the drive chain, backlash can be eliminated as follows:

1. With machine shut down (guide vanes closed), remove chain guard, loosen actuator hold-down bolts and remove chain.
2. Loosen vane sprocket set screw and rotate sprocket wheel until set screw clears existing spotting hole.
3. With set screw still loose, replace chain and move vane actuator to the left until all chain slack is taken up.
4. Tighten actuator hold-down bolts and retighten set screw in new position.
5. Realign chain guard as required to clear chain.

PNEUMATIC ACTUATOR (Fig. 21) — When instrument air pressure on the actuator (Fig. 21) is 0 psig, the actuator piston is fully retracted in the machine shutdown position. The vane crank arm should be at the approximate vanes closed angle shown.



"A" dimension = 107° except as follows:
C gear*, Size 5† compressor, 60-Hz motor — A = 90°
T gear, with turbine speed over 5800 rpm — A = 90°
*8th digit of compressor model number.
†5th digit of compressor model number.

Fig. 21 — Pneumatic Guide Vane Actuator and Linkage Adjustment

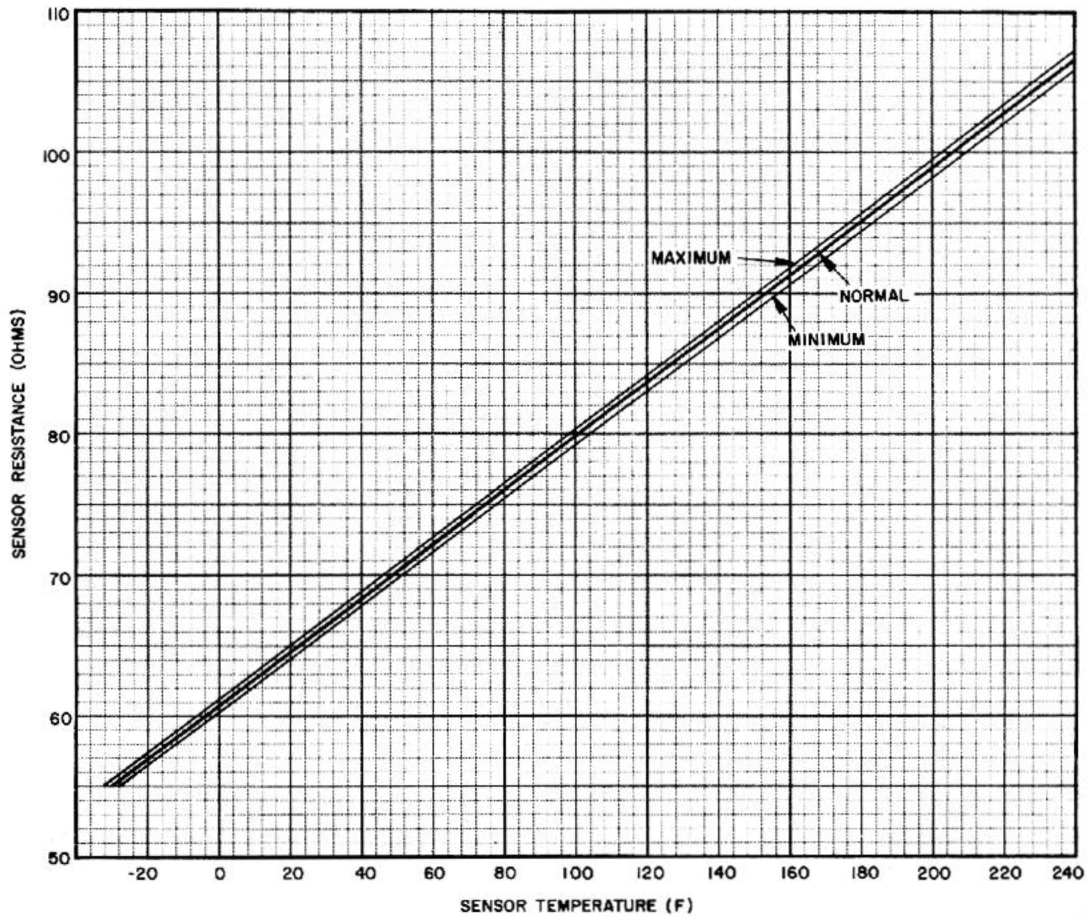


Fig. 22 — Bearing and Motor Sensor Resistance vs Temperature

To be sure that the guide vanes are closed at shutdown, loosen the 5/16-in. hex nuts and move the crank arm clockwise against the vane internal mechanical stop. Tighten the 5/16-in. hex nuts so that the actuator piston reaches its fully closed position *just before* the crank arm reaches the mechanical stop.

If the actuator piston is not fully retracted and there is sufficient supply air pressure, do not attempt adjustment or repair. Contact a qualified service organization for assistance.

Sensor Test Procedure — Bearing, discharge, motor slot and motor end-turn temperature sensors are connected to 2 modules in the machine control center (Fig. 26).

To check the sensors, turn off control power and disconnect the wires from module terminals SENSOR 1, SENSOR 2 and C. Refer to Fig. 22 and, with an ohmmeter, check resistance between wires from sensors as follows:

MODULE	SENSOR	CHECK BETWEEN WIRES FROM
Disch & Brg Temp Module	Discharge	Sensor 1 — C
	Bearing	Sensor 2 — C
Motor Temp Module	End Turn	Sensor 1 — C
	Slot	Sensor 2 — C

The values plotted in Fig. 22 are resistance values at the sensor itself and do not include fuse and wiring resistance.

Use an ohmmeter only. Application of more than 6 volts to sensor will cause damage.

To determine whether the module has tripped on a temperature safety, apply the ohmmeter test above for the following resistance levels immediately after shutdown:

MODULE	TRIP TEMP	RESISTANCE
Motor Temp	220 F	110 Ω
Disch & Brg	200 F(1)	105 Ω
	220 F(2)	110 Ω

(1) Control design 1. See Fig. 26.
(2) Control design 2. See Fig. 26.

TROUBLESHOOTING GUIDE

For pictorial identification of Control Design 1 and Control Design 2 models, refer to Fig. 26.

TROUBLE/SYMPTOM — COMPRESSOR WILL NOT START

SYMPTOM	PROBABLE CAUSE	REMEDY
All panel lights out.	No control power.	Check for building power failure. Check main circuit breaker.
	Blown fuse.	Check 15-amp fuse in control circuit; examine circuit for ground or short.
Panel lights as shown; SAFETY CIRCUIT light does not come on. ■ ON-STOP □ START □ OIL PUMP ■ POWER □ SAFETY CIRCUIT □ LOAD RECYCLE □ PROGRAM TIMER	Bearing or motor winding circuit breaker (CB1 or CB2) tripped. CONTROL DESIGN 1	Check CB1. If open, reset. Check relay KB by replacing it with relay KM. Check CB2. If open, reset. Check relay KM by replacing it with relay KB. If compressor trips out, check immediately for high bearing or motor temperatures. If present, DO NOT RESTART without proper corrective action. Check sensors. Refer to Sensor Test Procedure, page 25.
	Bearing or motor winding temperature switch open. CONTROL DESIGN 2	If BRG or MTR indicating light on relay module (Fig. 26) is lit, check immediately for high bearing or motor temperature. If temperatures are normal, check relay KB and KM. If compressor trips out, check immediately for high bearing or motor temperatures. If present, DO NOT RESTART without proper corrective action. Check sensors. Refer to Sensor Test Procedure, page 25. Reset is made by pressing ON-STOP button.
	Cooler low-temperature or condenser high-pressure switch tripped.	Reset switch manually.
	Blown fuse.	Check 3-amp fuse in control circuit; examine circuit for ground or short.
	Compressor motor overloads tripped.	Reset overloads in starter.
	Time-delay relay K4 open. CONTROL DESIGN 1	Remove control power and check continuity between (17) and (14); if open, check K4 relay.
	Program timer switch PT-4 in N.C. position. CONTROL DESIGN 2	Remove control power and check continuity between (17) and (14); if open, check PT-4.
Panel lights as shown; LOAD RECYCLE light does not come on. ■ ON-STOP ■ START □ OIL PUMP ■ POWER ■ SAFETY CIRCUIT □ LOAD RECYCLE □ PROGRAM TIMER	Chilled water temperature too low.	Check water temperature. Machine should start automatically when water temperature rises approximately 10 F above cutout point (see item 1, Table 4).
	Chilled water low-temperature switch incorrectly set.	Check setting of switch.
[*] **PROGRAM TIMER light goes on momentarily, then out.** ■ ON-STOP ■ START □ OIL PUMP ■ POWER ■ SAFETY CIRCUIT ■ LOAD RECYCLE [*] PROGRAM TIMER	1CR normally closed contact open.	Check for 115 volts between (15) and [L2].

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TROUBLESHOOTING GUIDE (Contd)

TROUBLE/SYMPTOM — COMPRESSOR WILL NOT START

SYMPTOM	PROBABLE CAUSE	REMEDY
◙ **OIL PUMP light goes on 10 to 30 seconds after pushing START button; goes out after about one minute.** **START light stays on.** ■ ON-STOP ■ START ◙ OIL PUMP ■ POWER ■ SAFETY CIRCUIT ■ LOAD RECYCLE ■ PROGRAM TIMER	Oil pump not operating (check by pressing OIL PUMP button). CONTROL DESIGN 1	Push ON-STOP button (light out) and then: Check for open oil pump disconnect. Check for faulty pump wiring. Check for faulty oil pump.
	Oil pump operates but oil pressure low. CONTROL DESIGN 1	Check oil level. Check for dirty oil filters; replace. Check oil pressure regulating valve.
	Oil low-pressure switch open (oil pressure normal). CONTROL DESIGN 1	Check setting of oil low-pressure switch. Check that both sets of contacts close when oil pressure is normal.
	Vane-Closed switch open. CONTROL DESIGN 1	Check continuity between (V1) and (V2); if none, check guide vane adjustment linkage per Fig. 20 or 21. If actuator is not in fully closed position, check relay K2 by replacing it with K3.
	Vane Closed switch open. CONTROL DESIGN 2	Check continuity between (V1) and [61]; if none, check guide vane adjustment linkage per Fig. 20 or 21. If actuator is not in fully closed position, check relay K2.
	Start relay 1CR inoperative.	Check for 120 volts between (V2) and (L2). Voltage should be present for 10 seconds approximately 1/2 minute after oil pump starts. If not, check PT-3; if so, then remove all power to main starter and examine 1CR relay.
◙ **OIL PUMP light goes on 10 to 30 seconds after pushing START button; goes out after about one minute.** **START light goes out.** ■ ON-STOP □ START ◙ OIL PUMP ■ POWER ■ SAFETY CIRCUIT ■ LOAD RECYCLE ■ PROGRAM TIMER	Water pumps not running.	Start pumps. Check pump starter(s) and relay(s).
	Water flow switches open (pumps running).	Check contacts of flow switches. Check for air in water line; vent air.
	Oil pump starter auxiliary contacts M3 open (oil pressure normal).	Check contacts.
	Oil pump not operating (check by pressing OIL PUMP button). CONTROL DESIGN 2	Push ON-STOP button (light out) and then: Check for open oil pump disconnect. Check for faulty pump wiring. Check for faulty oil pump.
	Oil pump operates but oil pressure low. CONTROL DESIGN 2	Check oil level. Check for dirty oil fiters; replace. Check oil pressure regulating valve.
	Oil low-pressure switch open (oil pressure normal). CONTROL DESIGN 2	Check setting of oil low-pressure switch. Check that both sets of contacts close when oil pressure is normal.

TROUBLE/SYMPTOM COMPRESSOR TRIPS OFF (Note: See Machine Recycle, page 42)

All panel lights out.	Power failure.	Check for building power failure. Check main circuit breaker and/or fuses.
	Blown fuse.	Check 15-amp fuse in control circuit; examine circuit for ground or short.
◙ **OIL PUMP light goes out approximately 40 seconds after compressor stops. START light goes out, but SAFETY CIRCUIT light stays on.** ■ ON-STOP □ START ◙ OIL PUMP ■ POWER ■ SAFETY CIRCUIT ■ LOAD RECYCLE ■ PROGRAM TIMER	Low oil pressure.	Check oil level in reservoir. Check for dirty oil filters.
	Oil pump not operating (button depressed).	Check for open oil pump disconnect. Check for faulty pump wiring. Check for faulty oil pump.
	Water-flow switch(es) open.	Pump(s) off; check starting equipment. Insufficient water flow; check water valves. Check for air in water lines; vent air. Defective flow switch; check contacts of switch.
	Momentary power interruption. CONTROL DESIGN 1	Push START button. Compressor will restart within 15 minutes.

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TROUBLE/SYMPTOM — COMPRESSOR TRIPS OFF

SYMPTOM	PROBABLE CAUSE	REMEDY
Panel lights as shown; START light and SAFETY CIRCUIT light go out. ■ ON-STOP □ START □ OIL PUMP ■ POWER □ SAFETY CIRCUIT □ LOAD RECYCLE ■ PROGRAM TIMER		Check bearing thermometer. If over 200 F, or if no one was present when machine stopped, DO NOT ATTEMPT TO RESTART MACHINE until cause is determined.
		Check for high discharge temperature; if present, make sure guide vanes are closed. Check condensing water flow and temperature. If water temperature is high, examine cooling tower operation. Check condenser for air or water leaks.
		Check oil reservoir temperature; if high, refer to Troubleshooting section in that category.
DESIGN 1 — Circuit breaker CB1 tripped. **DESIGN 2 — Bearing temperature light at relay module is on.**	High bearing or discharge temperature, or impeller displacement switch tripped.	With control power off, check 1/8 amp fuses in sensor junction box on compressor.
		Check for open circuit in sensors per Sensor Test Procedure, page 25.
		With control power on, check bearing and discharge protection-circuit transformer: 24 volts a-c across yellow leads S and S, 12 volts a-c across blue and yellow leads CT and S. If no voltage across CT and S, check continuity across leads of impeller displacement switch (Fig. 34). If switch is open, it must be inspected. DO NOT OPERATE MACHINE.
		Check relay KB. On DESIGN 1 machines only, relay function can be checked by exchanging it with relay KM.
		If all else fails, replace sensor module for discharge and bearing protection.
	High motor winding temperature.	Check motor cooling system; clean orifices, clean refrigerant strainer.
		With control power off, check 1/8 amp fuses in sensor junction box on motor end bell.
DESIGN 1 — Circuit breaker CB2 tripped. **DESIGN 2 — Motor temperature light at relay module is on.**		Check for open circuit in sensors per Sensor Test Procedure, page 25.
		With control power on, check motor protection circuit transformer: 24 volts a-c across yellow leads S and S, 12 volts a-c across red and yellow leads CT and S.
		Check relay KM. On DESIGN 1 machines only, relay function can be checked by exchanging it with relay KB.
		If all else fails, replace sensor module for motor protection.
	Momentary power interruption. Motor temp light goes on. CONTROL DESIGN 2	If power interruption is suspected, press ON-STOP button. If motor temp light then goes out, start machine and carefully monitor motor temperature.
	Cooler low-temperature switch tripped.	Manually reset switch and: Check that capacity control switch is at AUTO. position. Check for refrigerant loss. Determine and correct cause and add refrigerant. Low chilled water recycle switch should trip out machine before cooler low temperature switch. If chilled water temperature is low, check settings of both switches.

TROUBLESHOOTING GUIDE (Contd)

TROUBLE/SYMPTOM — COMPRESSOR TRIPS OFF

SYMPTOM	PROBABLE CAUSE	REMEDY
	Condenser high-pressure switch tripped.	Manually reset switch and: Check condensing water flow. Check condenser water temperature; if high, examine cooling tower operation. Check for air and water leaks, fouled tubes (see Maintenance section).
	Motor overload relays tripped.	Manually reset relays in starter and: Check that guide vanes stop opening when motor current exceeds 100% of full load amps. Adjust electrical demand control, if required. See Set Operating Controls. Check overload relay setting per starter manufacturer's instructions. DO NOT ATTEMPT FIELD ADJUSTMENT.
	Blown fuse.	Check 3-amp fuse in control circuit; examine circuit for ground or short.
Pneumatic Control Only	Inadequate air supply to guide-vane actuator.	Check air supply. If over 35 psig, check contacts of pressure supply switch (Fig. 6). Switch should close at 20 psig.

TROUBLE/SYMPTOM: COMPRESSOR RUNS BUT MACHINE MALFUNCTIONS AS NOTED

MALFUNCTION	PROBABLE CAUSE	REMEDY
GUIDE VANES WILL NOT OPEN	Compressor not in RUN condition.	At least one minute after compressor starts, check for 120 volts across (18) and (L2).
	K2 or K3 relay open.	Check continuity between [73] and [74].
Electronic Control Only	Capacity control switch improperly set.	Turn switch to AUTO. position.
Electronic Control Only	Motor current calibration incorrect.	Check per: Set Operating Controls
Electronic Control Only	Chilled water probe defective.	Check probe resistance per Fig. 23. Replace.
Electronic Control Only	Incorrect voltage in capacity control module.	Check for: +24 volts on *d-c scale*, between ⟨30⟩ and ⟨28⟩ (ground); −24 volts, d-c between ⟨81⟩ and ⟨28⟩ (ground). Replace module if voltage varies from above.
Pneumatic Control Only	Control air supply inadequate.	Check air supply. Adjust regulator.
Pneumatic Control Only	Chilled water pneumatic thermostat defective.	Check per manufacturer's instructions. Repair or replace.
CHILLED WATER TEMPERATURE TOO HIGH	Thermostat set too high.	Return thermostat to proper setting as marked on dial at initial start-up.
	Excessive cooling load (machine at capacity).	Check for infiltration of outside air into conditioned spaces.
	Condenser temperature too high.	Check condensing water flow. Check condensing water temperature; examine cooling tower operation. Check for air and water leaks, fouled tubes.
	Refrigerant level low.	Check for leak; repair. Add refrigerant.
	Liquid bypass in water box.	Examine division plates and gaskets for leaks.
Electronic Control Only	Excess throttling range (should be near minimum for proper control).	Reduce throttling range by turning adjusting screw clockwise in small increments.
Electronic Control Only	Guide vanes fail to open fully.	Ensure that capacity control switch is in AUTO. position. If vanes do not open with switch at INC, check for exessive cooling load (see above). Check relays K2 and K3. Check guide vane linkage. Check cycling timer. Check limit switch on actuator.
Pneumatic Control Only	Low sensitivity (should be as high as possible without vane hunting).	Increase sensitivity by moving sensitivity slider of pneumatic thermostat toward point DA.
Pneumatic Control Only	Guide vanes fail to open fully.	Check for excessive cooling load (see above). Check relays K2 and K3.

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TROUBLESHOOTING GUIDE (Contd)

TROUBLE/SYMPTOM – COMPRESSOR RUNS BUT MACHINE MALFUNCTIONS AS NOTED

MALFUNCTION	PROBABLE CAUSE	REMEDY
CHILLED WATER TEMPERATURE TOO LOW	Thermostat set too low.	Return thermostat to setting marked on dial at initial start-up.
	Low chilled water switch improperly set.	Water chilling duty – Switch should open at 5 F below design chilled water temperature, or at 37 F, whichever is higher. Brine chilling duty – Switch should open at 5 F below design leaving brine temperature.
Electronic Control Only	Excess throttling range (should be near minimum for proper control).	Reduce throttling range by turning adjusting screw clockwise in small increments.
Electronic Control Only	Guide vanes fail to close.	Ensure that capacity control switch is in AUTO. position. Check chilled water probe resistance per Fig. 23. Check guide vane actuator linkage. (See Fig. 20.) If all else fails, and vanes close in DEC but not in AUTO., replace capacity control module.
Pneumatic Control Only	Low sensitivity (should be as high as possible without vane hunting).	Increase sensitivity by moving sensitivity slider on pneumatic thermostat towards point DA.
Pneumatic Control Only	Guide vanes fail to close.	Check air signal to pilot positioner. Check guide vane actuator linkage. (See Fig. 21.)
CHILLED WATER TEMPERATURE FLUCTUATES: VANES HUNT — Electronic Control Only	Throttling range too narrow.	Add throttling range by turning adjusting screw counterclockwise in small increments.
Electronic Control Only	Defective capacity control module.	Replace module.
Pneumatic Control Only	Sensitivity too high.	Reduce sensitivity by moving sensitivity slider on pneumatic thermostat away from point DA. Set point may need readjustment; refer to calibration procedure in Initial Start-Up Instructions.
OIL RESERVOIR TEMPERATURE TOO LOW	Oil cooler water flow too high.	Throttle water to reduce flow.
	Thermostat improperly set or defective.	Check voltage across thermostat while adjusting it; if contacts do not close, replace thermostat.
	Oil heater defective.	If light indicates power but unit does not heat, check unit for open or short. Replace unit if required.
OIL RESERVOIR TEMPERATURE TOO HIGH	Thermostat improperly set.	Adjust thermostat.
	Oil cooler water flow too low.	Open plug valve.
	Oil cooler solenoid valve operating improperly.	Check electrical operation of solenoid. Inspect valve; if screen is fouled, clean screen and install a 20-mesh screen ahead of valve.
	Oil cooler tubes fouled.	Clean tubes.

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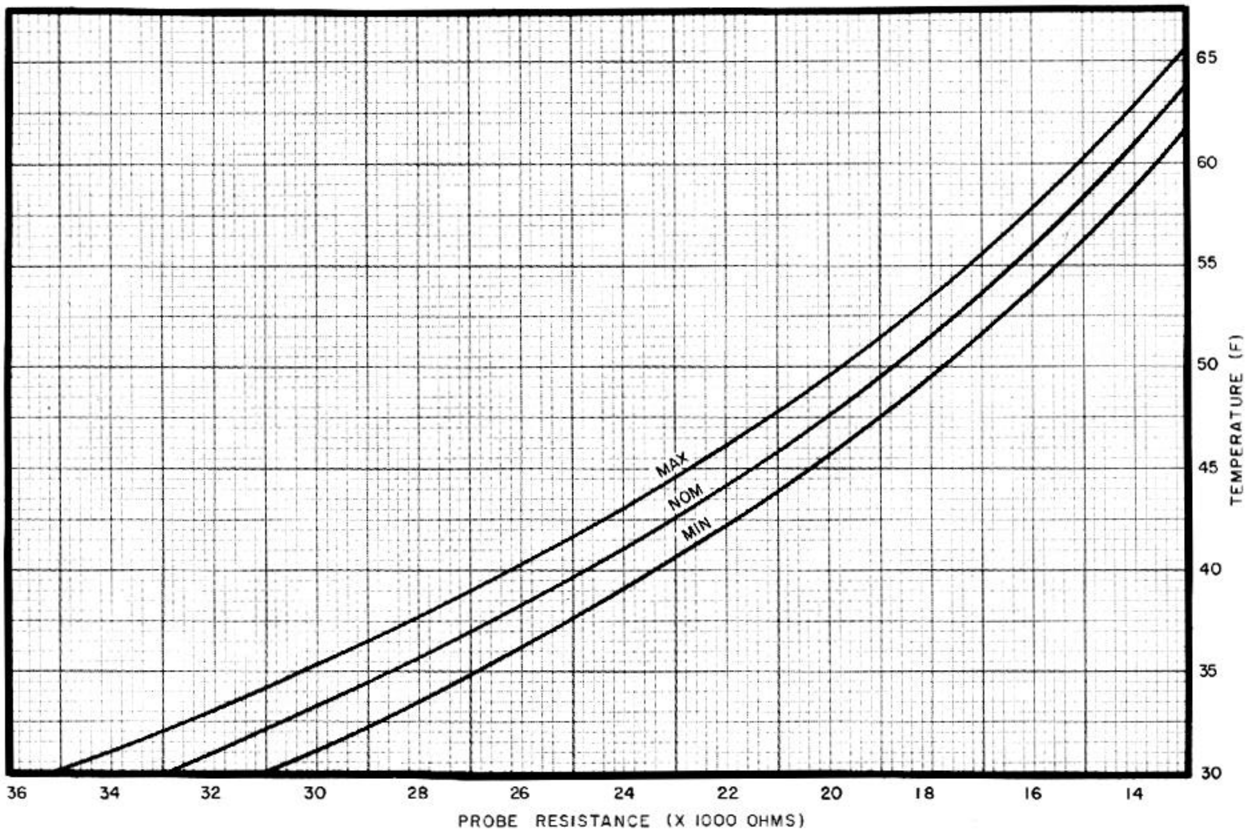

Fig. 23 — Chilled Water Probe Resistance vs Temperature

GENERAL DATA

Nameplate Location — The machine identification plate and the storage tank nameplates are mounted on the machine support base at the end opposite the compressor motor.

The cooler and condenser nameplates are mounted on the vessel support feet at the end opposite the compressor motor.

The economizer nameplate is located on the economizer shell facing the compressor.

The compressor nameplate is mounted on the compressor support foot adjacent to the oil pump.

When corresponding with Carrier, always list the machine model number, serial number and name of owner.

System Components — Major components include cooler, condenser, economizer, hermetic compressor and machine control center. Two storage tanks, capable of holding the entire refrigerant charge, form the support for compressor, control center and, when supplied, the pumpout unit.

COOLER — In this heat exchanger, flashing refrigerant picks up heat from, and thus chills, the water (or brine) flowing thru the cooler tubes.

CONDENSER — In this heat exchanger, heat is removed from compressed refrigerant and is carried out of the system.

ECONOMIZER — This vessel contains a valve system that permits collection and return of flash gas to the compressor second stage for greater refrigerant cycle efficiency. The valve system also helps maintain the necessary pressure difference between cooler and condenser.

MOTOR-COMPRESSOR maintains the necessary pressure differences in the system and moves the heat-carrying refrigerant from cooler to condenser.

CONTROL CENTER contains machine safety devices and pressure gages for cooler, condenser and oil pump. Control center modules control machine start, stop and recycle and regulate machine capacity. Machine operating hours are automatically recorded and displayed at the control center.

STORAGE TANKS support machine components and provide a ready receptacle for the refrigerant charge during machine service periods and at extended shutdown.

PUMPOUT UNIT is used for refrigerant transfer, machine evacuation and machine pressurizing.

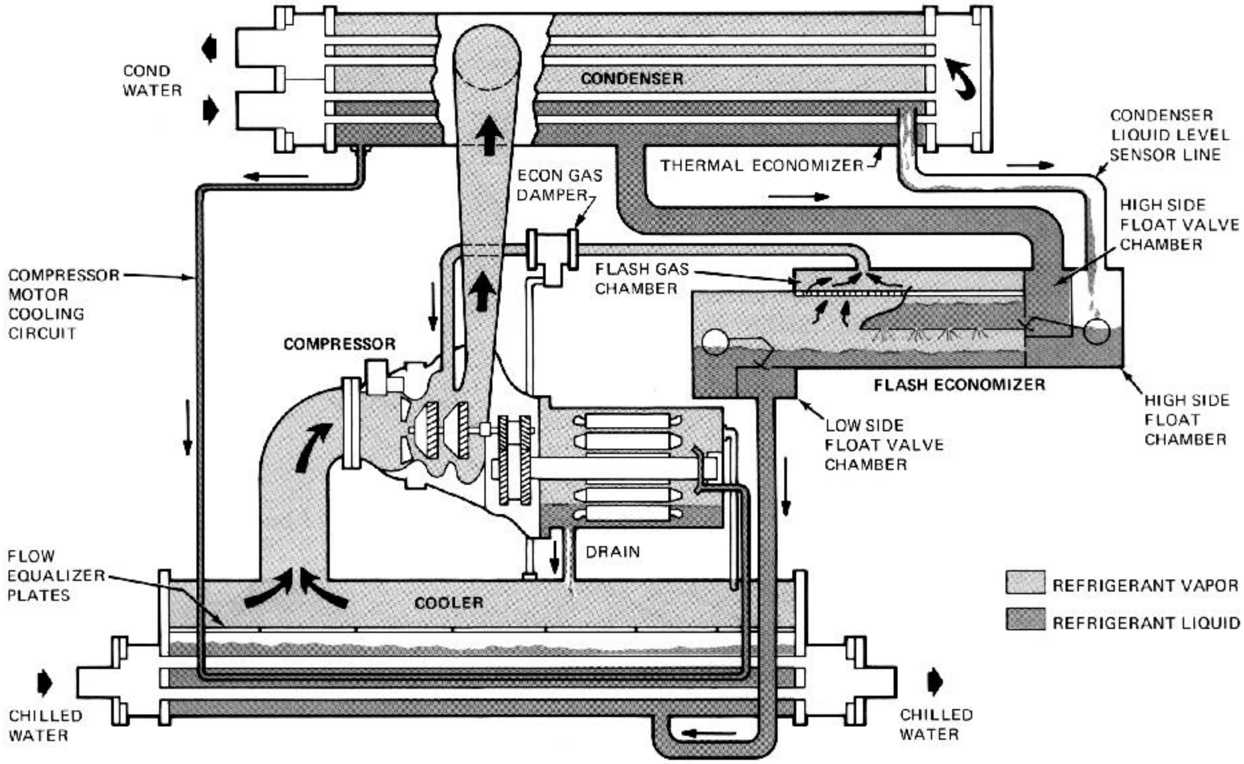

Fig. 24 — 19FA Refrigeration Cycle

REFRIGERATION CYCLE

With the exception of the thermal economizer, which is used on water chilling duty only, the basic refrigeration cycle described below is applicable to either water or brine chilling.

The machine compressor continuously draws large quantities of refrigerant vapor from the cooler, at a rate set by the amount of guide vane opening. This compressor suction reduces the pressure within the cooler and causes the remaining refrigerant to boil vigorously at low temperature (typically 30 to 35 F).

The energy required for boiling is obtained as heat from the water (or brine) flowing thru the cooler tubes. With heat removed, the chilled water (brine) can then be used for air conditioning or for process liquid cooling.

After removing heat from the water, the refrigerant vapor passes thru the compressor first stage, is compressed and moves into the compressor second stage. Here it is mixed with flash-economizer gas and is further compressed.

Compression raises the refrigerant temperature above that of the water flowing thru the condenser tubes. When the warm (typically 100 to 105 F) refrigerant is discharged into the condenser, the relatively cool condensing water removes some of the heat and the vapor condenses into a liquid. In water chilling machines, further removal of heat occurs in the thermal economizer at the bottom of the condenser. Here the liquefied refrigerant is subcooled by contact with the coolest (entering water) condenser tubes.

The liquid refrigerant drains into the flash economizer where a valve system helps maintain pressure intermediate between the condenser and the cooler pressure. At this lower pressure, part of the liquid refrigerant flashes to gas, thus cooling the remaining liquid. The flash gas is returned directly to the compressor second stage. Here it is mixed with gas already compressed by the first stage impeller. Since the economizer gas has to pass thru only half the compression cycle to reach condenser pressure, there is a savings in power, hence the term "economizer."

The cooled liquid refrigerant in the economizer is metered thru the low-side float chamber to the cooler. Because cooler pressure is lower than the economizer pressure, some of the liquid flashes and cools the remainder to cooler temperature. The cycle is now complete.

MOTOR COOLING CYCLE

Refrigerant liquid from a sump at the bottom of the condenser (Fig. 24) is subcooled by passage thru a line immersed in the refrigerant within the cooler. The liquid then enters the compressor motor end where it sprays on and cools the compressor rotor and stator. It then collects in the base of the motor casing and drains back into the cooler. Refrigerant gas is vented from the compressor motor casing and returns to the upper portion

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of the cooler thru a check valve. Differential pressure between condenser and cooler maintains the refrigerant flow.

LUBRICATION CYCLE

Summary — The compressor oil pump and oil reservoir are located in the compressor base. Oil is pumped thru an oil cooler and a filter to remove heat and any foreign particles. Part of the oil flow is directed to the compressor motor-end bearings and seal. The remaining flow lubricates the compressor transmission, thrust and journal bearings and seal. Oil is then returned to the reservoir to complete the cycle (Fig. 25).

Details — Oil is charged into reservoir (1) thru a hand valve (2) which also functions as an oil drain. If there is refrigerant in machine, a pump is required for charging. Sight glasses (5) on reservoir wall permit observation of oil level.

The motor-driven oil pump (6) discharges oil to an oil cooler (7) at a rate and pressure controlled by an oil regulator (8). The differential pressure (supply versus return) is registered on a gage at the machine control center.

Water flow thru the oil cooler is manually adjusted by a plug valve (9) to maintain the oil at an operating temperature, at the reservoir, of approximately 145 F. During machine shutdown, the oil temperature is also maintained at 140 to 145 F by an immersion heater (10) so that absorption of refrigerant by the oil is minimized.

After it leaves the oil cooler, the oil is filtered (11) and a portion flows to the motor-end bearing (12) and seal. The remainder lubricates the compressor transmission (14) and the thrust and journal bearings (15). Thrust bearing temperature is indicated on a gage (16) mounted on the bearing inspection cover. Oil from each circuit returns by gravity to the reservoir.

A demister (17) and (18), by centrifugal action, draws refrigerant gas from the transmission area to the motor shell. The resulting pressure difference prevents oil in the transmission cavity from leaking into the motor shell.

Several safety devices monitor the lubrication system:

In the event of power failure, a small oil reservoir (19) supplies sufficient oil reserve to ensure continued lubrication until all compressor parts have come to a complete stop.

Sensor (20) monitors thrust bearing temperatures and shuts off machine if temperature rises above a selected point.

Low-oil pressure cutout (Fig. 26) shuts down machine or prevents start if oil pressure is not adequate.

A program timer in the machine control center ensures proper lubrication at start-up and at coastdown by energizing the oil pump for approximately 30 seconds before the compressor starts, and keeping the pump running for almost one minute after the compressor motor is de-energized.

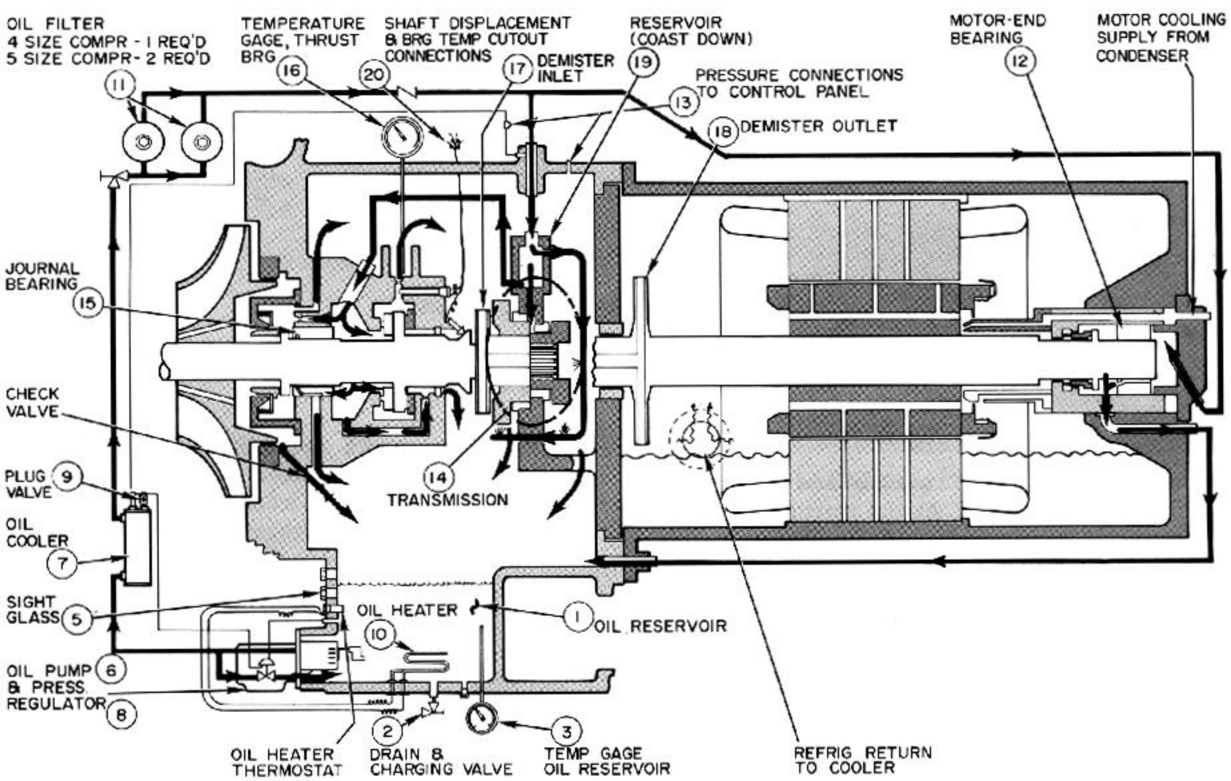

Fig. 25 — 19FA Lubrication Cycle

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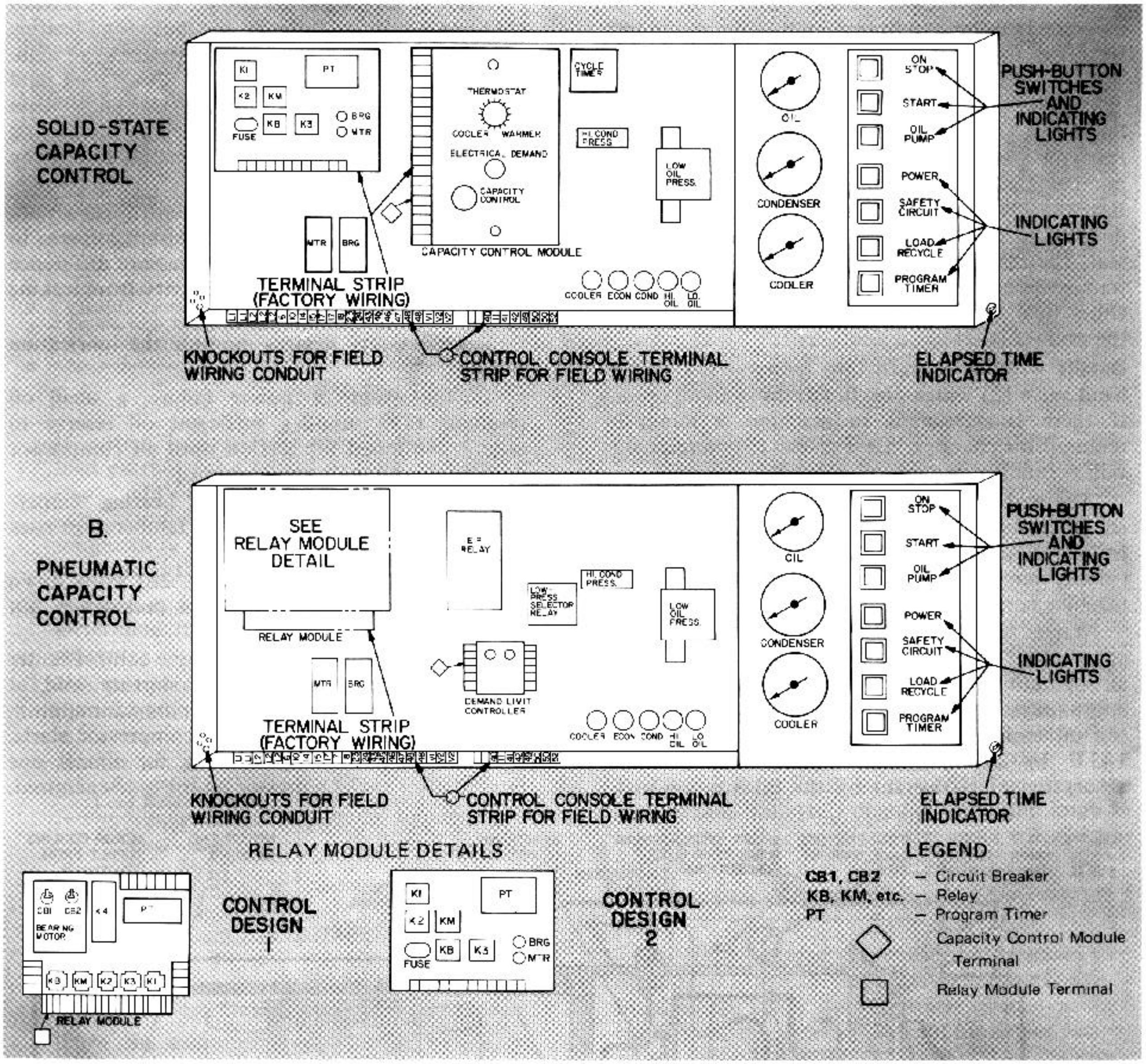

Fig. 26 — 19FA Control Center Variations

CONTROLS

General — Basic 19FA controls and wiring are described in this section. Actual machine controls may differ in some respects, depending upon job specifications.

Operating Controls — The cooling capacity of all 19FA machines is automatically adjusted to match the cooling demand by changing the position of the compressor inlet guide vanes. A temperature sensing device in the leaving chilled water (or brine) circuit of the machine cooler produces signals which are transmitted to an automatic guide vane actuator. A drop in leaving chilled water temperature causes the guide vanes to move towards the closed position. This reduces the rate of refrigerant evaporation and gas (vapor) flow into the compressor and decreases machine capacity. A rise in chilled water temperature opens the vanes. More refrigerant vapor moves thru the compressor and capacity increases. For precise control of guide vane response, signals from sensing device to vane actuator are modulated at machine control center.

SOLID STATE CAPACITY CONTROL — In addition to amplifying and modulating signals from the chilled water sensor, a solid state module in the control center provides means for preventing the compressor from exceeding full load amps and for limiting motor current down to 40% of full load amps as a means of reducing electrical demand rates. A throttle range adjustment screw eliminates guide vane hunting, and a manual capacity control knob allows the operator to open, close or hold guide vane position when desired.

PNEUMATIC CAPACITY CONTROL – An electrical demand limit controller (Fig. 12) prevents motor current from exceeding full load amperage, and allows limiting of power demand down to 40% FLA. The electrical signals of the demand control are converted to air signals by an electro-pneumatic relay. To be certain that the signals from the electrical demand control override any capacity increase signals from the pneumatic thermostat when motor current limits are approached, a selector relay compares and selects the proper signal from thermostats and demand control.

Safety Controls – Standard 19FA safety controls shut down the machine to protect it against damage from motor winding high temperature, discharge gas and bearing high temperatures, refrigerant low temperature, condenser high-pressure, low-oil pressure and inadequate cooler and condenser water flow. In addition, oil pump failure, compressor motor overload or impeller displacement can shut down the machine. Machines using pneumatic capacity control can also shut down on low air supply to the vane actuator.

If chilled water temperature drops approximately 5 F below the normal set point, the chilled water low-temperature cutout and recycle switch stops the compressor. Machine restart is automatic when the water temperature rises to approximately 5 F above the set point and a programmed safety time interval has gone by.

Oil Heater and Thermostat – Typical field wiring for the oil heater is illustrated in Fig. 27. To be sure that the heater remains energized during machine shutdown, power wiring is from a separate source.

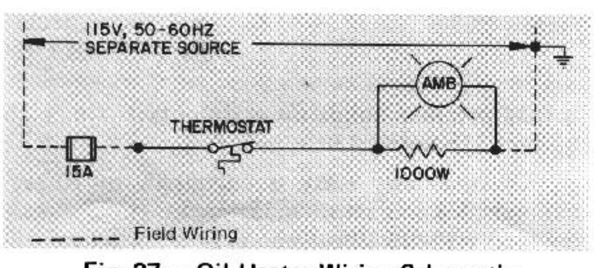

Fig. 27 – Oil Heater Wiring Schematic

Pumpout Controls – Include ON-OFF switch, 3-amp fuse, compressor contactor, compressor overloads and internal thermostat, refrigerant high-pressure cutout. The fused disconnect for the pumpout unit is customer supplied.

Standard pumpout compressor voltages are: 208, 230 and 460. Control voltage is 115 v, single phase.

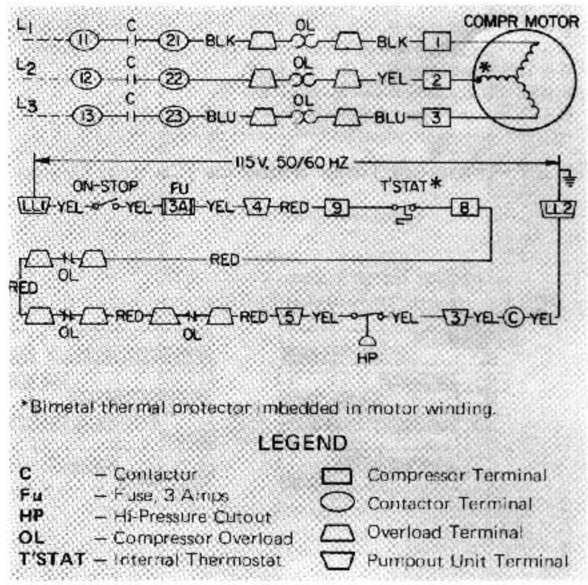

Fig. 28 – Pumpout Unit Wiring Schematic

Program Timer (Fig. 26, 29 and 30) – The 19FA program timer controls machine start and stop sequences and provides proper pre-lube and post-lube times for the compressor-motor assembly. The program timer also provides a minimum 15-minute interval to allow machine conditions to stabilize between shutdown and subsequent restart.

This 15-minute interval is not intended to permit or endorse modes of operation calling for continuous on-off recycling. The long term reliability of any induction motor-driven machinery depends on good system design and operating practices that minimize the number of starts and stops required of the equipment during normal operation.

The program timer sequences of Control Design 1 and Control Design 2 are illustrated in Fig. 29 and 30. The timer cam numbers and positions are those shown on the machine wiring schematics, Fig. 31 and 32.

The letters N.C. and N.O. on the program timer switches designate switch contact position only and do not necessarily indicate the de-energized or shutdown condition of the switch.

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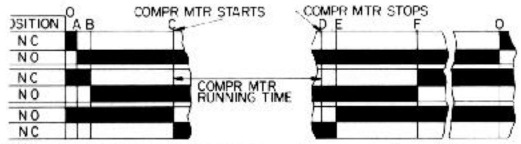
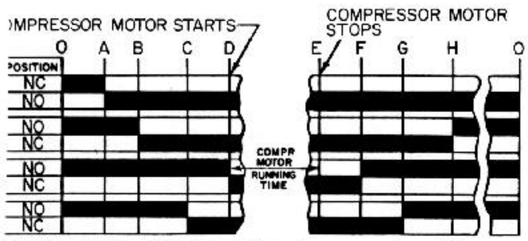


O = Starting sequence begins (condition shown on schematic)
A = 13 ± 5 sec after O
B = 10 ± 8 sec after A (oil pump starts)
C = 28 ± 8 sec after B (compr motor starts and program timer stops)
D = Time at which compr motor stops and program timer starts
E = 13 ± 5 sec after D
F = 28 ± 8 sec after E (oil pump stops)
O = 15 min ± 15 sec total cycle time (D to C)
NC, NO — Program timer switch contact designation

Fig. 29 — Program Timer Sequence (Control Design 1)



O = Starting sequence begins (condition shown on schematic)
A = 13 ± 5 sec after O
B = 10 ± 5 sec after A (oil pump starts)
C = 15 ± 5 sec after B
D = 13 ± 5 sec after C (compr motor starts and program timer stops)
E = Time at which compr motor stops and program timer restarts.
F = 13 ± 5 sec after E
G = 13 ± 5 sec after F
H = 15 ± 5 sec after G (oil pump stops)
O = 15 min ± 15 sec total cycle time (E-D)
NC, NO — Program timer switch contact designation

Fig. 30 — Program Timer Sequence (Control Design 2)

Machine Control Wiring — Figure 31 and 32 schematically illustrate typical machine control wiring. Numerals at the right of the diagrams indicate the line on which relay contacts may be found. Underlining indicates that the contact is normally closed.

Typical Machine Start Sequence, Control Design 1 — (See Fig. 31)

1. Supply power to machine. POWER light goes on.

   □ ON-STOP
   □ START
   □ OIL PUMP
   ■ POWER
   □ SAFETY CIRCUIT
   □ LOAD RECYCLE
   □ PROGRAM TIMER

2. Press water pump start button (line 2).
   a. Pilot relay (PR) energizes water pumps and cooling tower fan. PR contact holds relay in.
   b. Water flow switches (line 26) close.
3. Press ON-STOP button.
   a. Relays KM (line 9) and KB (line 17) are energized thru motor temperature module and bearing temperature and impeller displacement module.
   b. KB and KM contacts (lines 21 and 22) open, breaking circuit to CB1 and CB2 (lines 21 and 22).
   c. KB and KM contacts (line 23) close, completing circuit to cooler low-temperature and condenser high-pressure switches, compressor overloads in starter, K4 contact and low chilled water temperature switch. Water flow switches (line 26) and oil low-pressure switch are temporarily bypassed.
   d. ON-STOP, SAFETY CIRCUIT and LOAD RECYCLE lights go on.

      ■ ON-STOP
      □ START
      □ OIL PUMP
      ■ POWER
      ■ SAFETY CIRCUIT
      ■ LOAD RECYCLE
      □ PROGRAM TIMER

4. Press machine START button.
   a. K1 is energized and is held in by its holding contact. Second K1 contact (line 31) closes circuit to program timer motor (PT).
   b. START and PROGRAM TIMER lights go on.

      ■ ON-STOP
      ■ START
      □ OIL PUMP
      ■ POWER
      ■ SAFETY CIRCUIT
      ■ LOAD RECYCLE
      ■ PROGRAM TIMER

5. PT-1 (line 35) moves to N.O. position; timer motor is kept energized thru 1CR normally closed contact.
6. PT-2 moves to N.O. position (line 5).
   a. Power reaches oil pump starter relay M3.
   b. OIL PUMP light goes on.

      ■ ON-STOP
      ■ START
      ■ OIL PUMP
      ■ POWER
      ■ SAFETY CIRCUIT
      ■ LOAD RECYCLE
      ■ PROGRAM TIMER

   c. Oil pressure builds up and contacts (lines 26 and 31) close.
   d. K4 time-delay relay is energized. In 10 seconds, K4 contact (line 25) opens; safety circuit is completed thru water flow switches, oil-pressure switch and M3 contact. Second K4 contact (line 31) closes circuit to PT-3.
7. PT-3 moves to N.C. position. Compressor motor start relay 1CR and relay K2 are energized thru VANE CLOSED switch. Compressor starts.
   a. 1CR contact (line 31) closes to hold in 1CR relay.

b. 1CR contact (line 35) opens; program timer stops and PROGRAM TIMER light goes out.

ON-STOP	■
START	■
OIL PUMP	■
POWER	■
SAFETY CIRCUIT	■
LOAD RECYCLE	■
PROGRAM TIMER	□

c. K2 contact (line 40) opens and removes "close" signal from guide vane actuator.

d. Cycling timer (M) alternately makes and breaks circuit to K2 and K3 contacts (line 42).

8. Compressor reaches "Run" condition.

a. Relay K3, oil cooler solenoid valve (OCW) and capacity control module are energized.

b. K3 contacts close to interlock oil pump, water pumps and cooling tower fan (lines 3 and 4).

c. K2 and K3 contacts (line 42) are now closed to allow an "open" signal to reach guide vane actuator.

Typical Machine Stop Sequence, Control Design 1 — (See Fig. 31)

1. Push ON-STOP switch.

a. All machine control relays are de-energized.

b. As 1CR relay drops out, compressor stops. 1CR contact (line 35) closes and program timer starts.

c. As K3 relay drops out, its contacts (lines 3 and 4) open, and remove interlocking circuits to water pumps, cooling towers and oil pump starter.

d. Third K3 contact (line 42), and both K2 contacts return to de-energized condition and compressor guide vanes close.

e. ON-STOP, START, SAFETY CIRCUIT and LOAD RECYCLE lights go off; PROGRAM TIMER light goes on.

ON-STOP	□
START	□
OIL PUMP	■
POWER	■
SAFETY CIRCUIT	□
LOAD RECYCLE	□
PROGRAM TIMER	■

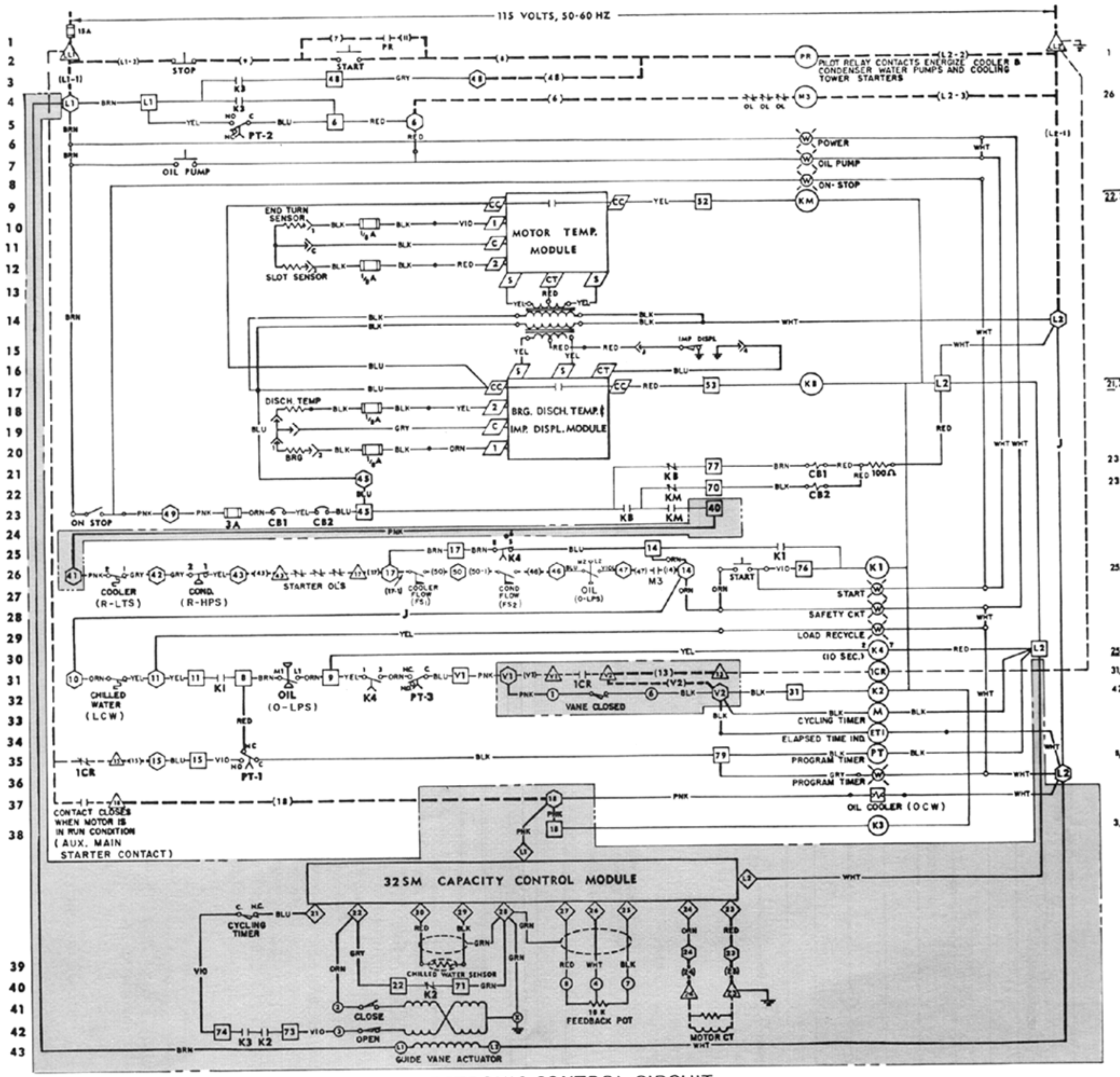
2. In a few seconds, PT-3 moves to its N.O. position, preventing compressor start relay 1CR from being energized for approximately 15 minutes.

3. PT-2 moves to N.C. position about 40 seconds after ON-STOP switch was pushed. Oil pump stops. OIL PUMP light goes off.

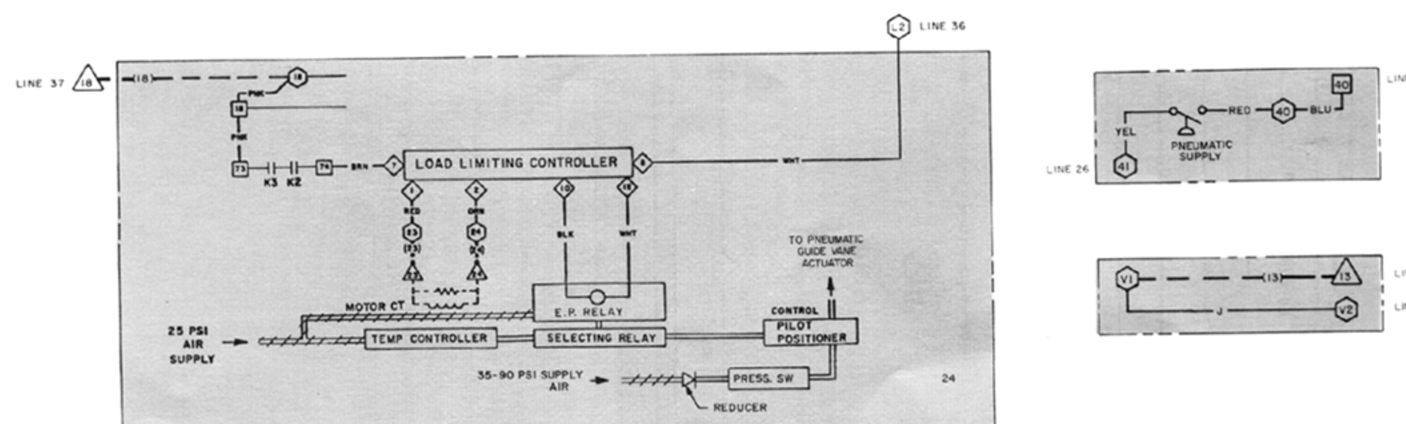
ON-STOP	□
START	□
OIL PUMP	□
POWER	■
SAFETY CIRCUIT	□
LOAD RECYCLE	□
PROGRAM TIMER	■

4. In approximately 14 minutes, PT-1 moves to its N.C. position. PROGRAM TIMER stops and light goes off. Machine may be restarted.

ON-STOP	□
START	□
OIL PUMP	□
POWER	■
SAFETY CIRCUIT	□
LOAD RECYCLE	□
PROGRAM TIMER	□



ELECTRONIC CONTROL CIRCUIT



PNEUMATIC CONTROL CIRCUIT (Interchange Shaded Area Components)

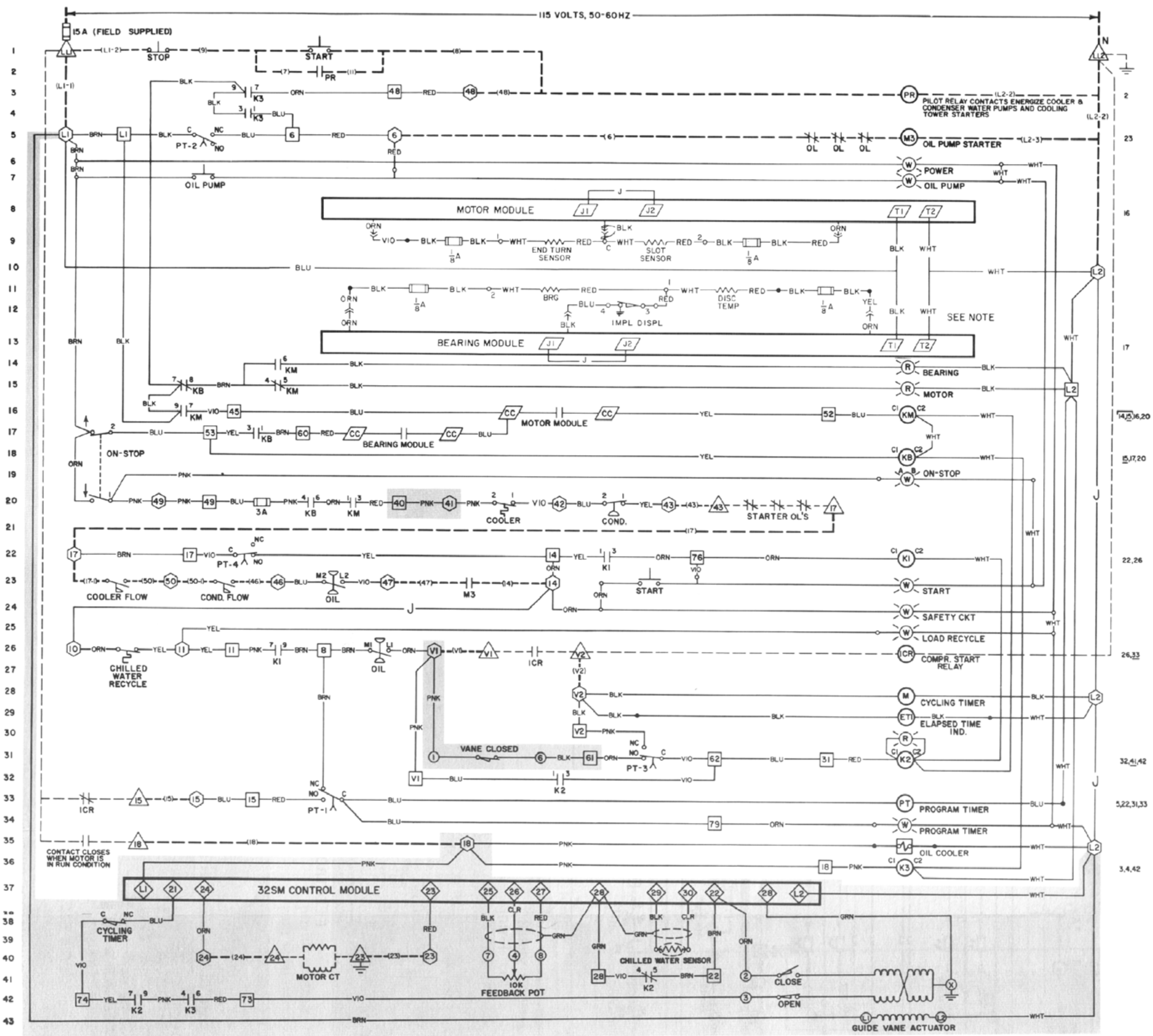
Fig. 31 — 19FA Control Design 1 Wiring Schematic

LEGEND
(For Fig. 31 and 32)

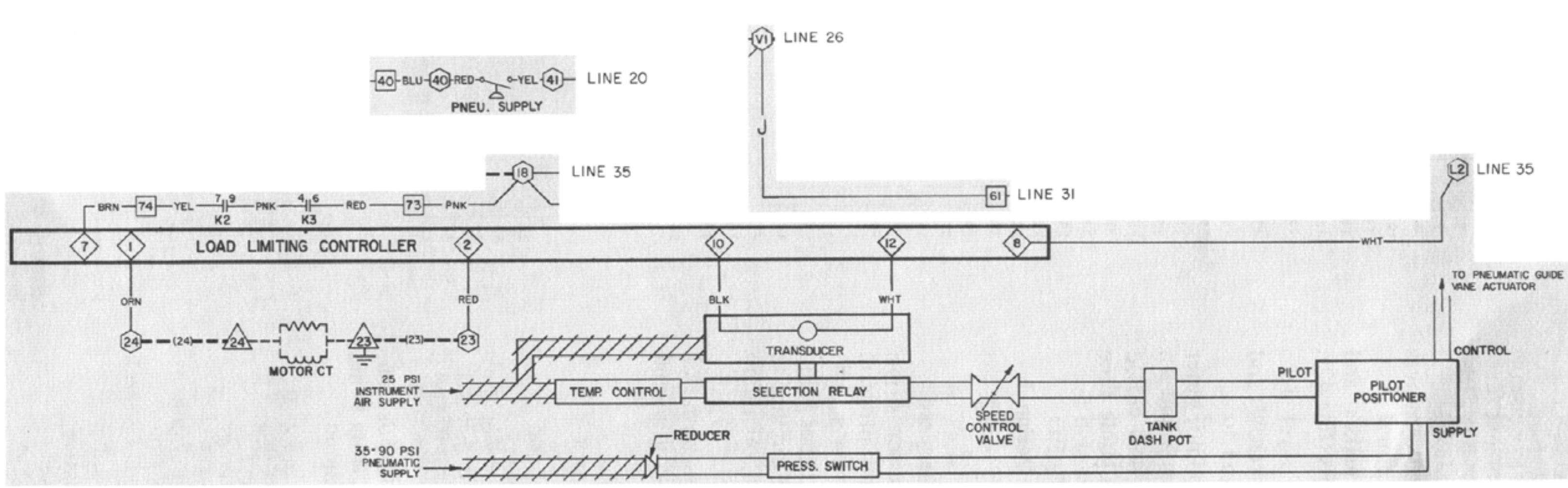
1CR	— Compressor Motor Starter Holding Coil
CB1, CB2	— Circuit Breakers
ETI	— Elapsed Time Indicator
FS1, FS2	— Flow Switches or Auxiliary Contacts (Cooler and Condenser)
J	— Jumper
K	— Relays
LCW	— Low Chilled Water Temperature Switch
M	— Cycling Timer Motor
M3	— Oil Pump Starter and Contact
OCW	— Oil Cooler Water Solenoid Valve
OL	— Motor Overloads
O-LPS	— Oil Low-Pressure Switch
PR	— Pilot Relay
PT	— Program Timer
R-HPS	— Refrigerant High-Pressure Switch (Condenser)
R-LTS	— Refrigerant Low-Temperature Switch (Cooler)
TDR	— Time-Delay Relay

—( )— Field Wiring
– – – – Starter Wiring
——— Factory Wiring
/////// Pneumatic Piping, not by Carrier
⬡ Field-Wiring Terminal
△ Starter Terminal
□ Relay Module Terminal
▱ Temperature Sensor Module Terminal
◇ Capacity Control Module Terminal (Electronic)
◇ Load Limiting Controller Terminal (Pneumatic)
○ Guide Vane Actuator Terminal

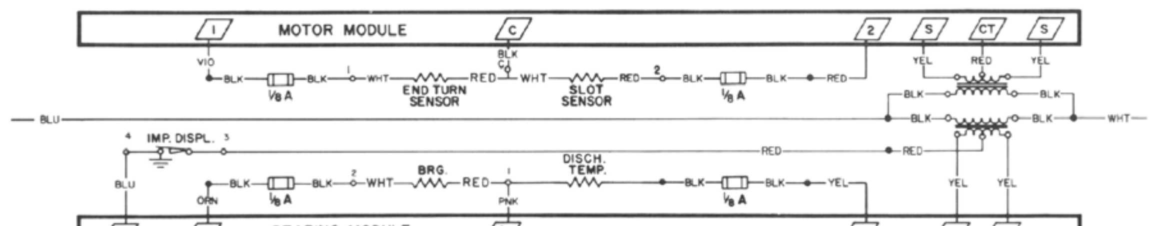
Contents



ELECTRONIC CONTROL CIRCUIT



PNEUMATIC CONTROL CIRCUIT
SAME AS ELECTRONIC CONTROL CIRCUIT EXCEPT INTERCHANGE SHADED AREAS

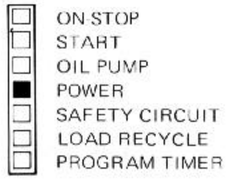


NOTE: Wiring for 24-volt motor and bearing modules (with transformers).

Fig. 32 — 19FA Control Design 2 Wiring Schematic

→Typical Machine Start Sequence, Control Design 2 — (See Fig. 32)

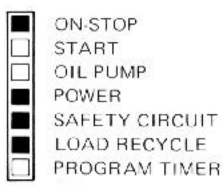
1. Supply power to machine.
   a. POWER light goes on.



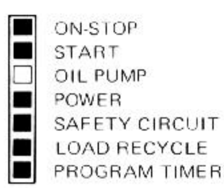
   b. Motor module (line 8) is energized. If impeller displacement switch (line 11) is closed, bearing module (line 13) is energized. Module contacts (lines 16 and 17) close; relays KM and KB (lines 16 and 18) are energized thru the normally closed contact of machine ON-STOP switch (line 17).

2. Press water pump start button (line 1).
   a. Pilot relay PR (line 3) energizes starters for water pumps and cooling tower fans. PR contact (line 2) holds relay in.
   b. Water flow switches (line 23) close.

3. Press machine ON-STOP button.
   a. Relays KM and KB remain energized thru KM contact (line 16) and KB contact (line 17). Circuit is completed thru cooler refrigerant low temperature cutout, condenser high pressure cutout and compressor motor overloads (line 20), and thru the chilled water recycle switch (line 26).
   b. Oil low-pressure switch and water flow switches (line 23) are temporarily bypassed thru program timer switch PT-4 (line 22).
   c. ON-STOP, SAFETY CIRCUIT and LOAD RECYCLE lights go on.



4. Press machine START button.
   a. Relay K1 (line 22) is energized and is held in by its holding contact. Second K1 contact (line 26) closes circuit to program timer motor PT (line 33).
   b. START and PROGRAM TIMER lights go on.



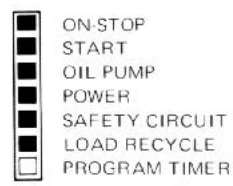
5. Program timer switch PT-1 moves to N.O. position (line 33). Timer motor is kept energized thru 1CR N.C. contact.

6. PT-2 moves to N.C. position (line 5).
   a. Oil pump starter M3 is energized.
   b. OIL PUMP light goes on.

   c. Oil pressure builds up. Pressure switch contacts (lines 23 and 26) close.
   d. Relay K2 (line 31) is energized thru the vane closed switch; K2 indicating light goes on. K2 contact (line 32) holds in the K2 relay. Second K2 contact (line 41) opens to remove "close" signal from guide vane actuator. Third K2 contact, in the actuator "open" circuit (line 42), closes.

7. In 15 seconds, contact PT-4 (line 22) moves to N.C. position and safety circuit is now complete thru flow switches, oil low-pressure switch and M3 contact (line 23).

8. PT-3 (line 30) moves to N.C. position 13 seconds later. Compressor motor start relay 1CR is now energized thru the K2 holding contact (line 32). Compressor starts. Cycling timer motor M (line 28) is energized; timer contact (line 38) alternately makes and breaks. N.O. K3 contact still prevents "open" signal from reaching guide vane actuator (line 42).
   a. Normally open 1CR contact (line 26) closes to hold in 1CR relay.
   b. Normally closed 1CR contact (line 33) opens; program timer stops and PROGRAM TIMER light goes out.



9. Compressor reaches run condition.
   a. Run contact (line 35) closes.
   b. Relay K3, oil cooler solenoid valve and capacity control module are energized.
   c. Normally open K3 contacts (lines 3 and 4) close to interlock oil pump, water pumps and cooling tower fans with compressor motor.
   d. Closing of K3 contact (line 42) allows "open" signal to reach the guide vane actuator.

→ Typical Machine Stop Sequence, Control Design 2 — (See Fig. 32)

1. Push machine ON-STOP switch.
   a. Machine control relays K1 and K2, and motor start relay 1CR are de-energized.

b. As 1CR relay drops out, compressor stops, 1CR contact (line 33) closes and program timer starts. Run contact (line 35) opens and de-energizes relay K3.

c. As K3 relay drops out, its contacts (lines 3 and 4) open and remove the interlocking circuit to water pumps, cooling tower fans and oil pump starter. Pumps and fans remain energized thru PR contact (line 2); oil pump remains energized thru PT-2 (line 5).

d. A third K3 contact (line 42) and both K2 contacts in the vane actuator circuit return to the de-energized condition and the guide vanes close.

e. ON-STOP, START, SAFETY CIRCUIT and LOAD RECYCLE lights go off. PROGRAM TIMER light goes on.

□ ON-STOP
□ START
■ OIL PUMP
■ POWER
□ SAFETY CIRCUIT
□ LOAD RECYCLE
■ PROGRAM TIMER

2. In a few seconds, PT-3 moves to N.O. position, preventing compressor start relay 1CR from being energized for 15 minutes.

3. Oil pump stops approximately 40 seconds after ON-STOP button is pushed when PT-2 moves to N.O. position. OIL PUMP light goes off.

□ ON-STOP
□ START
□ OIL PUMP
■ POWER
□ SAFETY CIRCUIT
□ LOAD RECYCLE
■ PROGRAM TIMER

4. In approximately 15 minutes after compressor stops, PT-1 moves to N.C. position. Program timer stops, PROGRAM TIMER light goes out and machine can restart.

□ ON-STOP
□ START
□ OIL PUMP
■ POWER
□ SAFETY CIRCUIT
□ LOAD RECYCLE
□ PROGRAM TIMER

5. Water pumps and cooling tower fans are stopped by pushing water pump stop button (line 1).

→ **Typical Machine Recycle Sequence, Control Designs 1 and 2** — During normal cooling, the building load may drop low enough to make continuous operation of the refrigeration machine unnecessary. When the chilled water temperature reaches its low cutout point, the machine shuts off automatically. It remains off for a minimum of 15 minutes and until the rise in chilled water temperature closes the switch contacts. The machine then restarts automatically.

1. Machine operating normally.

■ ON-STOP
■ START
■ OIL PUMP
■ POWER
■ SAFETY CIRCUIT
■ LOAD RECYCLE
□ PROGRAM TIMER

2. Chilled water temperature drops 5 F below selected set point; low chilled water temperature cutout opens. Relay 1CR is de-energized. Compressor stops.
Program timer starts.

■ ON-STOP
■ START
■ OIL PUMP
■ POWER
■ SAFETY CIRCUIT
□ LOAD RECYCLE
■ PROGRAM TIMER

3. Oil pump stops approximately 40 seconds after compressor.

■ ON-STOP
■ START
□ OIL PUMP
■ POWER
■ SAFETY CIRCUIT
□ LOAD RECYCLE
■ PROGRAM TIMER

4. Program timer completes its cycle (approximately 15 minutes after machine shutdown). Machine restart is now possible.

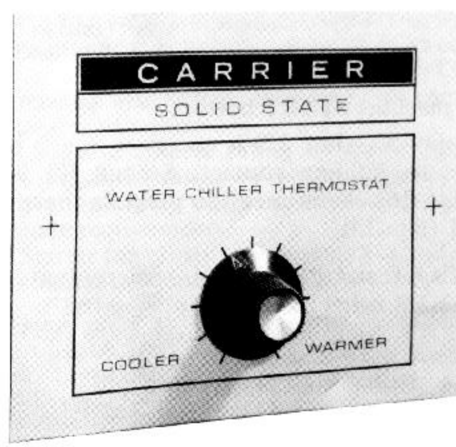
■ ON-STOP
■ START
□ OIL PUMP
■ POWER
■ SAFETY CIRCUIT
□ LOAD RECYCLE
□ PROGRAM TIMER

5. Chilled water temperature rises 10 F and low chilled water temperature cutout closes. Machine restarts automatically.

■ ON-STOP
■ START
■ OIL PUMP
■ POWER
■ SAFETY CIRCUIT
■ LOAD RECYCLE
□ PROGRAM TIMER

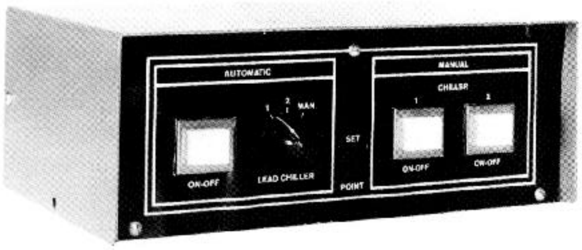
CONTROL OPTIONS

General — This section presents a brief description of the more common optional controls and their operation. Installation and calibration of optional controls are covered in the instructions accompanying each accessory package. Your nearest Carrier office can provide you with this information if required.



Remote Thermostat — This setpoint control permits selection and alteration of the leaving chilled water temperature from a central station or other location of the customer's choice.

Contents



Lead-Lag Control provides centralized control of 2 refrigeration machines. Control may be applied to parallel machines, series machines with a common control point or series machines with a split control point.

PREPARATION – On initial start only, push the ON-STOP and START buttons (lights go on) at each control center. Machine start and stop can now be made at the lead-lag control.

AUTOMATIC OPERATION – When the lead-lag ON-OFF button at the left side of the control is pushed and lighted, the chillers, water pumps and tower fans start and stop automatically in response to a field-supplied outside-air thermostat or other device. The transfer switch permits selection of either machine for part load recycle.

MANUAL OPERATION – With the transfer switch at MAN. position, either or both chillers may be stopped or started manually by pushing the ON-OFF buttons at the right side of the control.

Auxiliary Safety Indicator Panel provides "first out" indication for 7 machine safety controls listed below, plus the sounding or lighting of an optional remote alarm.

First-out indication is given for:

1. High motor or bearing temperature
2. Low refrigerant temperature
3. High condenser pressure
4. Motor overload
5. Insufficient water flow (cooler and condenser)
6. Low-oil pressure
7. Low chilled water temperature

SETTING INDICATOR PANEL – After refrigeration machine has been started, press the panel SAFETY RESET button. Panel is now in ready condition.

→ On some panels, SAFETY RESET button is equipped with a light. Light goes out when button is pressed and panel is reset.

All lights remain off until machine shuts down on a safety cutout. The indicator lamp for that particular safety then lights and (except for LOAD RECYCLE/AUTO. OFF lamp) remains lit until the panel is reset. The LOAD RECYCLE/AUTO. OFF lamp goes out when chilled water temperature rises and the switch remakes.

RESETTING INDICATOR PANEL

1. Correct the condition which caused the safety tripout (except low chilled water temperature).
2. Reset the safety control if manual reset.
3. Restart the refrigeration machine.
4. Press indicator panel SAFETY RESET button.

PRESS-TO-TEST FEATURE – To check the condition of any of the indicator lamps, merely press the lamp button. A burned out lamp does not affect the operation of the alarm circuit. This lamp test does not in any way indicate whether the safety control itself is tripped or not.

If an alarm has been added to the panel, it will sound and/or light while the LOW OIL PRESSURE button is pressed.

OTHER SAFETY INDICATIONS – On all 19FA machines, the HIGH MOTOR OR BEARING TEMP lamp lights in the unlikely event that the compressor impellers are displaced beyond the normal limits. If motor and bearing temperatures appear normal (under 180 F) but machine does not restart, check motor and bearing sensors, relays KB and KM and the impeller displacement switch contacts as described in Troubleshooting Guide.

Machines with pneumatic capacity control have a pneumatic supply switch which causes the HIGH MOTOR OR BEARING TEMP lamp to light if the air supply to the guide vane actuator is low.

Autostart Control – Automatic machine and auxiliary start and stop in response to an outside-air thermostat, time clock or other customer-supplied device is available as a modification to the refrigeration machine starter. Figure 33 shows a typical autostart circuit. For application of this circuit to machine control system, refer to your Job Data.

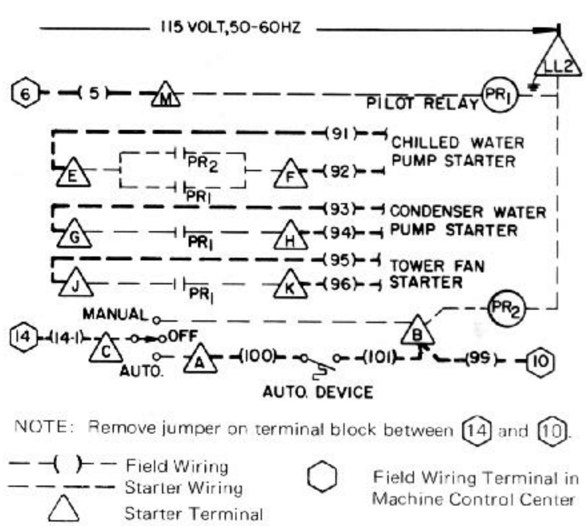


Fig. 33 – Autostart Connection Diagram (Typical)

Contents

COMPRESSOR FITS AND CLEARANCES

Service and repair of Carrier centrifugal compressors should be performed only by fully trained and qualified personnel. The information in this section is included as a reference for such personnel only.

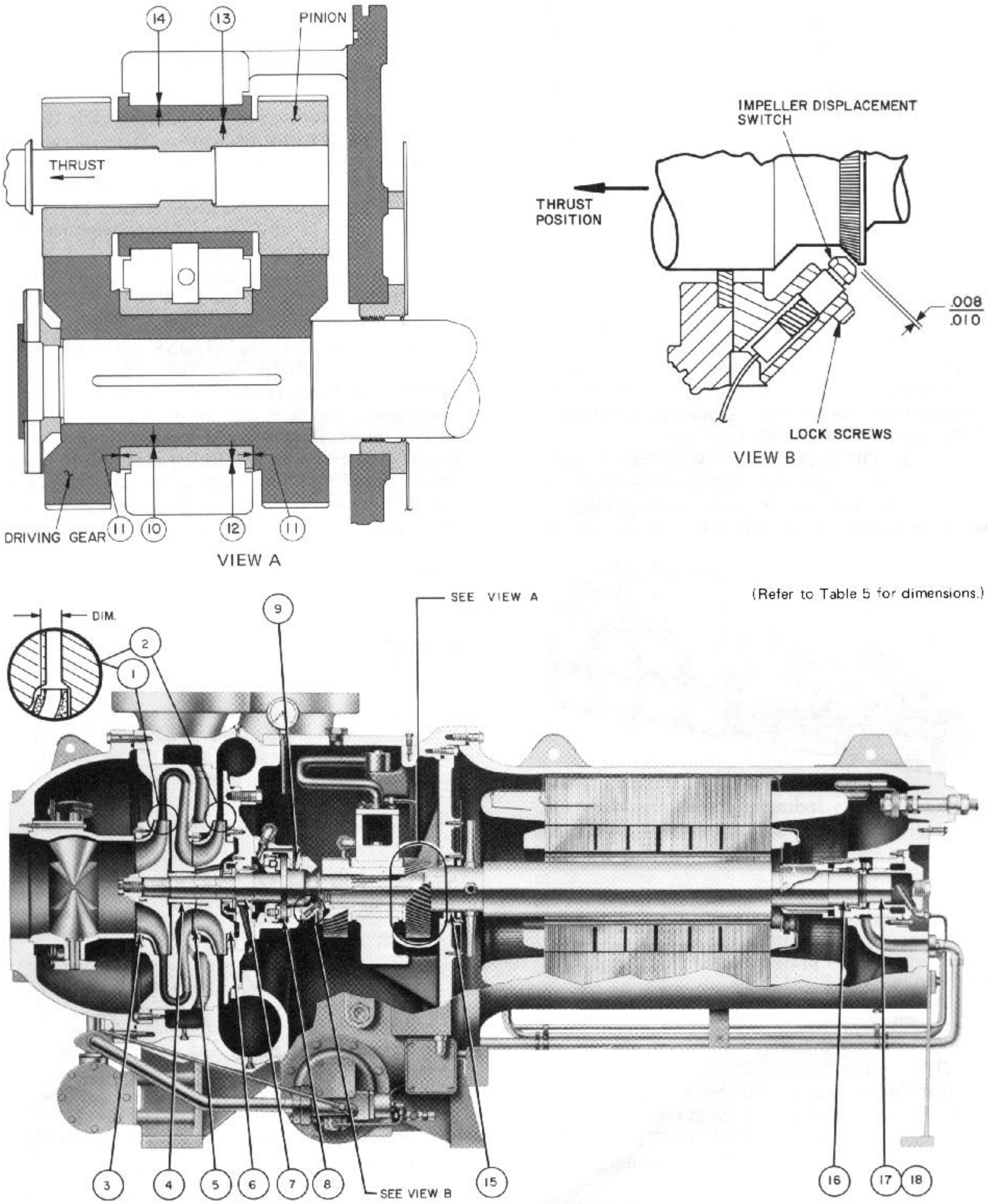


Fig. 34 — Compressor Fits and Clearances

Contents

Table 5 — Compressor Fits and Clearances

ITEM	DESCRIPTION	MEASUREMENT	DIMENSION 19FA4	DIMENSION 19FA5
1	1st stage impeller to diaphragm	Axial	See tabulation	
2	2nd stage impeller to discharge wall	Axial	See tabulation	
3	1st stage labyrinth	Diametral	.016/.020	.016/.020
4	Interstage labyrinth	Diametral	.012/.016	.012/.016
5	2nd stage labyrinth	Diametral	.008/.012	.008/.012
6	Balancing piston labyrinth	Diametral	.008/.012	.008/.012
7	Impeller shaft journal bearing	Diametral	.0020/.0035	.0030/.0045
8	Thrust-end float	Axial	.010/.015	.010/.015
9	Counterthrust bearing seal ring	Diametral	.002/.004	.002/.004
10	Gear bearing to gear	Diametral	.0040/.0055	.0050/.0065
11	Gear bearing to gear	Axial	.010/.0185	.010/.0185
12	Gear bearing to bearing housing	Diametral	.0005/.0025	.0005/.0025
13	Pinion bearing to pinion	Diametral	.0020/.0035	.0040/.0055
14	Pinion bearing to bearing housing	Diametral	.001/.003	.0005/.0025
15	Transmission labyrinth	Diametral	.006/.010	.006/.010
16	Motor-end labyrinth	Diametral	.005/.008	.005/.008
17	Motor-end bearing to shaft	Diametral	.0040/.0054	.0040/.0054
18	Motor-end bearing to bearing housing	Diametral	.0005/.0020	.0005/.0020

See Fig. 34 for item callouts.

Tabulation — Impeller Clearances

COMPR SIZE	SHROUD	IMPELLER DIAMETER	DIMENSION (Item 1)*	DIMENSION (Item 2)*
19FA4	2	9.10	.631	.498
		9.40	.596	.473
		9.70	.561	.448
		10.00	.531	.423
		10.40	.511	.418
	3	9.10	.701	.548
		9.40	.671	.508
		9.70	.641	.488
		10.00	.611	.468
		10.40	.596	.458
	4	9.10	.811	.628
		9.40	.781	.578
		9.70	.741	.558
		10.00	.711	.528
		10.40	.686	.518
	5	9.10	.921	.708
		9.40	.881	.688
		9.70	.841	.638
		10.00	.801	.598
		10.40	.776	.578
	6	9.10	1.041	.798
		9.40	.991	.758
		9.70	.951	.718
		10.00	.901	.668
		10.40	.886	.648
19FA5	3	12.00	.837	.638
		12.38	.797	.609
		12.75	.757	.579
		13.25	.717	.541
		13.75	.690	.541
	4	12.00	.977	.760
		12.38	.937	.726
		12.75	.897	.688
		13.25	.837	.639
		13.75	.810	.632
	5	12.00	1.177	.895
		12.38	1.137	.852
		12.75	1.077	.809
		13.25	1.017	.750
		13.75	.970	.731
	6	12.00	1.297	.972
		12.38	1.237	.928
		12.75	1.177	.880
		13.25	1.097	.817
		13.75	1.050	.796

*Measured with shaft in thrust position (towards suction end); tol = ±.005.

For compressor identification, refer to chiller model number on machine informative plate (see sample below).

MODEL NO. 19FA5 5 7-B-500-2728-L-ED

Frame — 5 (19FA**5**)
Shroud — 5
Impeller — 7

CODE NO.	IMPELLER DIAMETER Compressor Size 4	IMPELLER DIAMETER Compressor Size 5
1	9.10	12.00
3	9.40	12.38
5	9.70	12.75
7	10.00	13.25
9	10.40	13.75

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Book 2 Tab 5a Form 19FA-2SS Supersedes 19FA-1SS, 19FA-1SO Printed in U.S.A. 794 4-77 PC 211 Catalog No. 531-948