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19C HERMETIC CENTRIFUGAL
REFRIGERATING MACHINE

Refrigerant: CARRENE* - 3

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* Reg. U.S. Patent Office



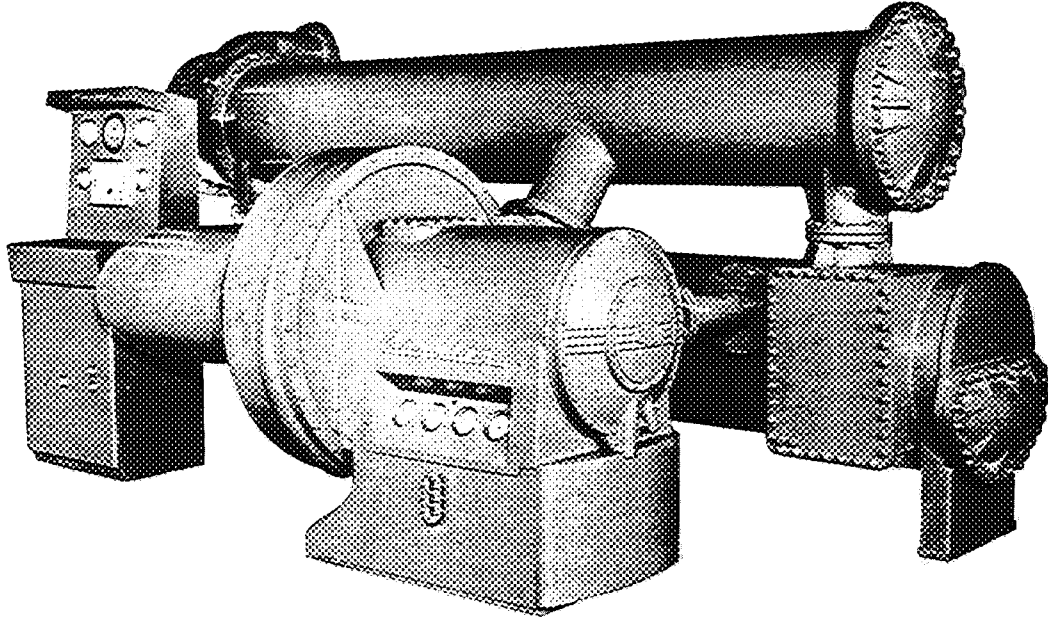
19C HERMETIC CENTRIFUGAL
REFRIGERATING MACHINE

CHAPTER 1 - GENERAL DESCRIPTION & DATA

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CHAPTER I - GENERAL DESCRIPTION AND DATA



TYPICAL 19C REFRIGERATING MACHINE

INTRODUCTION

These instructions are offered as guides for the operating engineer of a standard Carrier 19C Centrifugal Refrigeration Machine. They convey only specific information which is required for the operation of the machine, and are not intended as a manual for repairs.

Machines may differ in some details from the typical sketches and diagrams included.

MACHINE COMPONENTS

The Carrier 19C centrifugal refrigeration machine is a compact assembly of seven major elements:

1. COOLER - Heat exchanger which cools the "brine" passing through the tubes, by the evaporation of the refrigerant in which the tubes are immersed.
2. COMPRESSOR - Machine which compresses the evaporated refrigerant and discharges it to the condenser.
3. CONDENSER - Heat exchanger which liquefies the refrigerant coming to it from the compressor.
4. ECONOMIZER - An arrangement which permits partial cooling of the condensed refrigerant before it is passed on to the cooler. The refrigerant is cooled by evaporating a portion of the liquid. The vapor thus formed is used to cool the hermetic compressor motor and is passed to the second stage of the compressor.
5. PURGE RECOVERY UNIT - A small condensing unit with separator which continuously extracts gas from the top of the condenser and purifies it by removing air and water vapor which may be present.
6. DRIVE - Prime mover which supplies the power to drive the compressor. It is an electric motor, hermetically enclosed, with its rotor on a common shaft with the compressor impellers.
7. CONTROLS - Instruments which control the brine temperature, protect the various elements of the machine and automatically start and stop the compressor. When specified, additional automatic controls for fully automatic operation of interconnecting equipment such as pumps and fans are furnished.

*NOTE: The term "brine" is used throughout these instructions as applying to the substance cooled, which is usually water, but may be a brine or other fluid.



MACHINE DESIGNATION

Machine assemblies are designated according to the size of the compressor, cooler, and condenser. For example, 19C375-7-6 denotes the following:

- (19) Centrifugal Refrigeration Unit of the 19C type
- (C) Two stage hermetic unit
- (375) Compressor size and impeller combination
- (7) Cooler size
- (6) Condenser size

Each machine assembly also has a serial number. The nameplate containing this data is located on the right hand side of the control console. In referring to machines in correspondence with Carrier Corporation, always give the size, serial number and the name of the owner.

The compressor has a serial number which is different from the machine assembly serial number. This number is located on a nameplate on the motor housing leg, on the side toward the cooler.

REPAIR PARTS

When ordering parts, specify item numbers shown in the sketches in this booklet. Give serial number, and size of machine as described above. Items marked with an asterisk (*) are recommended to be carried as spares.

REFRIGERATION CYCLE

The 19C Centrifugal Refrigeration Machine operates on the standard compression cycle. It has several unique basic features, however:

1. The compressor has two stages and two impellers.
2. Low pressure refrigerant is used.
3. An economizer is located in the liquid return from condenser to cooler. The economizer materially reduces the horsepower required per ton of refrigeration, because it increases the efficiency of the cycle. It is made possible by the use of a two stage centrifugal compressor.
4. The hermetic compressor motor is cooled by dry refrigerant gas.



The refrigerant cycle, illustrated in Fig. 1-1, starts at the cooler. The brine flowing through the cooler tubes is warmer than the refrigerant in the shell surrounding the tubes, consequently, heat is transferred from the brine to the refrigerant. This heat evaporates the refrigerant at a temperature corresponding to the low pressure in the cooler, as maintained by the compressor (see pressure temperature curve).

The evaporated refrigerant vapor (gas) flows through the prewhirl vanes into the compressor where it is partially compressed by the first stage impeller. It then mixes with the stream of gas which has come from the economizer through the hermetic motor. The mixture of suction and economizer gas enters the second stage impeller where it is compressed and discharged into the condenser. Note that the economizer gas is compressed through only a portion of the total pressure difference between cooler and condenser. If the economizer were not used, this gas would all be generated at the cooler pressure and would all have to be pumped from the cooler pressure to the condenser pressure. The pumping of a portion of the gas back to the condenser from the intermediate economizer pressure increases the cycle efficiency and saves horsepower.

The refrigerant discharged by the compressor condenses on the outside of the condenser tubes, at a temperature corresponding to the condenser pressure (see pressure temperature curve). This temperature is higher than that of the water in the tubes so the heat is transferred into the condenser water.

The liquefied refrigerant drains into the condenser float chamber, where a float valve maintains a liquid "seal" to prevent gas from passing into the economizer. The rising refrigerant level in this chamber opens the float valve and allows liquid to pass into the economizer chamber.

The pressure in the economizer chamber is intermediate between the condenser and cooler pressures; consequently, enough of the warm refrigerant liquid evaporates to cool the remaining liquid to a lower temperature, corresponding to the lower pressure in the economizer chamber. This evaporation takes place by rapid flashing into gas as the liquid passes through the float valve and the conduit leading into the economizer chamber. The evaporated portion (gas) passes through eliminators to the hermetic motor, where it picks up a small amount of additional heat as it cools the motor. It then goes to the compressor and mixes with gas which has been compressed by the first stage impeller. This mixture enters the second stage impeller.

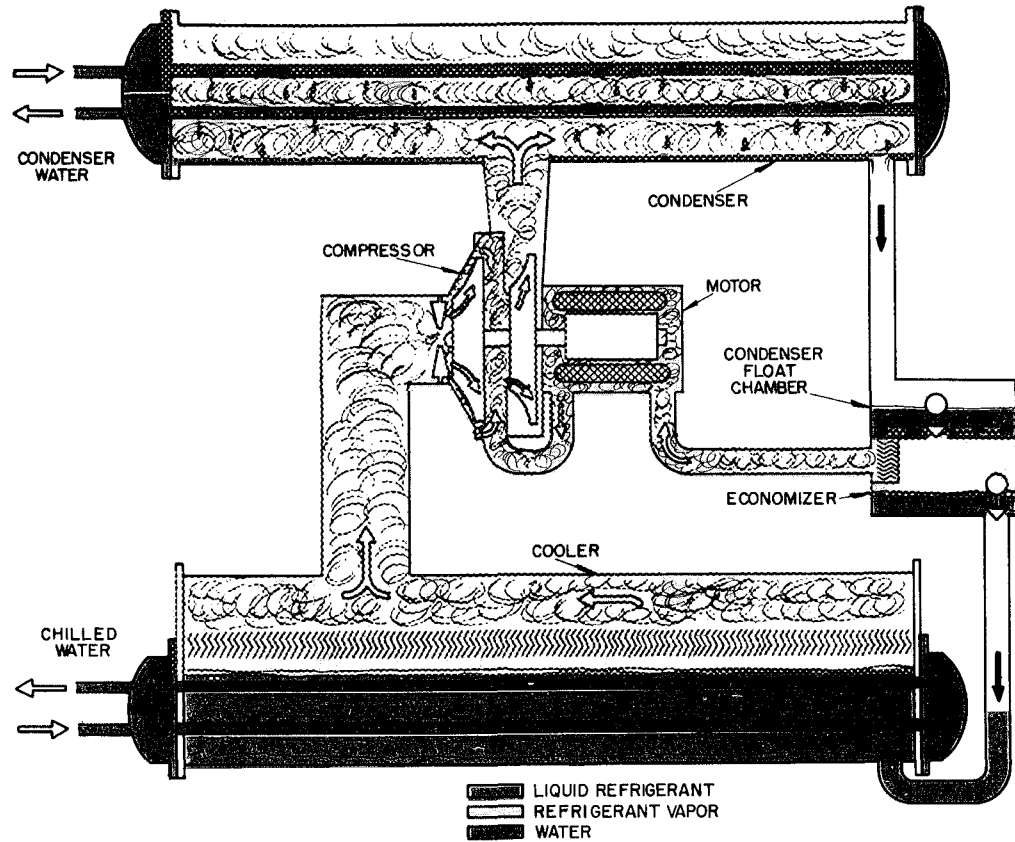


FIG. 1-1 — Refrigeration Cycle Diagram

The cooled liquid collects in the economizer float valve sump. The rising level in this sump opens the economizer float valve and allows this liquid to pass into the cooler. As the cooler pressure is lower than the economizer pressure, some of the liquid is evaporated and thereby cools the remainder to the cooler temperature. The vapor thus formed passes to the compressor along with the vapor being continuously formed by the cooling of the water. This completes the cycle.



CARRENE-3 REFRIGERANT

CARRENE-3 refrigerant is a clear white liquid at normal atmospheric pressures and temperatures. At atmospheric pressure it boils at 117.6F. It may be handled in open containers, with little evaporation loss. The liquid is about 1.5 times as heavy as water, and weighs about 13.1 lb. per gallon. A mixture of water and liquid refrigerant will separate, with the water floating above the heavier refrigerant. The liquid will dissolve oils and greases, and it dries the skin. It also destroys rubber and will, therefore, destroy packing materials containing rubber. Neoprene, however, is safe to use in contact with this refrigerant. The vapor is about 6 times as heavy as air. Being heavy, it will drop to the floor of a room and settle in low places. The odor of the vapor is similar to carbon tetrachloride. Large concentrations in air are not harmful, but will cause dizziness and eventual headache. It will not support combustion, and is classed as non-inflammable and non-toxic. Direct contact with a flame, however, will break it down into a toxic gas as is the case with any fluorinated gas, and breathing of such fumes should be avoided.

This refrigerant is shipped in drums of 100 and 200 lbs. The quantity required may be determined from Chapter 3.

See Table 1-1 Properties of Saturated CARRENE-3 Refrigerant

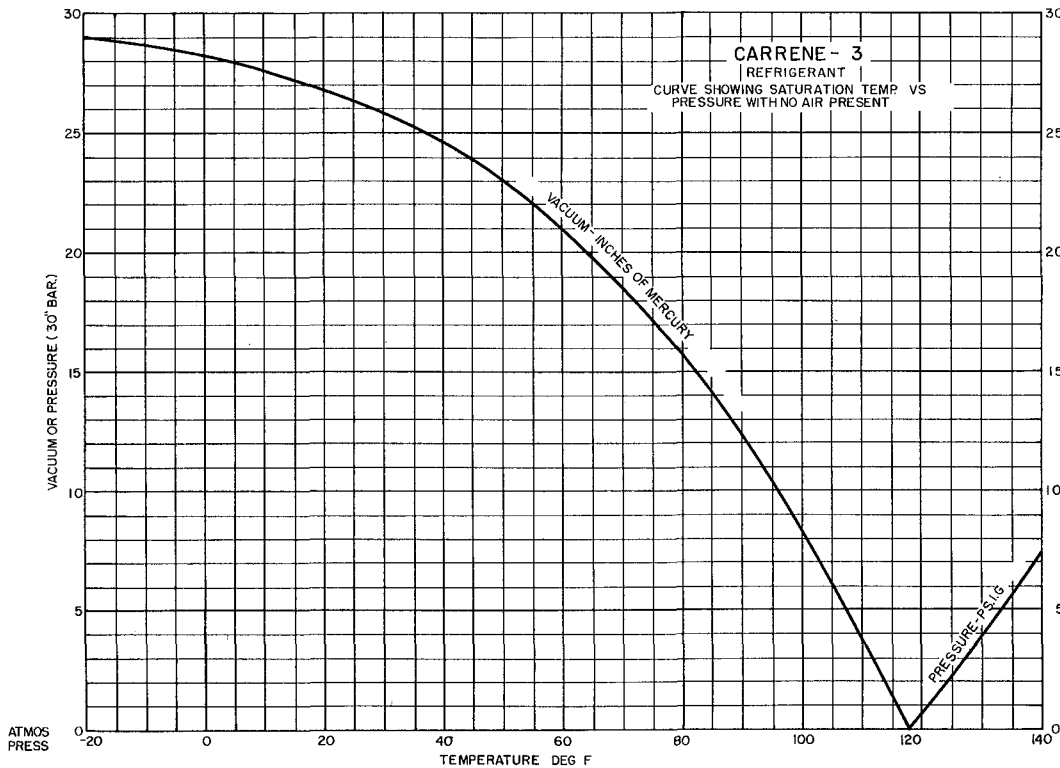


FIG. 1-2 --- Pressure Temperature Curve



OPERATION AND MAINTENANCE GENERAL INFORMATION

19C

TABLE 1-1 - PROPERTIES OF SATURATED CARRENE -3
REFRIGERANT LIQUID AND VAPOR

Temp ° F t	Pressure		Volume		Density		Heat Content from -40°			Entropy from -40°		Temp ° F t
	Abs lb/in ² p	Gage lb/in ² p _a	Liquid ft ³ /lb v _r	Vapor ft ³ /lb v _g	Liquid lb/ft ³ 1/v _r	Vapor lb/ft ³ 1/v _g	Liquid Btu/lb h _r	Latent Btu/lb h	Vapor Btu/lb h _g	Liquid Btu/lb °F s _r	Vapor Btu/lb °F s _g	
10	1.142	27.60*	0.00972	23.45	102.84	0.04265	10.00	70.32	80.32	0.0225	0.1723	10
12	1.213	27.45*	.00974	22.17	102.69	.04511	10.41	70.20	80.61	.0234	.1722	12
14	1.288	27.30*	.00975	20.97	102.55	.04769	10.81	70.08	80.89	.0242	.1722	14
16	1.366	27.14*	.00977	19.84	102.40	.05040	11.22	69.96	81.18	.0251	.1722	16
18	1.448	26.97*	.00978	18.79	102.25	.05322	11.62	69.84	81.46	.0259	.1722	18
20	1.534	26.80*	0.00979	17.81	102.10	0.05616	12.03	69.72	81.75	0.0268	0.1722	20
22	1.624	26.61*	.00981	16.89	101.96	.05922	12.44	69.60	82.04	.0276	.1721	22
24	1.719	26.42*	.00982	16.02	101.81	.06243	12.85	69.48	82.33	.0285	.1721	24
26	1.818	26.22*	.00984	15.20	101.66	.06579	13.26	69.36	82.62	.0293	.1722	26
28	1.922	26.01*	.00985	14.43	101.51	.06929	13.67	69.24	82.91	.0302	.1722	28
30	2.031	25.79*	0.00987	13.71	101.36	0.07294	14.08	69.12	83.20	0.0310	0.1722	30
32	2.145	25.55*	.00988	13.03	101.21	.07675	14.49	69.00	83.49	.0318	.1722	32
34	2.264	25.31*	.00990	12.39	101.06	.08071	14.91	68.87	83.78	.0327	.1722	34
36	2.388	25.06*	.00991	11.79	100.91	.08483	15.32	68.75	84.07	.0335	.1722	36
38	2.519	24.79*	.00993	11.22	100.76	.08913	15.74	68.62	84.36	.0343	.1722	38
40	2.655	24.52*	0.00994	10.68	100.60	0.09361	16.16	68.50	84.65	0.0352	0.1723	40
42	2.797	24.23*	.00996	10.18	100.45	.09826	16.57	68.37	84.94	.0360	.1723	42
44	2.944	23.93*	.00997	9.703	100.30	.1031	16.99	68.25	85.24	.0368	.1723	44
46	3.098	23.61*	.00999	9.253	100.14	.1081	17.41	68.12	85.53	.0377	.1724	46
48	3.258	23.29*	.01000	8.830	99.99	.1133	17.82	68.00	85.82	.0385	.1724	48
50	3.427	22.94*	0.01002	8.426	99.83	0.1187	18.24	67.87	86.11	0.0393	0.1725	50
52	3.602	22.59*	.01003	8.044	99.68	.1243	18.66	67.74	86.40	.0401	.1726	52
54	3.784	22.22*	.01005	7.682	99.52	.1302	19.08	67.61	86.69	.0410	.1726	54
56	3.973	21.83*	.01006	7.342	99.37	.1362	19.50	67.48	86.98	.0418	.1727	56
58	4.170	21.43*	.01008	7.018	99.21	.1425	19.93	67.35	87.28	.0426	.1727	58
60	4.374	21.02*	0.01010	6.713	99.05	0.1490	20.35	67.22	87.57	0.0434	0.1728	60
62	4.586	20.59*	.01011	6.424	98.89	.1557	20.77	67.09	87.86	.0442	.1729	62
64	4.807	20.14*	.01013	6.149	98.73	.1626	21.19	66.96	88.15	.0450	.1729	64
66	5.036	19.67*	.01015	5.889	98.58	.1698	21.62	66.83	88.45	.0459	.1730	66
68	5.275	19.18*	.01016	5.640	98.42	.1773	22.05	66.69	88.74	.0467	.1731	68
70	5.523	18.68*	0.01018	5.404	98.26	0.1851	22.48	66.56	89.04	0.0475	0.1731	70
72	5.780	18.16*	.01019	5.180	98.10	.1931	22.90	66.43	89.33	.0483	.1732	72
74	6.042	17.62*	.01021	4.971	97.93	.2012	23.33	66.29	89.62	.0491	.1733	74
76	6.320	17.06*	.01023	4.769	97.77	.2097	23.76	66.16	89.92	.0499	.1734	76
78	6.607	16.47*	.01025	4.574	97.61	.2186	24.19	66.02	90.21	.0507	.1735	78
80	6.902	15.87*	0.01026	4.392	97.45	0.2277	24.63	65.88	90.51	0.0515	0.1736	80
82	7.208	15.25*	.01028	4.218	97.28	.2371	25.06	65.74	90.80	.0523	.1737	82
84	7.527	14.60*	.01030	4.051	97.12	.2468	25.49	65.60	91.09	.0531	.1738	84
86†	7.856	13.93*	.01031	3.893	96.96	.2569	25.93	65.46	91.39	.0539	.1739	86†
88	8.194	13.24*	.01033	3.742	96.79	.2672	26.36	65.32	91.68	.0547	.1740	88
90	8.545	12.53*	0.01035	3.600	96.63	0.2778	26.80	65.18	91.98	0.0555	0.1741	90
92	8.908	11.79*	.01037	3.463	96.46	.2888	27.24	65.04	92.28	.0563	.1742	92
94	9.281	11.03*	.01039	3.333	96.30	.3001	27.67	64.90	92.57	.0571	.1743	94
96	9.668	10.24*	.01040	3.208	96.13	.3117	28.11	64.75	92.86	.0578	.1744	96
98	10.07	9.42*	.01042	3.089	95.96	.3237	28.55	64.60	93.15	.0586	.1745	98
100	10.48	8.59*	0.01044	2.976	95.79	0.3360	28.99	64.46	93.45	0.0594	0.1746	100
102	10.91	7.71*	.01046	2.867	95.63	.3488	29.44	64.31	93.75	.0602	.1747	102
104	11.35	6.82*	.01048	2.762	95.46	.3620	29.89	64.16	94.05	.0610	.1748	104
106	11.81	5.88*	.01050	2.662	95.29	.3756	30.33	64.01	94.34	.0618	.1750	106
108	12.28	4.93*	.01051	2.567	95.12	.3896	30.78	63.86	94.64	.0626	.1751	108
110	12.76	3.95*	0.01053	2.477	94.95	0.4038	31.22	63.71	94.93	0.0634	0.1752	110
112	13.25	2.95*	.01055	2.391	94.78	.4182	31.67	63.56	95.23	.0641	.1753	112
114	13.76	1.91*	.01057	2.308	94.61	.4333	32.12	63.40	95.52	.0649	.1755	114
116	14.29	0.83*	.01059	2.228	94.43	.4489	32.57	63.25	95.82	.0657	.1756	116
118	14.84	0.14	.01061	2.151	94.26	.4649	33.03	63.09	96.12	.0665	.1757	118
120	15.40	0.70	0.01063	2.078	94.09	0.4813	33.48	62.93	96.41	0.0673	0.1758	120
122	15.97	1.27	.01065	2.008	93.92	.4981	33.93	62.78	96.71	.0680	.1760	122
124	16.56	1.86	.01067	1.941	93.74	.5153	34.38	62.62	97.00	.0688	.1761	124
126	17.17	2.47	.01069	1.876	93.57	.5330	34.83	62.46	97.29	.0696	.1763	126
128	17.80	3.10	.01071	1.814	93.39	.5514	35.29	62.30	97.59	.0704	.1764	128

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OPERATION AND MAINTENANCE COMPRESSOR AND MOTOR

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19C HERMETIC CENTRIFUGAL REFRIGERATING MACHINE

CHAPTER 2 - COMPRESSOR & MOTOR ASSEMBLY

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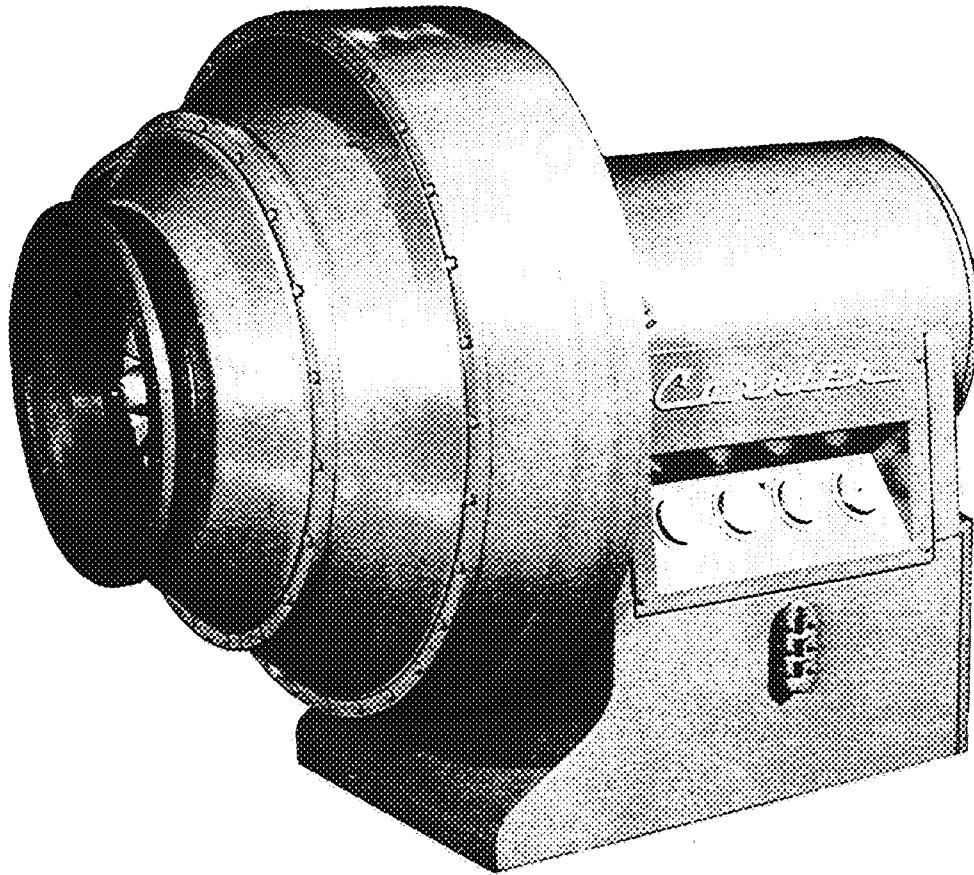


Fig. 2-1 - Typical Compressor Assembly

DESCRIPTION

The 19C Compressor is a two-stage, centrifugal type, designed for use with Carrene-3 refrigerant.

Its purpose is to maintain a cooler pressure corresponding to the desired cooler temperature, and to raise the pressure of the refrigerant gas removed from the cooler to a pressure which corresponds to a temperature well above that of the water in the condenser.

Centrifugal compressors create a gas velocity through centrifugal force set up by the impellers, and then by means of diffusers convert this velocity into pressure, with a minimum of energy loss.

The compressor casing and its various diffuser and return passages, formed by the diaphragms, intake walls, and guide vanes, are made of cast iron and constitute the bulk of the compressor.



The shaft is a turned and ground forging with key ways provided for the impellers, the motor armature, and the thrust collars.

The impellers have backward curved blading and are unshrouded. Each impeller is balanced separately, and the completed rotor is also balanced statically and dynamically.

The rotor assembly, consisting of shaft, impellers, motor rotor, impeller spacers, and thrust collars, runs in two sleeve type bearings which are pressure lubricated directly from a positive displacement oil pump. Bearing oil rings provide lubrication during coast down.

Dial type thermometers, with remote bulbs inserted in the lower half of each bearing indicate the temperature of the bearings.

The thrust bearing is an integral part of the main journal bearing. The bearing insert has a babbitted flange on each end, against which the two thrust collars ride. The bearing can take thrust therefore in either direction. The normal thrust of the rotor is toward the suction end. This thrust is minimized by balancing pistons which are integral with each impeller.

Brass labyrinths are provided to restrict interstage leakage and leakage from the compressor into the motor housing.

Variable pitch prewhirl vanes, at the inlet of the compressor, direct the suction gas into the first stage impeller and control the pressure existing in the cooler. These vanes are automatically positioned by a hydraulic motor as explained in detail in Chapter 6. Stationary guide vanes are provided to direct the refrigerant gas into the second stage impeller.

There are no horizontal joints. All flanges are vertical and sealed with "O" ring gaskets.

The compressor, motor housing, and base assembly constitute a single hermetic assembly. A shaft seal is not required.

The lubrication system consists of a gear type oil pump with motor, having hermetically sealed armature, reservoir, pressure regulating valve, filter, automatic heater, thermostatically controlled cooler, bearing oil rings, bearing thermometers, oil thermometer and oil pressure gauge. A detailed description of the oiling system may be found on pages 2-6 and 2-7.

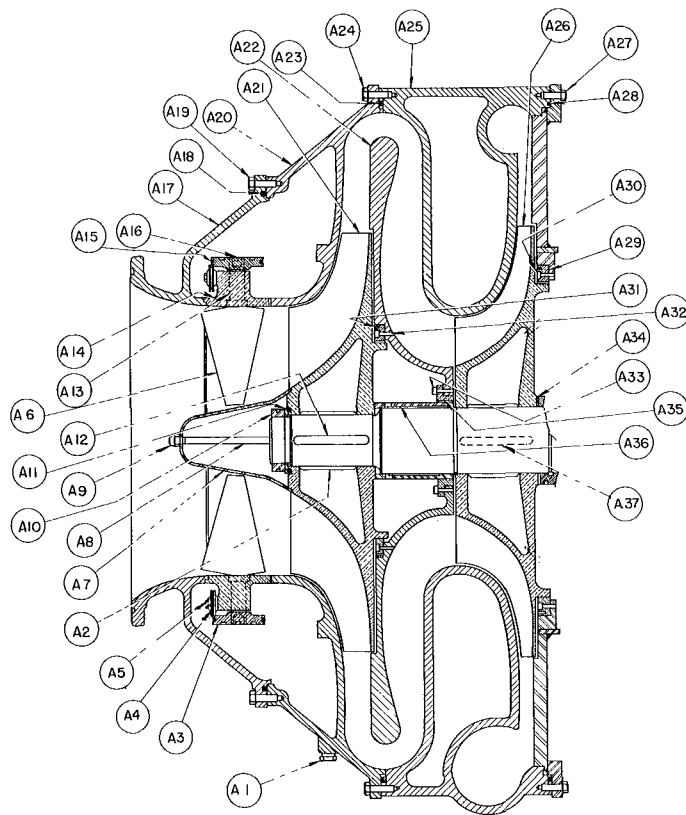


Fig. 2-2 - COMPRESSOR

NOMENCLATURE

A1	Drain Plug	A20	Intake Wall Assembly
A2	Shaft	A21	1st Stage Impeller
A3	Pulley	A22	Diaphragm
A4	Idler Pulley	*A23	"O" Ring Gasket
A5	Shoulder Screw	A24	Bolt
A6	Prewirl Blade	A25	Discharge Volute
A7	Shaft Cap	A26	2nd Stage Impeller
A8	Shaft Cap Stud	A27	Bolt
A9	Shaft Cap Nut	*A28	"O" Ring Gasket
A10	Shaft Locknut	A29	2nd Stage Labyrinth
A11	Shaft Lockwasher	A30	Screw
A12	1st Stage Impeller Key	A31	1st Stage Labyrinth
*A13	Blade Shaft Bearing (16)	A32	Screw
A14	Blade Ring	A33	Screw
*A15	Cable	A34	Shim
A16	Locking Plug	A35	Labyrinth - Shaft
A17	Inlet Venturi	A36	Impeller Spacer
*A18	"O" Ring Gasket	A37	2nd Stage Impeller Key
A19	Bolt		

(*) Recommended Spares

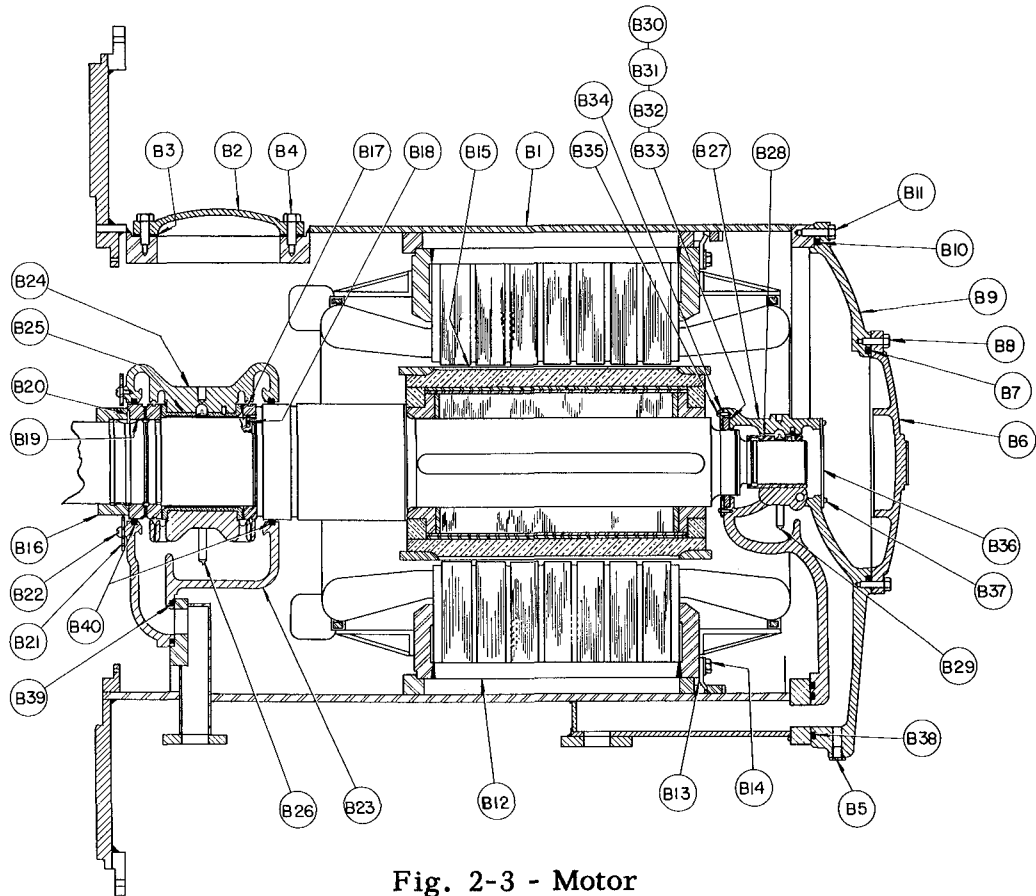


Fig. 2-3 - Motor

NOMENCLATURE

B1	Motor Shell Assembly	B21	Windage Baffle
B2	Inspecting Cover	B22	Screws
*B3	Gasket	B23	Lower Bearing Half
B4	Bolt	B24	Bearing Cap (Large)
B5	Drain Plug	*B25	Bearing Liner Assembly (Large)
B6	End Cover	B26	Bearing Oil Ring (Large)
*B7	"O" Ring	B27	Bearing Cap (Small)
B8	Bolt	*B28	Bearing Liner Assembly (Small)
B9	End Bell Assembly	B29	Bearing Oil Ring (Small)
*B10	"O" Ring Gasket	*B30	Carbon Ring
B11	Bolt	*B31	Carbon Ring Garter Spring
B12	Stator	*B32	Carbon Ring Insert Springs (3)
B13	Stator Locking Clamp	B33	Carbon Ring Key
B14	Bolt	B34	Carbon Ring Retainer
B15	Rotor	B35	Screws
B16	Thrust Nut	B36	Bearing End Cover
*B17	Thrust Ring	B37	Screws
B18	Thrust Ring Lock Pin	*B38	"O" Ring Gasket
*B19	Counter Thrust Ring	*B39	"O" Ring Gasket
B20	Counter Thrust Ring Key	*B40	Felt Rings

(* Recommended Spares

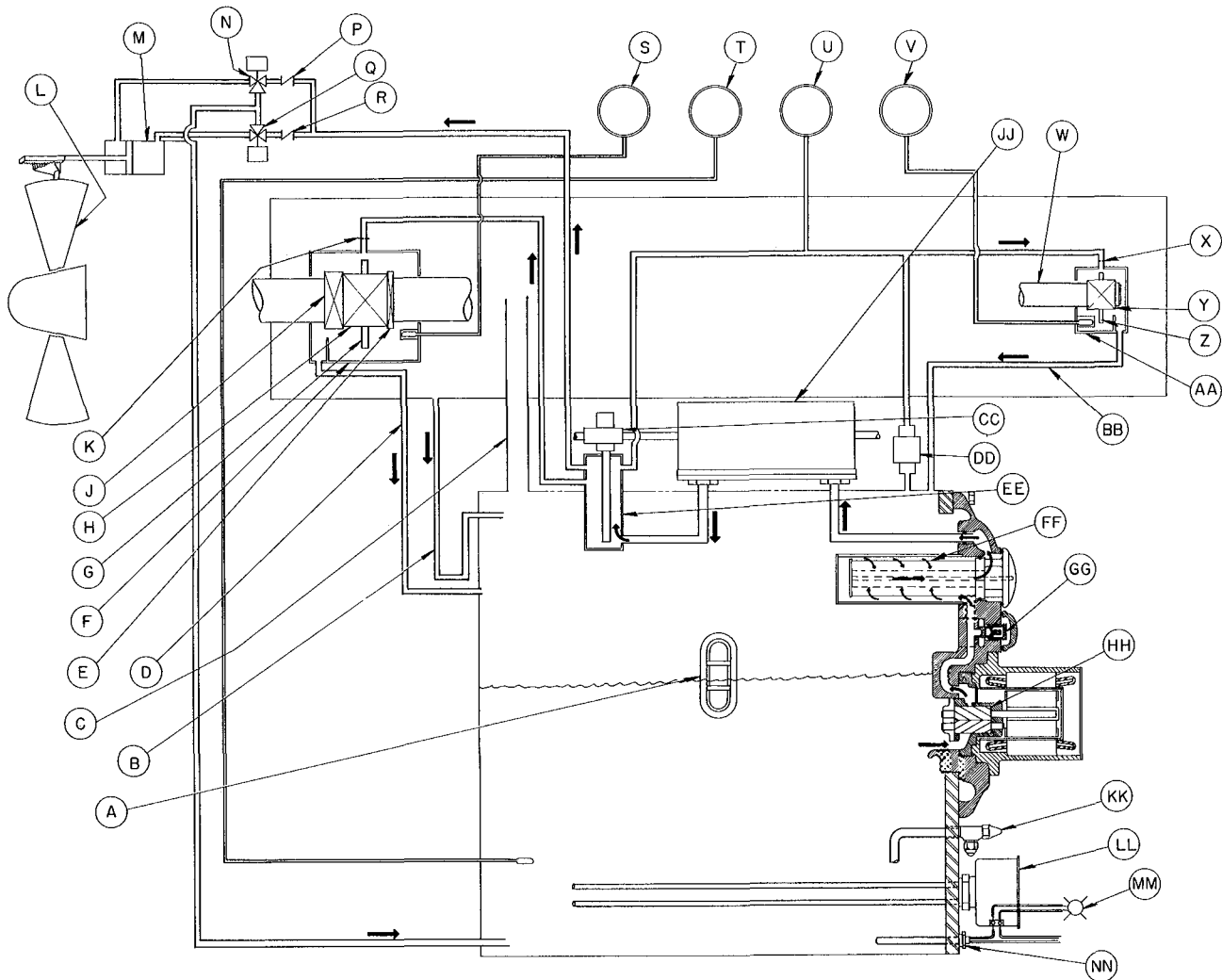


Fig. 2-4 - SCHEMATIC OIL CYCLE DIAGRAM

NOMENCLATURE

- | | |
|---|---|
| <p>A - Oil Level Sight Glass
 B - Drain and Trap
 C - Vent Pipe
 D - Overflow Return Pipe
 E - Thrust Ring
 F - Main Bearing Oil Well
 G - Main Bearing Oil Ring
 H - Main Journal Bearing
 J - Counter Thrust Ring
 K - Orifice
 L - Prewirl Vanes
 M - Hydraulic Motor
 N - Solenoid Valve - Closing
 P - Check Valve
 Q - Solenoid Valve - Opening
 R - Check Valve
 S - Main Bearing Dial Thermometer
 T - Oil Temperature Dial Thermometer
 U - Oil Pressure Gauge</p> | <p>V - Motor End Bearing Dial Thermometer
 W - Compressor Shaft
 X - Orifice
 Y - Motor End Journal Bearing
 Z - Motor End Bearing Oil Ring
 AA - Motor End Bearing Oil Well
 BB - Overflow Return Pipe
 CC - Automatic Water Regulating Valve
 DD - Differential Pressurestat
 EE - Manifold
 FF - Filter
 GG - Oil Pressure Regulating Valve
 HH - Oil Pump
 JJ - Oil Cooler
 KK - Oil Charging and Removal Valve
 LL - Oil Heater
 MM - Indicating Light ("Heater On")
 NN - Oil Heater Thermostat</p> |
|---|---|

OIL CYCLE

The oil cycle, Fig. 2-4, for the 19C Compressor is as follows:

The oil pump (HH) located in the lower part of the oil chamber, picks up oil and discharges it through internal passages in the oil pump chamber cover to the oil pressure regulating valve (GG). This valve permits the proper amount of oil to flow back to the oil chamber to maintain the required oil pressure. The main oil supply continues through internal passages to the filter (FF). Passing from the outside to the inside of the filter cartridge, the oil is thoroughly cleaned and continues through internal passages to the tubing which conveys it to the oil cooler (JJ) and then to the manifold (EE) which houses the thermal element of the thermostatic water regulating valve (CC).

Oil flowing over the thermal element of the water regulating valve causes this valve to pass the correct amount of water to the oil cooler (JJ), maintaining the oil at proper temperature. Oil is then routed from the manifold through copper tubing to the two journal bearings and to the prewhirl vane operator.

As the oil enters the motor end bearing (Y), it passes through an orifice (X), which is sized to supply the correct amount of oil for lubricating and cooling the bearing. The bearing is also equipped with an oil ring (Z) which picks up oil from the oil well (AA) and moves it to the bearing. Oil overflowing from the bearing well passes through the overflow lines (BB) back to the oil chamber.

Oil passing to the main bearing (H) must pass through an orifice (K) which is properly sized for the bearing. The main bearing liner has a babbitted flange on each end. Item (E) is the thrust ring which is attached to the shaft and which contacts the babbitted flange of the bearing to take the thrust of the rotor.

The counter thrust ring (J) also attached to the shaft, contacts the forward end of the babbitted flange to absorb counter thrust. Oil ring (G) continuously moves oil from the bearing oil well (F) to the journal bearing. Oil overflowing from this well passes through the overflow line (D) back to the oil chamber.

Oil supplied from manifold (EE) to operate the prewhirl vanes is controlled by solenoid valves (N) and (Q). When valve (Q) is open to the hydraulic motor (M) and valve (N) is bleeding oil from the hydraulic motor the vanes (L) will open. When valve (N) feeds and valve (Q) bleeds oil the vanes will close. When both valves feed oil to the hydraulic motor, the bleed ports will be closed and the oil pressure will be the same on each side of the piston. Gas flow over the prewhirl vanes exerts pressure on the piston. Check valves (P) and (R) prevent this pressure from moving the piston. Oil bled from the hydraulic motor returns through copper tubing to the oil pump chamber.



Oil Heater (LL) is controlled by the thermostat (NN) to prevent the temperature of the oil from dropping below approximately 130F to minimize absorption of refrigerant into the oil during shutdown. During operation the temperature of the oil is normally above this setting. Pilot light (MM) is lit when the heater is on.

The dials near the top of the sketch represent the four dials located on the side of the compressor. Thermometer (S) shows the temperature of the main bearing. Thermometer (T) shows the temperature of the oil in the oil chamber. Gauge (U) shows the main oil pressure. Thermometer (V) shows the temperature of the motor end bearing.

Item (W) is the compressor shaft. Vent (C) is located between the motor housing and the oil chamber. Drain and trap (B) drains oil that might escape from one of the bearings into the motor housing. The trap seals this low opening and prevents foaming oil from entering the motor housing from the oil reservoir.

The differential oil pressurestat (DD) will break contact and shut down the compressor motor if the oil pressure drops to 8 lb. above oil reservoir pressure.

Item (KK) is the oil charging valve. It is also used to remove oil, and for this purpose it has an internal line extending to the bottom of the oil chamber. By raising the pressure in the machine the oil can be forced up the pipe and out this valve.

Item (A) is the oil level sight glass. The oil level should be maintained approximately 2" high in this glass.

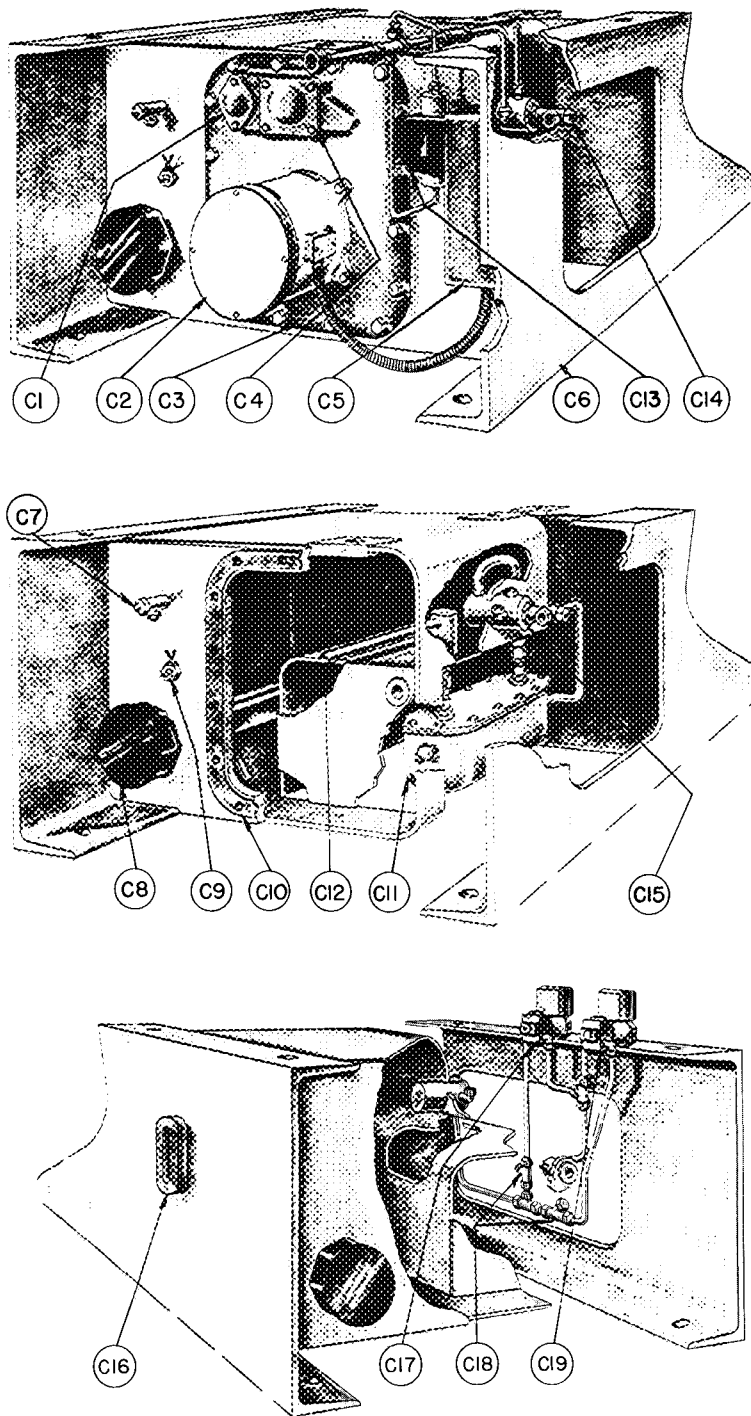


FIG. 2-5 - OIL RESERVOIR ASSEMBLY

NOMENCLATURE

- | | | | |
|-----------------------------|-------------------------------------|--|------------------------------------|
| C1 - Oil Pressure Regulator | C6 - Oil Reservoir | C11 - Oil Cooler | C16 - Oil Level Sight Glass |
| C2 - Oil Pump and Motor | C7 - Oil Charging and Removal Valve | C12 - Oil Supply Line | C17 - Solenoid Valve #1 (Form "F") |
| C3 - Oil Reservoir Cover | C8 - Oil Heater | C13 - Differential Oil Pressure Switch | C18 - Oil Check Valves |
| *C4 - Oil Filter | C9 - Oil Heater Thermostat | C14 - Water Regulating Valve | C19 - Solenoid Valve #2 (Form "G") |
| C5 - Oil Pump Motor Starter | *C10 - Oil Reservoir Cover Gasket | C15 - Oil Manifold | |

* Recommended Spares

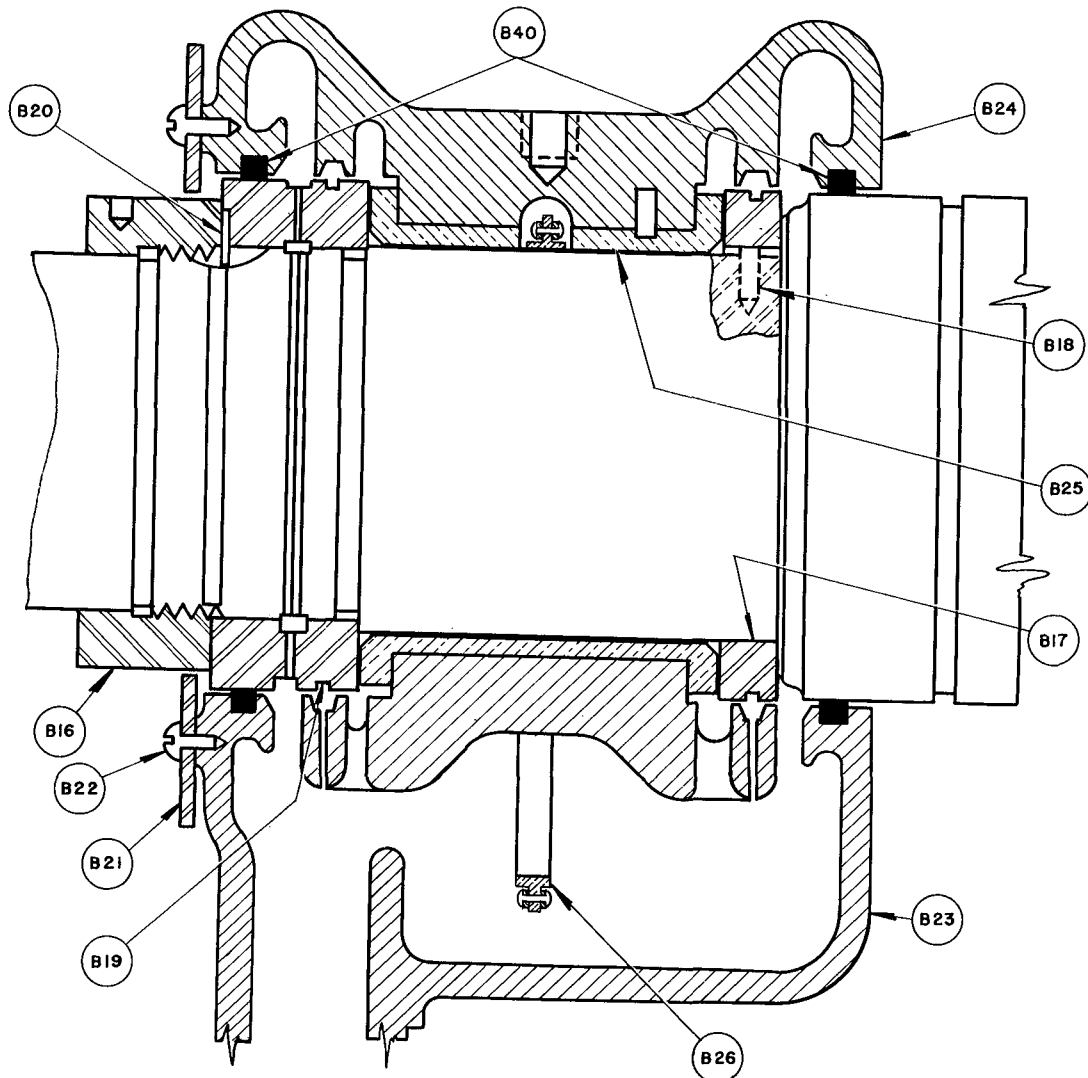


FIG. 2-6 - MAIN BEARING

NOMENCLATURE

B16	Thrust Nut	B22	Screws
B17	Thrust Ring	B23	Lower Half Bearing
B18	Thrust Ring Lock Pin	B24	Bearing Cap
B19	Counter Thrust Ring	B25	Bearing Liner Assembly
B20	Counter Thrust Ring Key	B26	Bearing Oil Ring
B21	Windage Baffle	B40	Felt Rings

NOTE: Above items with identical numbers can be seen in sketch of motor, Fig. 2-3. They are shown here to give larger and clearer detail.

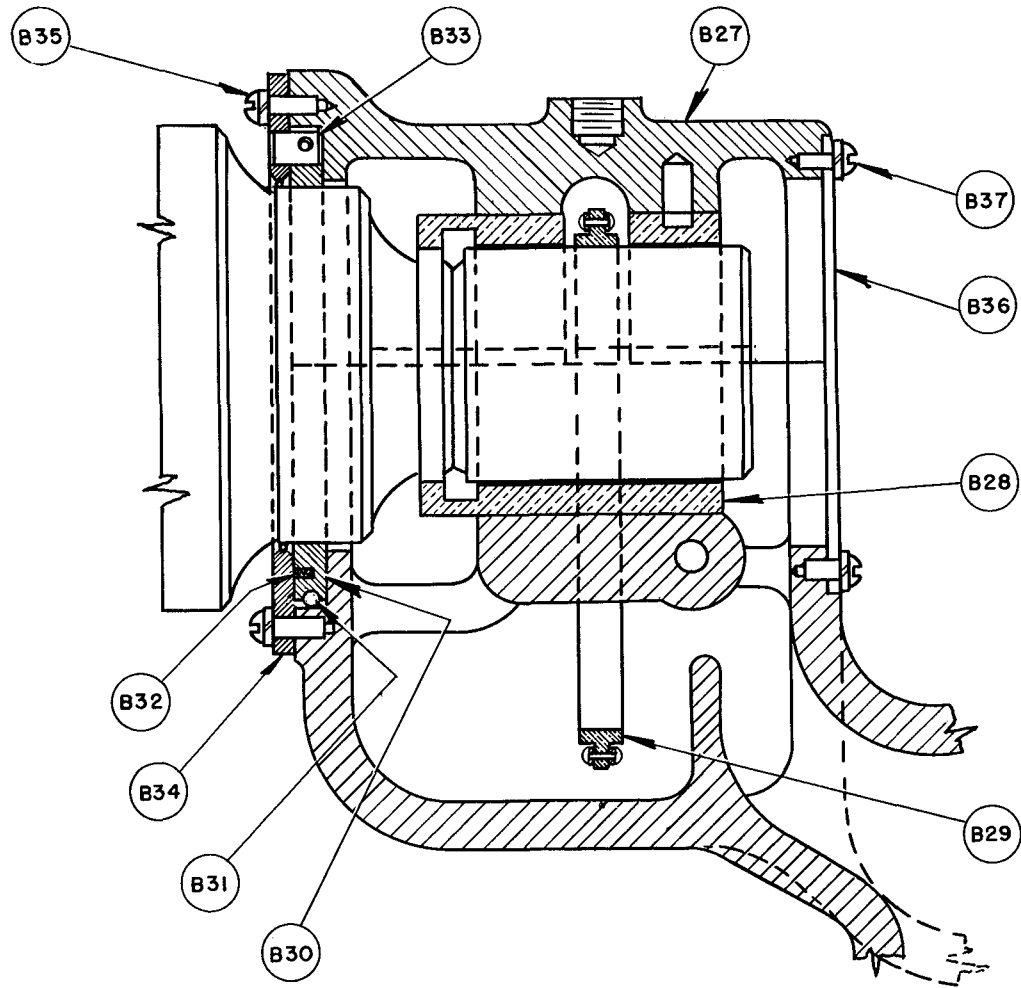


FIG. 2-7 - MOTOR END BEARING

NOMENCLATURE

- B27 Bearing Cap
- B28 Bearing Liner Assembly
- B29 Oil Ring
- B30 Carbon Ring
- B31 Carbon Ring Garter Spring
- B32 Carbon Ring Insert Springs (3)
- B33 Carbon Ring Key
- B34 Carbon Ring Retainer
- B35 Screws
- B36 Bearing End Cover
- B37 Screws

NOTE: Above items with identical numbers can be seen in sketch of motor, Fig. 2-3. They are shown here to give larger and clearer detail.

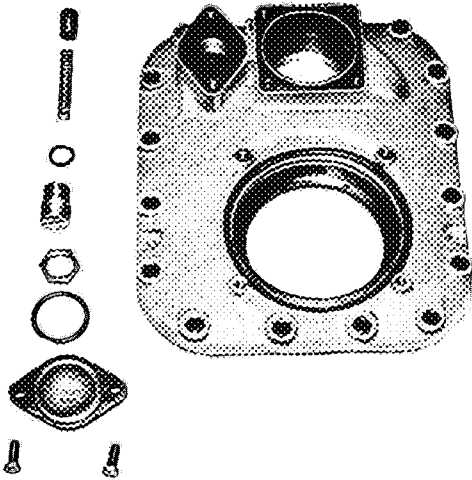


FIG. 2-8 - RESERVOIR COVER
AND OIL PRESSURE
REGULATING VALVE

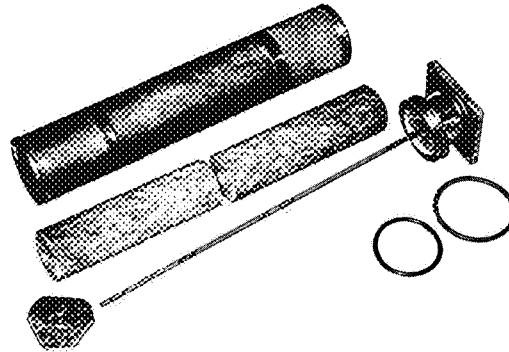


FIG. 2-9 - OIL FILTER

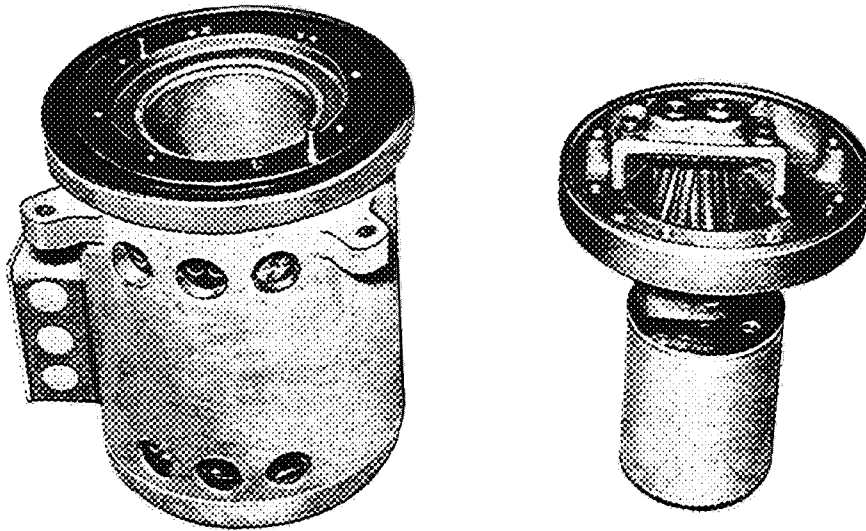


FIG. 2-10 - OIL PUMP AND MOTOR

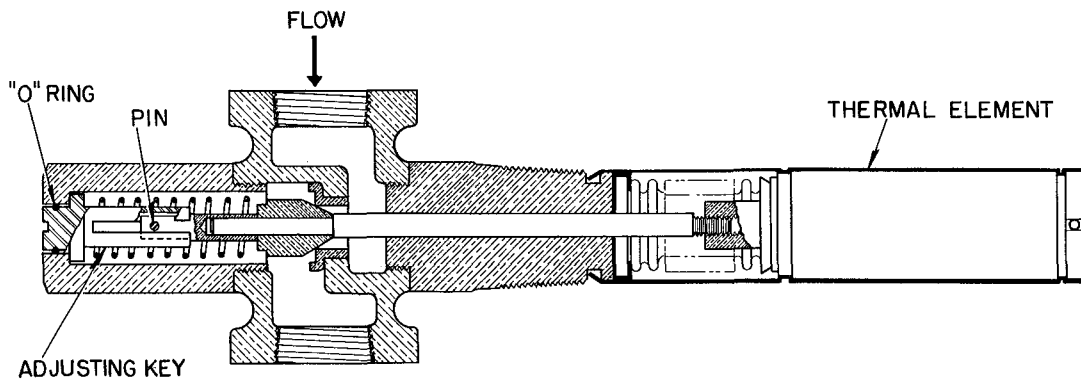


FIG. 2-11 - WATER REGULATING VALVE



MAINTENANCE

LUBRICATION

For proper lubrication use only high grade turbine oil such as that originally furnished. An additional supply can be obtained from the Carrier Service Parts Department. If oil other than that furnished by Carrier is used it must meet the following specifications:

Viscosity at 100 F., SSU	300 + 25
Dielectric, Minimum	25 KV
Pour Point, Maximum	20 F
Flash Point, Minimum	400 F
Neutralization No., Maximum	0.10
Flock Point, Maximum	-10 F

NOTE: In recommending oils suitable for use in centrifugal compressors, Carrier assumes no responsibility other than that covered by the standard guarantee.

The normal oil charge for 19C Compressors is 12 gallons. The level should be maintained approximately 2" high in the oil sight glass.

Oil temperature in the reservoir should be maintained at approximately 130F to 135F during shutdown by adjusting the oil heater thermostat. This will minimize refrigerant absorption by the oil. When operating, the temperature of the oil in the reservoir should be maintained at approximately 140F by adjustment of the automatic water regulating valve.

Bearings will normally operate at 145F to 150F but 155F would not be too high. A sudden rise from the established operating temperature, however, indicates trouble. If this happens, the bearing temperature should be kept under close observation and if the temperature rise continues, the bearing should be inspected and the trouble corrected.

The oil system operating pressure is approximately 15 lb above the reservoir pressure. The centrifugal compressor should be shut down so the reservoir pressure will be the same as the cooler and condenser pressures. The oil pressure can then be set by operating the oil pump only.

Oil pressure can be adjusted by loosening the locknut and turning the adjusting screw of the oil pressure regulating valve (see Figs. 2-5 and 2-8). Turn the adjusting screw clockwise to raise and counterclockwise to lower the pressure. The oil reservoir is normally under a vacuum. In calculating the oil pressure, count each inch of vacuum as .489 lb pressure and add this to the reading on the oil pressure gauge. (Low oil pressure can be caused by a dirty oil filter.)



The differential oil pressurestat, Fig. 2-5, protects against loss of oil pressure. Set the pressurestat to break contact and shut down the compressor if the oil pressure drops to within approximately 8 lb of the oil reservoir pressure. The contacts should close at approximately 12 lb above reservoir pressure.

To set the pressurestat, operate the oil pump and vary the oil pressure by adjusting the oil pressure regulator. Note the pressures at which the contacts close and open and adjust accordingly. (With the machine shut down the "Oil Pressure" light on the console will not come on -- remove the cover from the pressurestat and observe the movement of the switch or connect an ohm-meter across its contacts to determine when it is opened or closed.)

Operation of the pressurestat should be checked at least yearly.

IMPORTANT: Keep a record of all oil added or removed from the compressor as it can be a guide to the service engineer.

Change oil once a year unless the machine is opened for repairs. If the oil becomes contaminated during repairs, recharge with new oil.

When charging with oil, the machine must be under vacuum. To add oil, attach a copper tube to the oil charging valve, Fig. 2-5, place the other end in a container of oil and open the charging valve. Care should be taken to keep the end of the tube submerged in the oil to prevent air entering the machine.

Do not break the oil container seal until the oil is ready to be charged into the machine.

To remove the full charge of oil from the machine, break the vacuum and raise the machine pressure to approximately 5 lb with air pressure from the purge compressor. (See Chapter 5 for details.) Attach a copper tube to the oil charging valve, open the valve, and drain the oil into a container.

To drain small amounts of oil without breaking the vacuum and without shutting down, loosen the flare nut on the entering side of the solenoid on one of the external oil lines to the Hydraulic Motor and bleed the oil.

WARNING: Do not attempt to bleed oil from a line that is under vacuum.



A rise in oil level may be caused by absorption of refrigerant by the oil. This could be caused by improper operation of the oil heater (not heating the oil sufficiently) or the water regulating valve (passing water through the oil cooler when it should be shut off). If this happens do not remove oil. Correct cause of trouble and boil refrigerant out of oil by operating the oil pump with the heater on. If the vapor pressure in the machine is high, the purge should also be operated during this period.

Starting the machine with excess refrigerant in the oil will cause excess foaming and loss of oil.

BEARINGS

Bearing maintenance consists primarily of maintaining clean oil in the lubricating system. See "Filter" section.

Overheating can cause damage to the bearings. (See "Lubrication" section). If bearing temperatures rise above normal, check the water supply to the oil cooler and the setting of the water regulating valve.

Bearings should be inspected yearly for wear and liners replaced if necessary.

FILTER

The filter cartridges should be renewed after an initial operating period of one or two weeks and then once yearly. A dirty filter will cause loss of oil pressure.

To renew the filter cartridges remove the filter assembly shown in Fig. 2-5 and 2-9 and replace the cartridges on the rod. Vacuum will be lost and it will be necessary to operate the purge and remove the air before start-up.

OIL COOLER

The oil cooler is external of the oil reservoir. The oil flows thru the core and is cooled by water flowing thru the shell. The water side of the core is easily accessible for cleaning by removing it from the shell.

A dirty oil cooler will cause a low pick up of heat by the water circulating through it, and will fail to cool the oil to the required temperature.

The automatic valve which regulates the water supply to the cooler should be set to maintain the oil temperature in the reservoir at approximately 140F when running.

19C OPERATION AND MAINTENANCE COMPRESSOR AND MOTOR



OIL HEATER

The oil heater element is submerged in the reservoir oil. It keeps the oil hot during shutdown to minimize absorption of refrigerant by the oil. To maintain the required oil temperature, set the oil heater thermostat to close contacts at 135F and open contacts at 138F.

A small red pilot light in the center of the compressor gauge panel lights when the heater contacts close.

If the pilot light is out when it is apparent the heater should be on, feel the sides of the reservoir. If it is warm the pilot light may be burned out. To be sure, check the terminals of the thermostat with a volt-meter to see if the contacts are closed.

OIL PUMP

The oil pump will give exceptionally long service since it is completely immersed in oil. It is a gear type, positive displacement pump.

The motor is a "Canned" motor, that is its armature is inside a sealed housing and the stator surrounds the housing. The magnetic currents of the stator flow through the sealed housing and cause the armature to rotate. The motor has no bearings to wear or burn out as the armature is on a common shaft with the oil pump.

The pump motor is wired into the control circuit so the compressor will not start unless the pump is running and delivering oil pressure. If the oil pressure is too low check the filter and the oil pressure regulator. (See "Lubrication".) A worn oil pump is the least likely cause of low oil pressure.

AIR LEAKS

In checking for air leaking into the machine, all joints of the compressor should be checked as it is under vacuum at all times. See "Leak Testing" Chapter 6.

WATER LEAKS

When checking for a water leak do not overlook the compressor oil cooler. See "Leak Testing" Chapter 6.



OPERATION AND MAINTENANCE COMPRESSOR AND MOTOR

19C

EXTENDED SHUTDOWN

During extended shutdown some refrigerant may tend to absorb into the lubricating oil. This can be minimized by being sure the oil heater is operating properly, operating the purge as required to keep the refrigerant vapor pressure down and operating the oil pump occasionally to agitate the heated oil and permit the refrigerant to escape from it.

If the machine is in an area subjected to sub-freezing temperatures, water must be removed from the oil cooler. To do this, close the water valves, remove the plug in the end of the cooler shell and drain all water.

The oil heater should have a source of electricity which is not shut off during extended shutdown.

SECT. 19C
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OPERATION AND MAINTENANCE COOLER

19C

19C HERMETIC CENTRIFUGAL REFRIGERATING MACHINE

CHAPTER 3 - COOLER

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DESCRIPTION

INTRODUCTION

The cooler is a heat exchanger which cools the "brine" passing through the tubes, by the evaporation of the refrigerant in which the tubes are immersed. It is a shell and tube, flooded type, which means the refrigerant is in the shell and the "brine" is in the tubes.

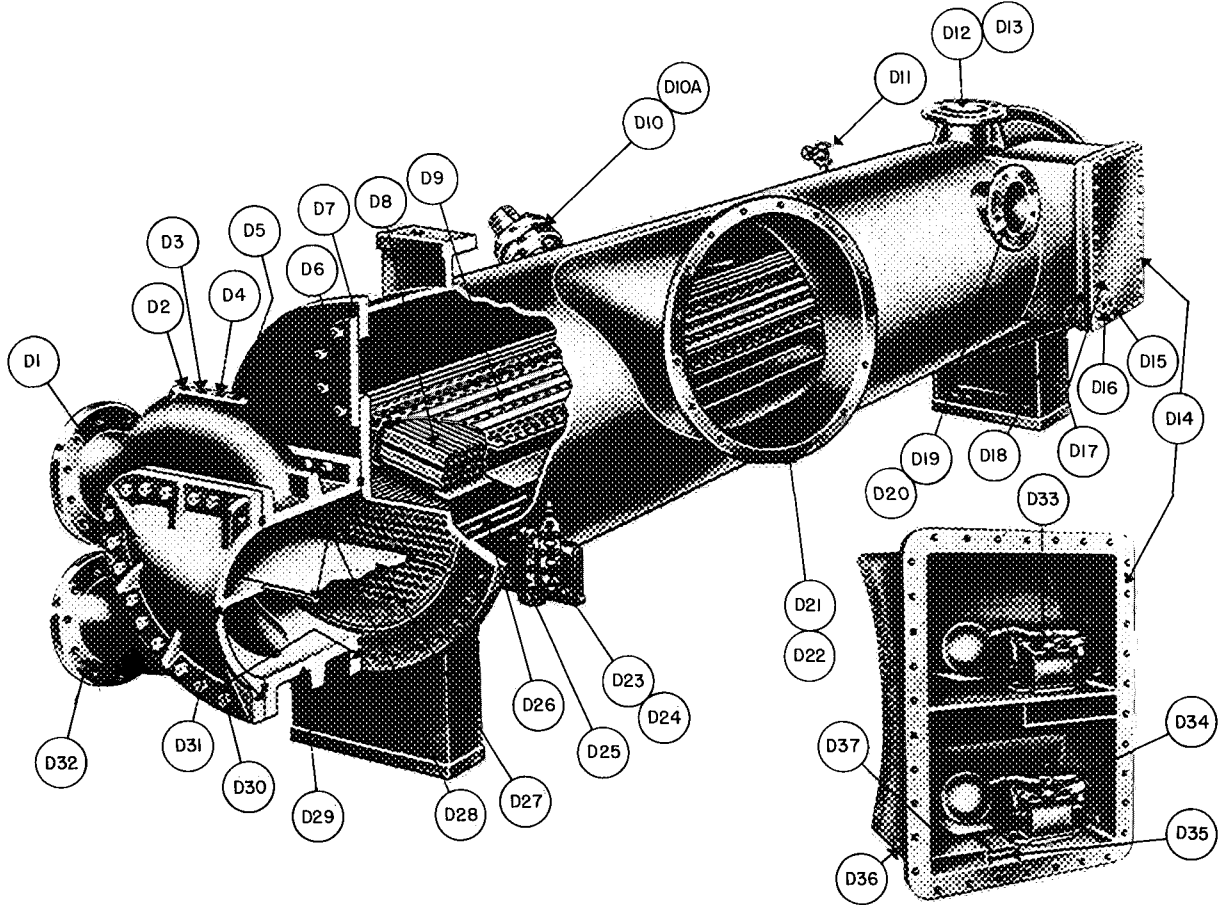


Fig. 3-1 TYPICAL COOLER

NOMENCLATURE

D1 - Water Outlet Nozzle	D13 - Gasket Condenser Drain	D26 - Tubes
D2 - Opening - Chilled Water Control	D14 - Float Chambers	D27 - Division Plate
D3 - Opening - Vent	D15 - Opening - Refrigerant Safety Stat	*D28 - Gasket Division Plate
D4 - Well - Test Thermometer	D16 - Opening - Refrigerant Thermometer	D29 - Water Box
D5 - Opening - Stop-Go Control	D17 - Float Chamber Cover	*D30 - Gasket Water Box
D6 - Inspection Cover	*D18 - Gasket Float Chamber Cover	D31 - Water Box Cover
D7 - Gasket Inspection Cover	D19 - Economizer Gas Outlet	D32 - Water Inlet Nozzle
D8 - Eliminators	D20 - Gasket Economizer Gas Outlet	D33 - Condenser Float Valve
D9 - Gas Baffle	D21 - Compressor Suction Opening	D34 - Economizer Float Valve
*D10 - Rupture Disc	*D22 - "O" Ring Gasket Comp. Suct. Opening	D35 - Strainer
*D10A - Gaskets Rupture Disc - 2	*D23 - Sight Glass - Refrigerant Level	D36 - Well - Test Thermometer
D11 - Charging Valve	*D24 - Gaskets Sight Glass - 2	D37 - Expansion Thermometer Chamber
D12 - Condenser Drain	D25 - Gasket - Sight Glass Neck	

(*) Recommended Spares.



COOLER CONSTRUCTION

SHELL - Cooler shells are made of high grade steel, welded to heavy steel end flanges. Nominal length is 15 feet and the diameter varies with the tonnage size.

TUBES - These are Trufin copper tubes having external fins around the tube through its full length, except where the tube is rolled into the tube sheets and expanded into the support sheets. The fins have the same outside diameter as the plain section of the tube which is expanded into the tube sheet hole. The advantage of an easily removable tube is therefore maintained.

TUBE SHEETS - These are welded into the cooler end flanges, thereby avoiding internal gasketed flanges. Each tube hole is multiple grooved inside to obtain greater strength and better sealing when the tube is rolled into the hole.

SUPPORT SHEETS - Each cooler has three brass tube support sheets, equally spaced through the length of the cooler. They maintain accurate spacing of the tubes and add strength to the assembly. Tubes are expanded into the hole at each support sheet.

ELIMINATORS - Brass eliminators are installed above the tube bundle to prevent the carry over of liquid refrigerant droplets into the compressor suction. Excess carry over could decrease the capacity of the machine and increase its power requirements. The economizer section is also equipped with eliminators to prevent carry over.

GAS BAFFLE - These are steel strips on a perforated steel sheet properly shaped and arranged to maintain an equal boiling rate over the entire cooler liquid surface. They are located directly above the eliminators. Without these, the refrigerant would tend to boil more violently directly under the compressor suction connection, causing liquid refrigerant droplets to be carried over into the compressor.

INLET BAFFLE - A steel distribution baffle located beneath the tube bundle conveys the liquid refrigerant from the inlet, distributing it uniformly throughout the length of the cooler.

WATER BOX - Cast iron water boxes are used to obtain maximum corrosion resistance in contact with water. Standard design is for 200 lb. per square inch working pressure. Gauge, vent, drain, thermometer, and control bulb openings are provided. Tubes may be inspected or cleaned by removal of water box covers only. Normal water flow is in the lower water box nozzle and out the top nozzle.



DIVISION PLATES - These are located in the water box to separate the water passes. They are cast iron and designed to break, in the event of a bad water hammer, to protect the tubes and tube sheets.

SIGHT GLASS - A reflex type sight glass is provided for observing the charging and operating refrigerant level. A wire across the face of the glass indicates the approximate shut down level.

CHARGING VALVE - This valve is located on the side of the cooler opposite the compressor. In addition to charging, it is also used for removing refrigerant from the cooler. For this reason, the charging line extends to the cooler sump. A clean-out plug is provided at the charging line connection to the sump.

RUPTURE VALVE - A properly sized rupture valve with replaceable Impervite rupture disc, designed to rupture at 15 pounds per square inch is provided.

INSPECTION COVER - A steel inspection cover, located at the cooler end opposite the economizer, permits inspection of the space above the eliminators and gas baffles.

FLOAT VALVES - Two identical float valves are provided, one to maintain a liquid refrigerant seal between the condenser and the economizer, and the other to maintain a seal between the economizer and the cooler. These are Carrier designed, balanced valves. They are not positive seating and therefore have no tendency to bind.

EXPANSION THERMOMETER CHAMBER - This is a small chamber welded into the lower left side of the economizer float chamber. See Figs. 3-2 and 3-3. Liquid refrigerant is admitted to the chamber through an orifice which is covered by a strainer. An opening from the chamber into the cooler subjects the chamber to the pressure existing in the cooler. The liquid refrigerant in the chamber, therefore, is reduced to a temperature corresponding to the temperature in the cooler. The bulb of the refrigerant safety thermostat is inserted in a well in this chamber. A test thermometer well is also provided and an opening is available for the permanent installation of a thermometer, if desired.

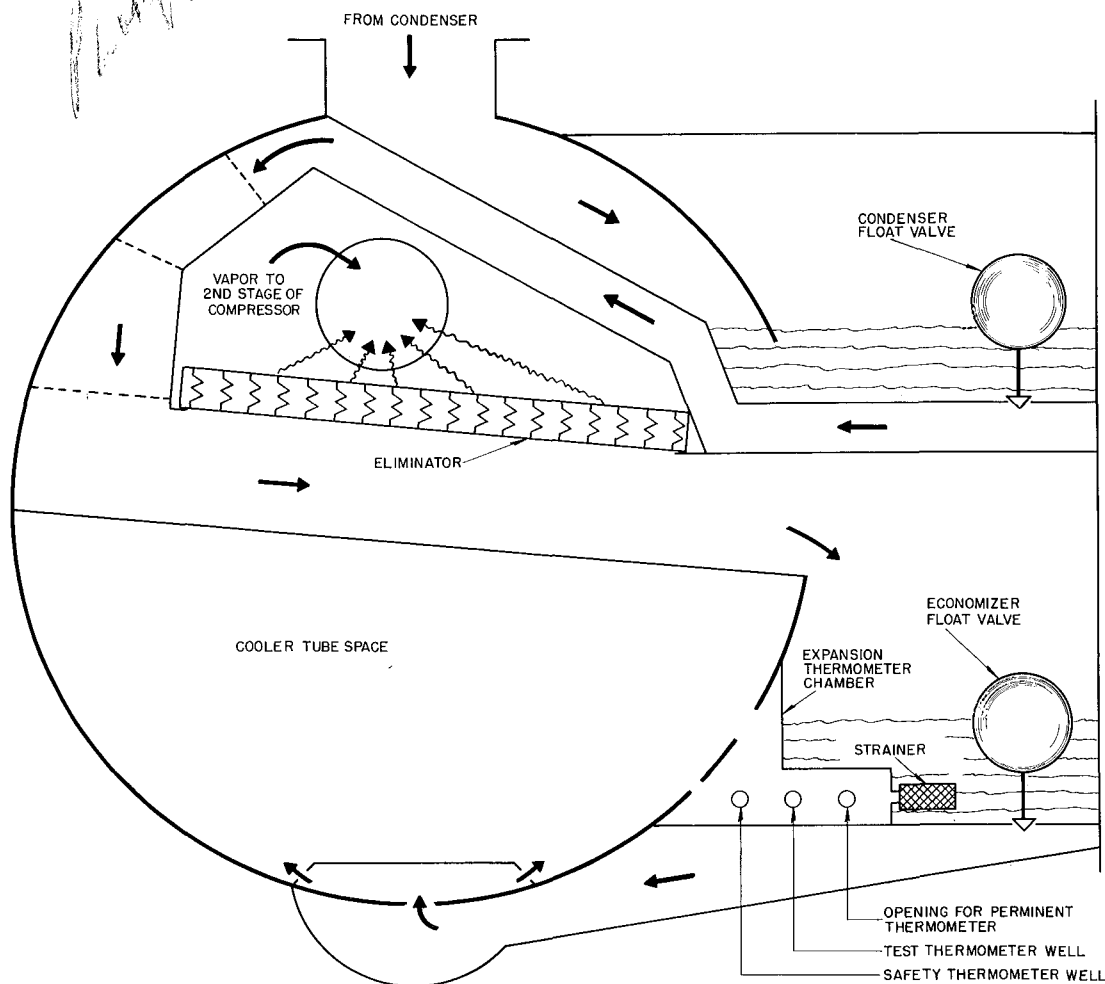


Fig. 3-2 - Economizer Schematic Diagram

ECONOMIZER - The economizer is a small flash chamber built into the end of the cooler shell above the tubes. In this chamber, the liquid refrigerant flowing to the cooler is subjected to the pressure existing at the suction of the second stage compressor wheel. This causes a portion of the refrigerant to flash into gas, cooling the remainder of the liquid. The gas is then drawn through the motor, cooling it and picking up additional heat before passing into the suction of the second stage impeller.

The liquid passing through the economizer is cooled to a point that is approximately halfway between the condenser and cooler temperature. It then passes into the bottom of the cooler. This gives the advantage of a relatively cold liquid entering the cooler while the gas generated to obtain this cold liquid is compressed through only one stage of the compressor, instead of two, as would be necessary if the warm liquid passed directly from the condenser to the cooler. This results in a definite power savings on the motor; hence, the term "Economizer."

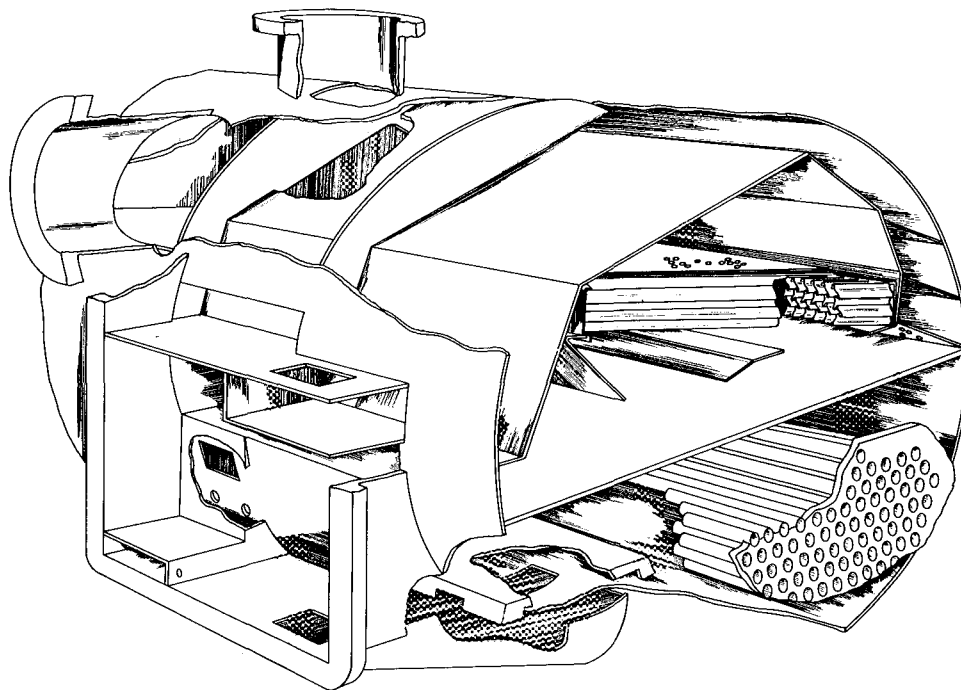


Fig. 3-3 - Economizer

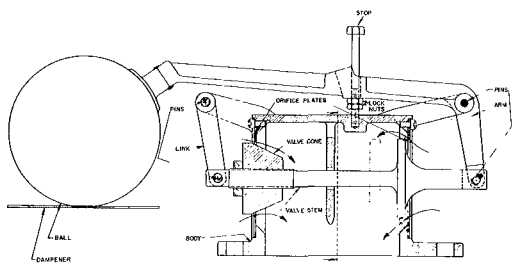


Fig. 3-4 - Float Valve

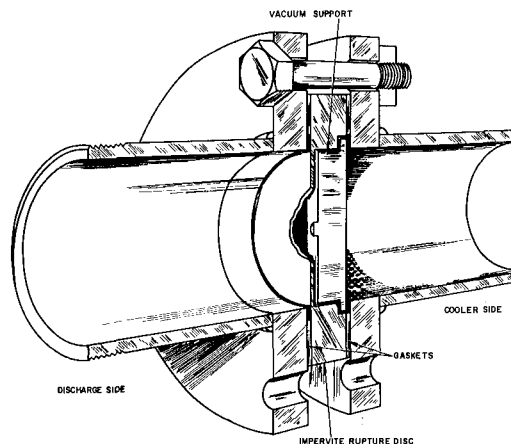


Fig. 3-5 - Rupture Valve Assembly

A double chamber with two float valves is located on the side of the cooler. The top chamber contains the condenser float valve which permits all liquid refrigerant to drain from the condenser to the economizer and prevents the passage of refrigerant gas. The bottom chamber contains the economizer float valve which permits all liquid refrigerant to drain from the economizer to the cooler and prevents the passage of refrigerant gas into the cooler.

The amount of refrigerant for any size cooler is shown in Table 3 - 1 "Cooler Refrigerant Quantities".

MAINTENANCE

REFRIGERANT CHARGE

CARRENE-3 is shipped in 100 and 200 lb drums.

TABLE 3-1 - COOLER REFRIGERANT QUANTITIES

COOLER SIZE	CARRENE -3 (lb)
19Q 1	1045
2	1010
3	980
4	950
5	910
6	890
7	855
8	940
9	1020
10	995
11	1300

The amounts given in Table 3-1 are approximate. A cross wire on the sight glass indicates the proper shutdown level. Too much refrigerant in the cooler will cause liquid droplets to be pulled into the compressor suction resulting in too much horsepower for the tonnage produced. Too little refrigerant causes improper water cooling in the upper tubes. The refrigerant temperature will drop to compensate for this and in extreme cases the machine could shut down on low refrigerant safety control even though the chilled water temperature was too high.

ADDING REFRIGERANT:

To charge the cooler with refrigerant use a drum valve and fittings as shown in Fig. 3-6. With the valve closed, screw the fitting into the drum as shown in Fig. 3-7.

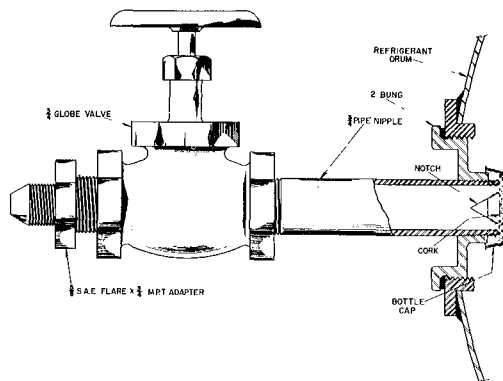


Fig. 3-6 - Drum Charging Valve

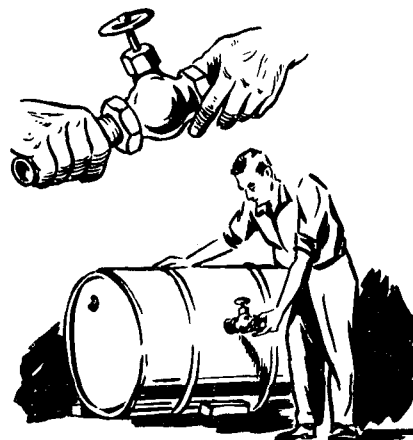


FIG. 3-7 - Charging Valve Installed On Drum

An inverted bottle cap under the drum plug stays in place when the 3/4" plug is removed from the 2" bung. The 3/4" pipe nipple in the drum charging valve forces this bottle cap off its seat when the nipple is screwed into the drum. The nipple should be notched, as shown in Fig. 3-6, so the cap will not be held against the end of the nipple if there is pressure in the drum.

Hoist the drum above the cooler (See Fig. 3-8) and turn it so the valve will be on the bottom. Connect the drum to the Cooler Charging Valve with soft copper tubing as shown in Fig. 3-9. With the connection at the Cooler valve loose, open the drum valve slightly and force the air out of the line with refrigerant. Then tighten the connection and open both valves wide. The ends of the drum will usually pull in when all the refrigerant is removed and the drum is subjected to the vacuum in the cooler. If this does not happen, you can tell when the drum is empty by tapping it.

The cooler should be under vacuum when charging. The purge may be operated to keep the cooler pressure down.

Drums of refrigerant should always be stored in a cool place. If the temperature of the drum is allowed to rise above the boiling point of the refrigerant, there will be pressure in the drum. Opening a drum which contains pressure in any way other than that described above could result in serious loss of refrigerant and possible injury to the operator.

If equipment is not available to hoist the drum, the cooler can be charged with the refrigerant drum at a lower level by turning the drum valve down and maintaining a pressure difference between the cooler and the drum great enough to force the refrigerant into the cooler. This may require heating the drum with steam or hot water.

Empty drums should be saved for storing refrigerant during service operations.

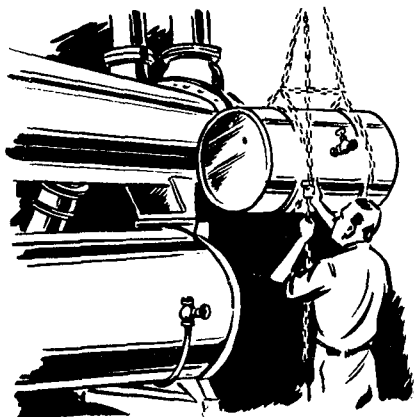


FIG. 3-8— Hoisting Drum
Above Cooler

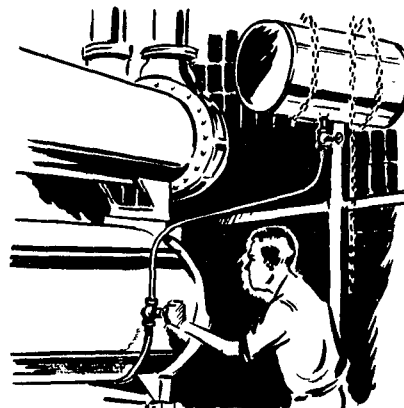


FIG. 3-9— Connecting Drum
To Cooler



REMOVING REFRIGERANT

To remove refrigerant from the cooler, connect a copper tube to the cooler charging valve and put the other end into the drum which should be on the floor. The tube should extend to the bottom of the drum to prevent splashing.

Raise the pressure in the cooler to approximately 5 lb by pumping air into the machine with the purge unit as explained in Chapter 5. Open the cooler charging valve and the refrigerant will flow into the drum.

CAUTION: Leave about 3" of space above the liquid in the drum to permit the refrigerant to expand. If the large bung is removed and the refrigerant is put into the drum through this opening, the level can be easily observed with a flashlight.

The colder the refrigerant, the less loss there will be by evaporation. The refrigerant temperature can be reduced before removing, by operating the machine or by running the purge,

REFRIGERANT LOSS

Although the cooler is usually under vacuum at all times, it is still possible to lose refrigerant indirectly through air leaks. Air that leaks into the cooler is removed by the purge. Since it is not possible to completely separate the air from the refrigerant gas, some gas will be discharged with the air through the purge relief valve. A leak which causes the purge to continuously discharge air should be located and repaired.

To locate cooler leaks it is necessary to put a positive pressure in the cooler and test each joint with a Halide Leak Detector. The purge compressor can be used to pressurize the cooler with air - See Section 5 "Purge and Recovery System". The refrigerant charge should not be removed when making this leak test. Care should be taken to prevent damaging the rupture disc with excessive pressure. A good leak test can be made at 5 psig. **DO NOT EXCEED 10 lb.**

During an extended shutdown, the refrigerant in the cooler may eventually rise to a pressure corresponding to the room temperature. (See Pressure Temperature Curve - Chapter I). It is desirable to hold the pressure to 10" vacuum or below, to avoid excessive absorption of refrigerant into the lubricating oil. This pressure can be maintained by operating the purge occasionally or by circulating a small amount of cool water through the cooler tubes as required.



TUBES

At the end of the first operating season, the cooler tubes should be checked and cleaned. Their condition at this time should be a guide for future frequency of cleaning and should indicate whether or not water treatment is desirable in the chilled water circuit.

A close check on temperature difference between refrigerant and leaving chilled water under comparable operating conditions will also indicate when the tubes need cleaning. For example, if the temperature difference when the machine is new and the tubes are clean is 8 degrees and this later increases to 10 or 12 degrees (when operating at the same load, same entering water temperature and flow, and the same head pressure), then it is evident that the heat transfer through the tubes has decreased and it is time to clean them.

Tube cleaning brushes especially designed to prevent scraping or scratching of copper tube walls are available through Carrier Service Parts Department. Any brush used should have bristles which will not scratch copper.

Where tubes are covered with a coating of hard scale, it may be necessary to use chemical cleaning. It is best to have this done by a reliable organization specializing in chemical cleaning of heat exchangers.

If the machine is shut down during the winter months it is desirable to flush out the chilled water system with clean water to remove loose rust that may have formed, before putting the machine into operation.

The refrigerant must be kept free of water or damage to the tubes will result. See Chapter 5 "Purge and Recovery System".

To prevent freeze-up of the tubes the freeze protection controls should be tested at least once a year. See Chapter 6 "Controls".

If the machine is exposed to freezing temperatures during winter shut-down, all water should be drained from the chilled water circuit to protect the lines and the cooler tubes from damage due to freezing.



19C HERMETIC CENTRIFUGAL
REFRIGERATING MACHINE

CHAPTER 4 - CONDENSER

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DESCRIPTION

The condenser is a shell and tube heat exchanger. Refrigerant gas discharged from the compressor is condensed on the outside of the tubes by transfer of heat to the water which flows through the tubes. The condensed liquid refrigerant drains directly from the condenser shell to the upper float valve chamber, and the shell is kept free of liquid so all tubes are exposed to refrigerant gas.

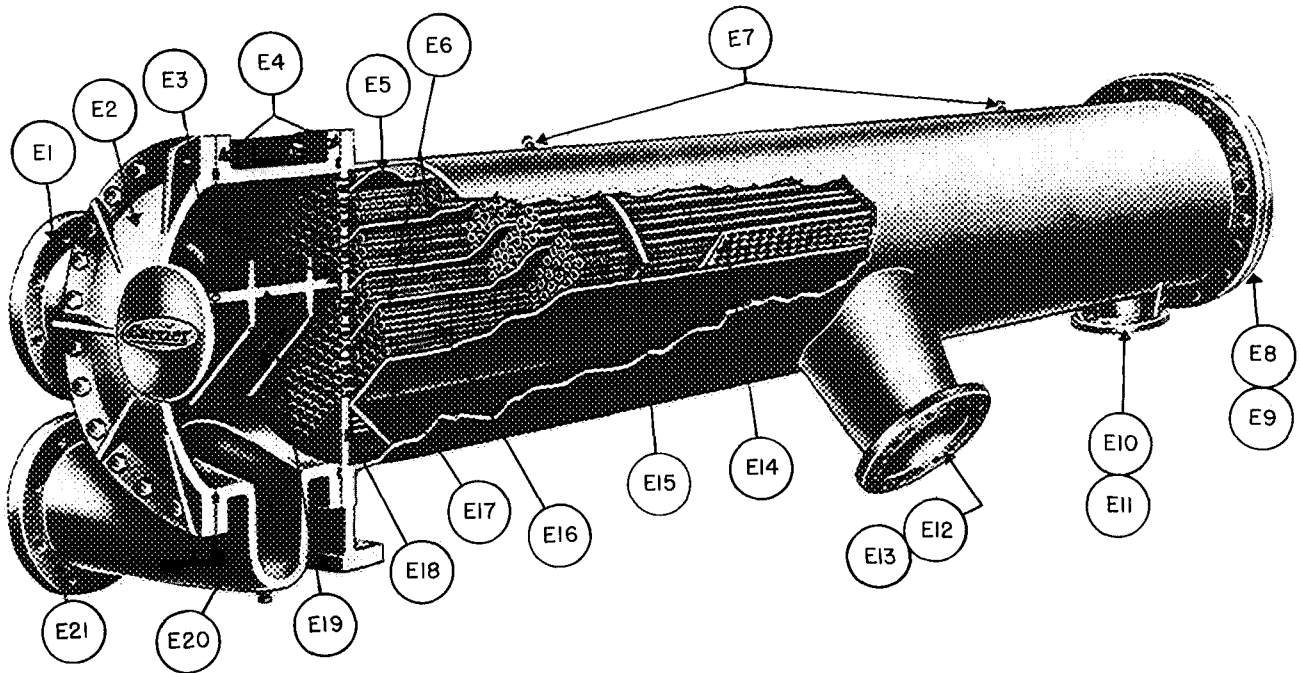


Fig. 4-1 — TYPICAL CONDENSER

NOMENCLATURE

E1 - Water Inlet Nozzle	E12 - Gas Inlet
E2 - Water Box Cover	*E13 - Gasket - Gas Inlet
*E3 - Gasket - Division Plate	E14 - Perforated Section of Gas Distribution Baffle
*E4 - Gaskets - Water Box	E15 - Tube Support Sheet
E5 - Purge Baffle	E16 - Tubes
E6 - Tube Drain Baffles	E17 - Gas Distribution Baffle
E7 - Purge Connections	E18 - Tube Sheet
E8 - End Cover	E19 - Division Plate
*E9 - Gasket - End Cover	E20 - Water Box
E10 - Drain Opening	E21 - Water Outlet Nozzle
E11 - Gasket - Drain Opening	

(*) Recommended Spares

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STANDARD CONDENSER CONSTRUCTION

SHELL - Condenser shells are made of high grade steel. Heavy steel flanges containing tube sheets are welded to each end of the shell. Nominal length is 12-1/2 feet and the diameter varies with the size. All shells are cylindrical in shape.

TUBES - Tubes are copper Trufin having external integral fins around each tube through its full length except where the tube is rolled into the tube sheets and where it passes through the support sheets. The fins have the same outside diameter as the plain section of the tube which is expanded into the tube sheet hole. This permits easy removal of the tube.

TUBE SHEETS - Tube sheets are welded into the condenser end flanges, thereby avoiding internal gasketed flanges. Each hole is grooved inside to give greater strength and better sealing when the tube is rolled into the hole.

SUPPORT SHEETS - Each condenser has two brass tube support sheets. They maintain accurate spacing of the tubes throughout the length of the condenser and add strength to the assembly.

GAS DISTRIBUTION BAFFLE - A steel baffle is located inside the shell to distribute the refrigerant gas the full length of the condenser and direct it over the tubes in the most efficient manner. A section of the baffle nearest the compressor discharge is a steel perforated sheet designed to prevent impingement of high velocity gas directly on the copper tubes.

PURGE BAFFLE - This is a steel baffle in the top of the condenser. It provides an area of less turbulence to permit the segregation of air which must be purged from the machine. It encloses a portion of the tubes which are in the first water pass. The colder water temperature in the first pass gives better condensation of the refrigerant and causes the air to concentrate at this point.

TUBE DRAIN BAFFLES - Steel drainage baffles are arranged in the tube bundle to collect condensed refrigerant and prevent it from dropping onto lower tubes, thus maintaining the efficiency of these tubes.

WATER BOXES - Cast iron water boxes are standard. Cast iron has a very high resistance to water corrosion. Standard design is for 200 lb per square inch working pressure. Gauge, vent, and drain openings are provided. Tubes may be inspected or cleaned by removing water box covers only, without disconnecting any piping.



DIVISION PLATES - Division plates, located in the water box, separate the water passes. They are cast iron and designed to break under excessive water hammer. This safety design protects the tubes and tube sheets from damage.

PURGE SERVICE VALVE - The purge service valve is located at the purge opening in the top of the condenser shell. In the closed position, it isolates the condenser from the purge.

SHOULDER BOLTS - The condenser foot is attached to the cooler with shoulder bolts. These permit lengthwise expansion and contraction of the condenser while adequately securing it to the cooler.

MAINTENANCE

TUBES - The condensing water circuit is usually an open system using a cooling tower and requiring makeup water to replace evaporation loss. For this reason the condenser tubes are subject to contamination by foreign matter -- scale, algae, etc. Since water conditions vary in all parts of the country it is recommended that a reliable water treatment specialist be consulted and a sample of the condensing water be tested to determine the type of water treatment required, if any.

The condenser tubes should be cleaned at least once a year or more frequently if the water is heavily contaminated. Higher than normal head pressure usually indicates dirty tubes. Air in the machine would give the same indication however. To be sure of a correct analysis the head pressure should be checked against the actual condensing temperature. The correct temperature for the pressure is shown in red on the condenser pressure gauge. The actual condensing temperature can be obtained by inserting a test thermometer in the well on the right hand side of the condenser float chamber. If the thermometer reading is below the temperature shown for the existing pressure, air is present in the machine. If the temperature and pressure correspond, there is no air in the machine and the high head pressure is due to either high entering condensing water temperature, lack of condensing water, or dirty tubes.

A larger than normal difference between leaving condensing water temperature and actual condensing temperature, coupled with a smaller difference in temperature of entering and leaving condenser water, would be a definite indication of dirty tubes. To use this method a log must be made of the temperature difference when the machine is new and operating under full load. Comparisons made later should also be at full load and with identical entering condensing water temperature.

Tube cleaning brushes especially designed to prevent scraping or scratching of copper tube walls are available through Carrier Service Parts Department. Any brush used should have bristles which will not scratch copper.

Where tubes are covered with a coating of hard scale it may be necessary to use chemical cleaning. It is best to have this done by some reliable organization specializing in chemical cleaning of heat exchangers.

If the machine is shut down during the winter months flush out the condensing water circuit with clean water to remove any loose rust that may have formed before putting the machine into operation.

If the machine is located in an area which is subjected to freezing temperatures during winter shutdown, drain the water from the condenser to protect the tubes, water boxes and piping from freeze-up.

AIR LEAKS

Machines using CARRENE-3 refrigerant usually have a vacuum in the condenser at all times. For this reason any leak will permit air to enter the machine.

The presence of air in the machine is indicated by an increase in head pressure in the condenser. However, dirty tubes will give the same indication. Therefore to be sure of a correct analysis, the head pressure should be checked against the actual condensing temperature. The correct temperature for the pressure is shown in red on the condenser pressure gauge. The actual condensing temperature can be obtained by inserting a test thermometer in the test well on the right hand side of the condenser float chamber. If the thermometer reading is below the temperature listed for the existing pressure, air is present in the machine.

If the purge unit is properly operated and in good repair the purge relief valve will give the first indication of air in the machine. See Chapter 5 "Purge and Recovery System".

WATER LEAKS

Accumulation of water in the purge separation chamber could be caused by a water leak in the condenser. Locating and repairing water leaks is a job for a Carrier trained Service Engineer. Call your nearest Carrier district office. It should be remembered that air entering the machine will bring some moisture with it. Therefore, small amounts of water at the purge separation chamber do not necessarily indicate a water leak.



REFRIGERANT LOSS

Refrigerant can be lost because of air leaking into the machine. Since air must be removed by the purge unit and since it is impossible to completely separate the air and the refrigerant, some refrigerant will always be discharged from the machine with the air. Therefore, all leaks which cause the purge unit to continuously discharge air through the relief valve should be located and repaired. To locate leaks in condensers which are normally under vacuum, it is necessary to shut down, if operating, and put a positive pressure in the machine and test each joint with a Halide leak detector. The purge compressor can be used to pressurize the machine. (See Chapter 5 "Purge and Recovery System"). The refrigerant charge should not be removed when making this leak test. Care should be taken not to exceed the breaking point of the cooler rupture disc (15 psig). A good leak test can be made at 5 psig. DO NOT EXCEED 10 psig.

CONTROLS

The condenser head pressure should never exceed 10 lbs. The head pressure protection control should be tested at least once a year as explained in Chapter 6 "Controls".



OPERATION AND MAINTENANCE PURGE RECOVERY SYSTEM

19C

19C HERMETIC CENTRIFUGAL REFRIGERATING MACHINE

CHAPTER 5 - PURGE RECOVERY SYSTEM

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DESCRIPTION

COMPONENTS*

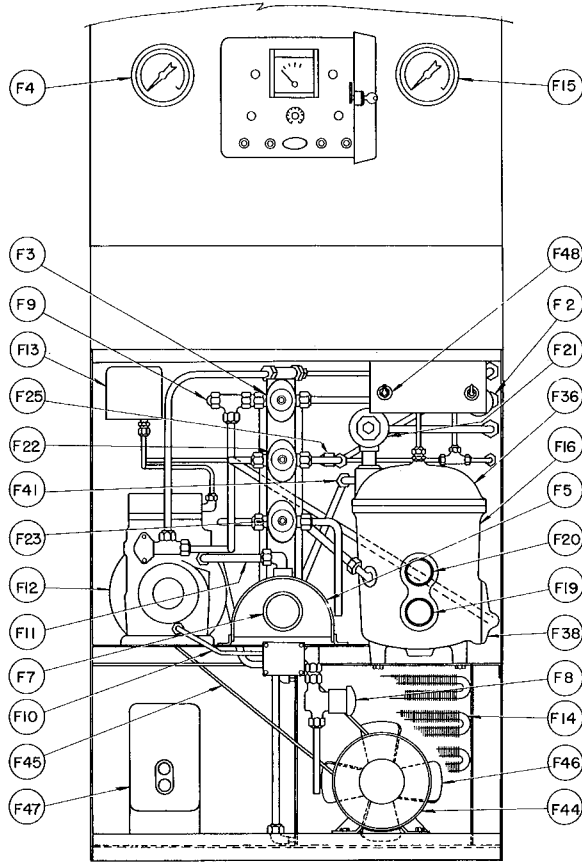


Fig. 5-1 - Console Assembly

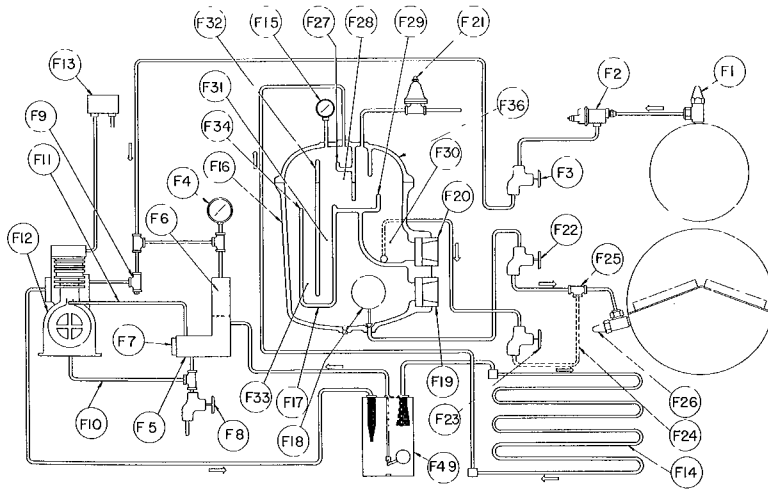


Fig. 5-2 - Purge Cycle

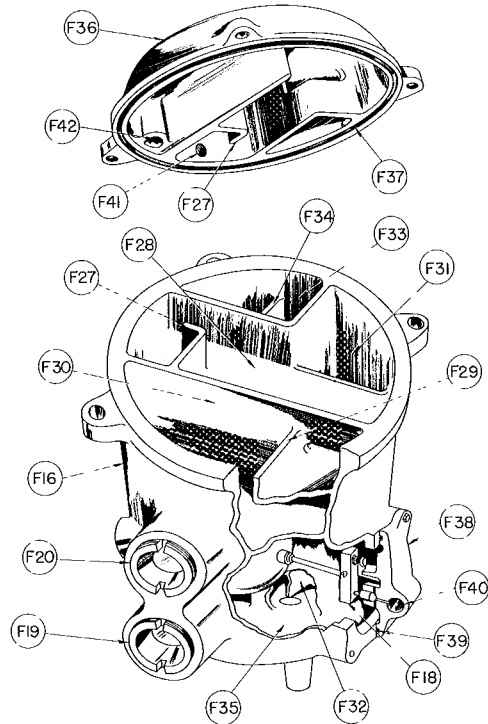


Fig. 5-3 - Purge Separation Chamber - Cut-Away View

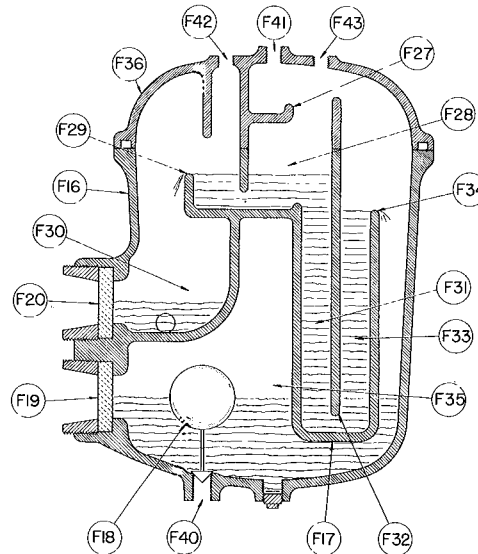


FIG. 5-4 - Purge Separation Chamber - Schematic Cross-Section

*See page 5-3 for identification of components.



OPERATION AND MAINTENANCE PURGE RECOVERY SYSTEM 19C

NOMENCLATURE

Purge components are identified below. Each component can be located by its number on the sketches of the purge and separation chamber, Figs. 5-1, 5-3, and 5-4, or on the purge cycle schematic diagram, Fig. 5-2. Where the component can be seen in both the cycle diagram and the sketches, the numbers are duplicated. In this way the components shown in the cycle diagram can be quickly and easily located in the actual purge unit.

1. Stop valve on main condenser - This is an angle-type, back seating service valve. It must be open when purging.
 2. Pressure reducing valve in suction line - It regulates the compressor suction pressure to protect the motor against overload and prevents liquid refrigerant entering the purge compressor. For proper setting see Table 5-1 on Page 5-9.
 3. Stop valve in suction line - This valve is marked "From condenser." It must be open when the purge is in operation.
 4. Suction pressure gauge.
 5. Auxiliary oil reservoir - The reservoir relieves the refrigerant from the compressor crankcase to the suction line without loss of oil.
 6. Copper wool - Prevents oil pull over.
 - *7. Oil level sight glass - Shows the level of the oil in the auxiliary oil reservoir (Fig. 5-8 shows cutaway view) and the compressor crankcase.
 - *7A Gaskets for item 7 - (Not shown)
 8. Oil charging and removal valve.
 9. Air intake tee - For use in pressurizing machine during service operations. See "Leak Testing."
 10. Oil equalizing line.
 11. Gas equalizing line.
 12. Compressor - See Fig. 5-9.
 13. High pressure cut-out switch - Stops purge compressor if discharge pressure reaches 110 psig. It closes automatically on reduction of pressure to about 75 lb. This is a dual pressure switch - the second bellows is connected to the main centrifugal condenser and shuts down the compressor in the event of excessive head pressure.
 14. Air cooled condenser.
 15. Discharge pressure gauge.
 16. Separation chamber.
 17. Trap - Permits refrigerant to pass into float chamber and also traps water.
 - *18. Float valve - Returns recovered refrigerant to cooler. Removable with plate on side of chamber.
 - *19. Refrigerant sight glass.
 - *19A. Gaskets for item 19 - (Not shown)
 - *20. Water sight glass.
 - *20A. Gaskets for item 20 - (Not shown)
 - *21. Relief valve - See Table 5-1 on Page 5-9 for proper setting.
 22. Stop valve in refrigerant return line - This valve is marked "Refrigerant Return." It must be open when the purge is in operation.
 23. Stop valve in line from water chamber - Identified as "Water Drain."
 24. Air line - This short cross-over line is shipped loose in the console. It is used to pressurize the machine during service operations. See "Leak Testing."
 25. Service tee - Used with air line above.
 26. Stop valve at cooler - Angle-type, back seating valve for service operations. Must be open when purging.
 27. Inlet baffle - Minimizes disturbance of settling liquids.
 28. Settling compartment.
 29. Water weir.
 30. Water compartment.
 31. Entering side of trap.
 32. Trap partition.
 33. Leaving side of trap.
 34. Refrigerant weir.
 35. Refrigerant float compartment.
 36. Purge chamber cover.
 - *37. "O" ring gasket for item 36.
 38. Float valve cover plate.
 - *39. "O" ring gasket for item 38.
 40. Refrigerant return-opening.
 41. Inlet opening from purge condenser.
 42. Opening to relief valve.
 43. Opening to pressure gauge.
 44. Motor - Squirrel cage, sleeve bearing type, 1/2 hp, 3 phase, 50/60 cycle, 1450/1750 rpm.
 - *45. V-belt.
 46. Fan - Cools condenser. Attached to motor pulley.
 47. Starter - See Fig. 5-6
 48. Operating Switch - Manual, automatic, off.
 49. Oil Separator (See Fig. 5-8A)
- (*) Recommended spares.
(See Fig. 5-9 for recommended spares for compressor.)



PURGE RECOVERY UNIT

The purge unit is located in the lower part of the console. It consists of a reciprocating compressor with motor and V-belt drive, oil separator, auxiliary oil reservoir, condenser, separation chamber, and gauges, valves and inter-connecting copper tubing. The suction and discharge pressure gauges are located on the front of the console at eye level.

The purpose of this unit is to evacuate air and water from the centrifugal machine, and to recover and return refrigerant which is mixed with the air. The air is relieved automatically to the atmosphere, the recovered refrigerant returned automatically to the cooler, and water, if present, is isolated in a compartment from which it can be drained manually.

PURGE CYCLE

The compressor item (12), Fig. 5-5, removes vapor from the top of the main condenser. This vapor is mostly refrigerant gas; however, some air or water vapor may be present. The mixture is compressed and discharged into the oil separator (49) which removes and returns oil to the oil reservoir. The mixture then passes to the purge condenser (14). Air blown over the condenser by the fan condenses the refrigerant and water vapor. The mixture is then air, liquid refrigerant and water. This mixture passes from the condenser into the separation chamber (16). If an appreciable amount of air is forced into the separation chamber, the pressure rises until it reaches the setting of the relief valve(21) and is discharged to atmosphere.

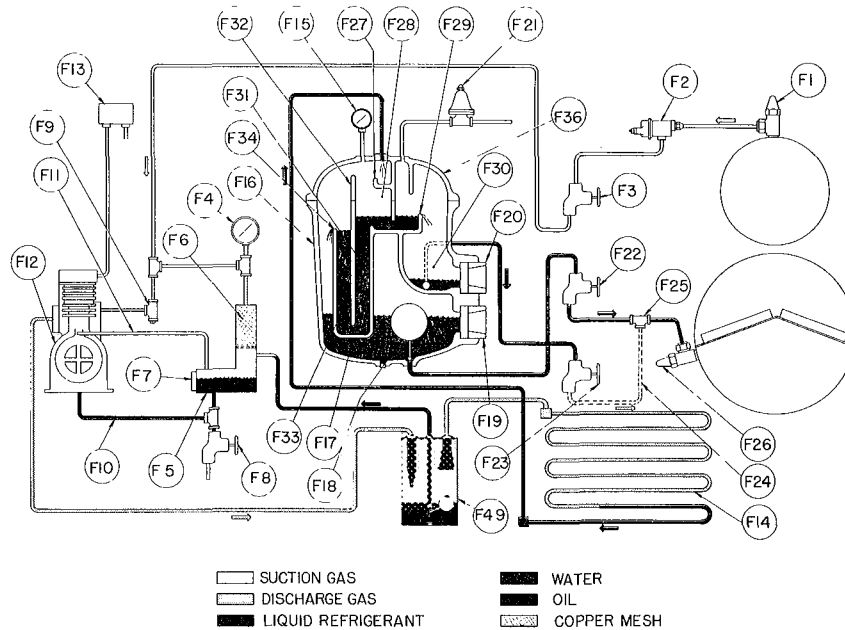


FIG. 5-5 - PURGE CYCLE

The mixture of liquid refrigerant and water accumulates in the settling compartment (28) and the lighter water floats on top of the heavier refrigerant. This settling process is continuous and the water is always trapped above the liquid refrigerant. Excess water spills over the water weir (29) into the water compartment (30), and is drained through the water valve (23). The water level can be seen through the bulls-eye (20).

This is intentionally a manual operation, as the presence of water in the machine should be noted by the operator, and its automatic removal would preclude this. See "Water Leaks" Page 5-7 for details.

Any liquid refrigerant added to the mixture will cause the column of liquid on the entering side of the trap (31) to exceed the height of the column of liquid on the leaving side of the trap (33) and consequently, liquid refrigerant will spill over the refrigerant weir (34) into the float valve compartment (35) where it will lift the float valve (18) and be automatically returned to the cooler.

OPERATING REQUIREMENTS

As stated on the purge unit nameplate, the purge system should be operated any time the centrifugal machine is operating. Even though the machine may be perfectly air tight it could develop a water leak which can be detected only by operating the purge system. If water is allowed to remain in the machine, serious damage to tubes, and other internal parts of the machine will result.

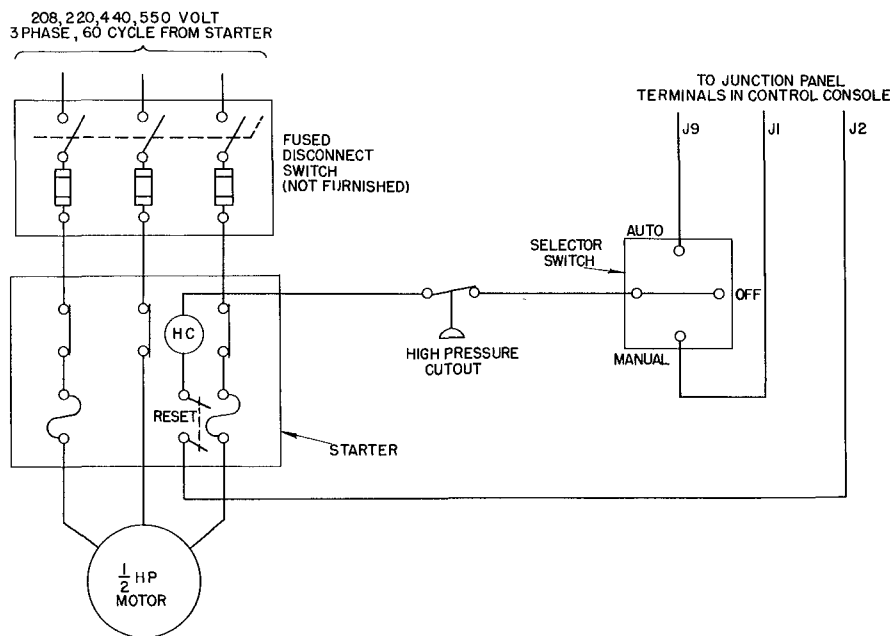


Fig. 5-6 - Purge Starter Wiring Diagram



It is economical insurance therefore to operate the purge at all times when the centrifugal machine is operating.

The purge is equipped with a 3-way switch - "Automatic - Off - Manual" illustrated in Fig. 5-6. In the "Automatic" position the purge will operate any time the centrifugal machine operates. In the "Manual" position it will operate at all times. The "Off" position permits shutdown for service.

If the head pressure rises above normal and causes the centrifugal compressor to surge at startup, air has entered the machine during shutdown. Unless the head pressure reaches the safety cutout point, the surging will continue and diminishing slowly until all air is removed by the purge. If the head pressure reaches the cutout point the machine will shut down and the green light marked "Condenser Pressure" on the console panel will go out. If this happens change the purge switch to "Manual" and purge the machine of all air before attempting to start again. After starting set the switch back to "Automatic".

During extended shutdown periods the purge should be operated as required to keep the pressure to at least 10" vacuum. This will minimize absorption of refrigerant by the lubricating oil.

AIR AND WATER LEAKS

REFRIGERANT LOSS

Although the purge unit does a very efficient job of removing refrigerant from the air being purged, it is physically impossible to remove all refrigerant. Some will always be lost when purging air. It is therefore important to locate and repair all leaks which cause the purge to continuously discharge air through the relief valve.

The high pressure side of the purge unit can be a source of refrigerant loss if a leak develops. All fittings, flanges, etc. in the pressure side of the purge unit should be checked with the leak detector at least once a month. See "Leak Testing".

AIR LEAKS:

An air leak in the centrifugal machine will be indicated by a high head pressure on the purge discharge gauge and by air discharging at the purge relief valve. Although the purge may be able to remove the air as fast as it leaks into the machine, the leak should be located and repaired. There are two reasons for this: first, air purged from the machine will carry with it some refrigerant vapor and a machine which has a continuous air leak will have a continuous refrigerant loss; second, air which enters the machine will contain some water vapor which is harmful to the machine.



WATER LEAKS:

Water removed from the machine will accumulate in the water compartment of the purge separation chamber and will show in the top bulls-eye. This water should always be drained into a container so it can be measured and an accurate record kept of the amounts removed. It should be remembered that some water vapor will enter the machine any time air enters the machine and this will show up as water at the purge separation chamber. However, if water is continually being drained from this chamber, the services of a Carrier trained Service Mechanic should be obtained from your nearest Carrier district office.

If water is allowed to remain in the machine, serious damage to the tubes and other internal parts of the machine can result.

LEAK TESTING:

To leak test machines which are normally under vacuum it is necessary to shut down and put a pressure in the machine by using Nitrogen, CO₂ or air. WARNING - Never pressurize a machine with oxygen as serious explosions may result from pure oxygen and oil in a system under pressure.

WARNING - When using Nitrogen or CO₂ always disconnect the line from the drum after obtaining the required test pressure.

PRESSURIZING THE MACHINE

The most expedient method is to use the purge compressor and pressurize the machine with air as follows:

1. Open water drain valve (23) and drain water. Close valve after water is drained.
2. Close hand valve (3) marked "From Condenser".
3. Close hand valve (22) marked "Refrigerant Return".
4. Remove cap from tee (25). This will admit air to the machine. Wait until machine pressure is up to atmospheric.
5. Install air line (24) between discharge of valve (23) and tee (25).
6. Remove cap from air intake tee (9).
7. Start compressor and observe purge discharge gauge. Pressure should immediately start to build up on this gauge.
8. Open water drain valve (23). Air will now be discharged directly into the cooler and the pressure on the purge discharge gauge will drop to the cooler pressure.
9. Stop compressor when pressure reaches 5 to 10 lb. Test pressure should not exceed 10 lb as damage to the cooler rupture valve could result.

The refrigerant should not be removed from the cooler when making leak tests. In the event a leak test is being made with the refrigerant removed, approximately 1 quart should be recharged into the cooler so the leak will show on the Halide leak detector.

A Halide leak detector as shown in Fig. 5-7 can be obtained from any refrigeration supply house. To use the detector, attach it to the prestolite drum, light it and adjust the flame so it is very low yet hot enough to cause a red glow on the copper reaction ring. Too large a flame will melt the copper ring and the detector will be ineffective.

In checking for leaks place the end of the exploring tube at the joint, or point of test, and observe the flame. (The exploring tube pulls a sample of air into the burner where any refrigerant present will decompose into free acids which will react with the copper ring and change the flame color.) Small leaks give a greenish tint while larger leaks color the flame a vivid blue.

A heavy concentration of refrigerant in the room will decrease the efficiency of the test since the flame will indicate refrigerant present anywhere in the room. It is best to air the room before attempting a test.

REMOVING REFRIGERANT:

To remove refrigerant from the cooler put air pressure in the machine. This forces the refrigerant out the charging line; see Chapter 3 - "Cooler" for details. To use the purge for this purpose, proceed as outlined above under "Leak Testing", items 1 through 9. A pressure of 5 lb should be sufficient for removal of refrigerant. Excessive pressure will cause excessive loss by evaporation due to turbulence in the drum.

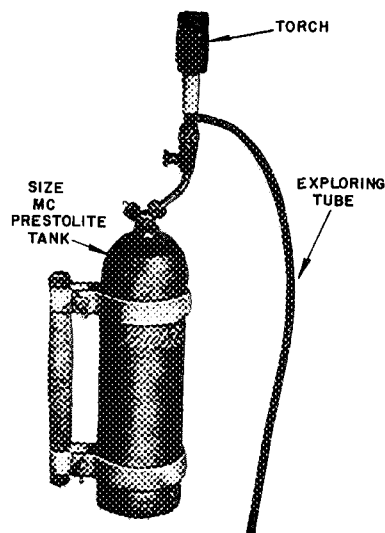


FIG. 5-7 - Leak Detector



OPERATION AND MAINTENANCE PURGE RECOVERY SYSTEM

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MAINTENANCE

INTRODUCTION

The purge recovery unit is the scavenger for the centrifugal machine. In performing its job of protecting the machine, (by removing noncondensable gases, air and water vapor) it handles corrosive mixtures which are at their highest concentration as they are purged. It is important, therefore, that the purge be kept in good repair as repairs to the purge are much more economical than repairs to the major parts of the machine, which might result from inadequate purging.

TABLE 5-1 - VALVE SETTINGS

Room Air Temperature	65	75	85	95	105
Suction Pressure (Maximum allowable) By Adjustment of Valve 2	20" Vac.	18" Vac.	15" Vac.	11" Vac.	7" Vac.
Relief Pressure - By Adjustment of Valve 21	30-35#	35-40	40-45	50-55	60-65

PRESSURE REDUCING VALVE:

Proper settings for the pressure reducing valve are shown in Table 5-1. This valve prevents overload of the purge compressor and damage to the compressor from liquid refrigerant which may condense in the suction line.

This latter purpose is the reason the setting is governed by room temperature as shown in Table 5-1.

To set the valve, operate the centrifugal compressor and have the condenser pressure above the desired valve setting. Remove the knurled cap from the valve and turn the adjusting screw. Observe the purge suction gauge while adjusting the valve. Clockwise adjustment will raise the suction pressure and counter clockwise will lower it.

RELIEF VALVE:

The relief valve setting is also governed by the room temperature. See Table 5-1, Page 5-9. The pressure in the purge condenser and the temperature of the room air being blown over the condenser determine how much refrigerant will be condensed from the air being purged. If the room temperature is high the relief pressure must be high to maintain good recovery of refrigerant.



To set the relief valve, loosen the flare cap at tee (9) and admit some air to the compressor. Remove the adjusting screw cover and turn the screw until the valve just starts to discharge when the desired setting shows on the purge discharge gauge. Turning the adjusting screw clockwise will raise the relief pressure. Counter clockwise will lower it. Be sure to retighten the flare nut at tee (9).

Once the purge has handled air the discharge pressure will tend to stay up near the relief valve setting. After repairing the leak, this pressure should be reduced by opening the water drain valve (23) momentarily. It will then be possible to tell when additional air enters the machine as the pressure will again rise to the relief point.

COMPRESSOR LUBRICATION

The same oil as used in the centrifugal compressor can be used in the purge compressor.

If the oil level shows anywhere in the bull's-eye (7), the compressor will have adequate lubrication.

Oil should be changed at least once a year.

To add oil to the compressor, the crankcase must be under vacuum. Valve (8) is equipped with an oil filling line. Hold a container of oil in position so the oil filling line will extend down into the oil. Open the valve and oil will be drawn into the crankcase.

To remove oil from the purge compressor:

1. Stop compressor.
2. Close valve (3) marked "From condenser."
3. Remove flare cap from tee (9). This will admit air to the suction side of the compressor and bring the crankcase pressure up to atmospheric.
4. Open valve (8) and drain oil into container.

MOTOR LUBRICATION:

The purge motor has sleeve type bearings. Several drops of oil should be added to the oil cup at each bearing approximately once a month. Do not over lubricate, as oil may get into the motor windings.

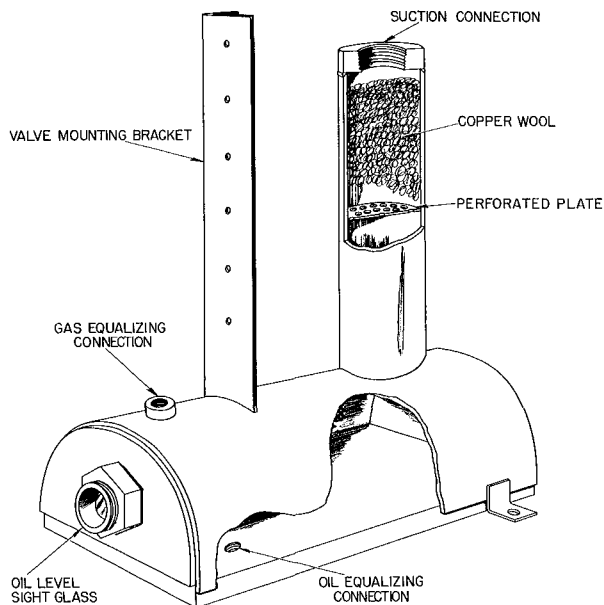


FIG. 5-8 - Purge Oil Reservoir

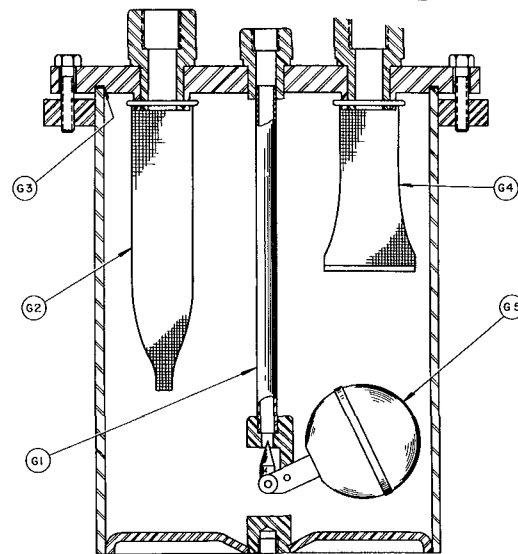


FIG. 5-8A - Cross Section Oil Separator

- G1 - Oil Return Pipe
- G2 - Inlet Screen
- *G3 - Cover Gasket
- G4 - Outlet Screen
- *G5 - Float Valve
- * Recommended Spares

FLOAT VALVE

If the purge float valve should stick open or permit refrigerant to leak by, the purge discharge pressure would drop and gas pumped by the compressor would go directly to the cooler and air or water vapor would not be removed.

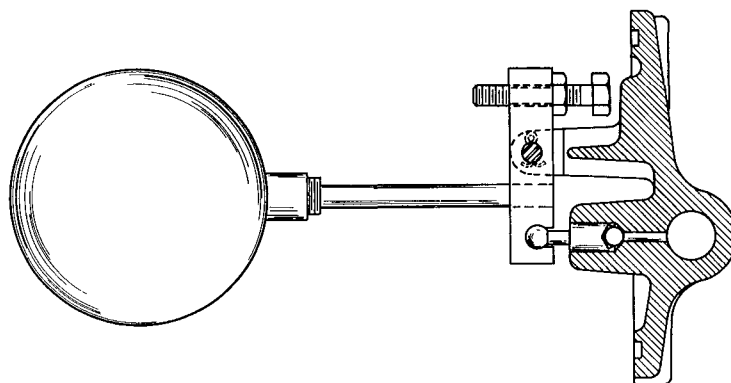


FIG. 5-9 - PURGE FLOAT VALVE

If the float valve should stick closed, the refrigerant level would rise and fill the lower bulls-eye. If permitted to operate long in this condition, the refrigerant level would eventually fill the complete separation chamber and liquid refrigerant would be forced out the relief valve. If this should happen, check refrigerant return valves (22) and (26) and be sure they are open.



To adjust the normal refrigerant level maintained by the float valve it is necessary to bend the float valve stem. If the level is maintained anywhere in the lower bulls-eye where it can be observed, it is satisfactory.

The float valve is easily accessible by removing the side cover plate (38). The float is attached to the plate.

To salvage any refrigerant which may be in the lower bulls-eye, prior to removing the float valve cover proceed as follows:

1. Open valve (23) and blow out any water which may show in the top bulls-eye. Then close this valve.
2. Close "Refrigerant Return" valve (22).
3. Close valve (26) at cooler.
4. Close valve (3) "From Condenser".
5. Install air line (24) between discharge of "Water Drain" valve (23) and tee (25).
6. Open "Water Drain" valve (23).
7. Open valve (26) at cooler. This will subject the separation chamber to the cooler pressure and, assuming the cooler pressure is below the pressure corresponding to the room temperature, refrigerant in the chamber will be boiled by room temperature and the gas formed will flow to the cooler. This will take a while, depending upon the difference in temperatures.

It may be desirable to waste this small amount of refrigerant if repairs are to be made quickly.

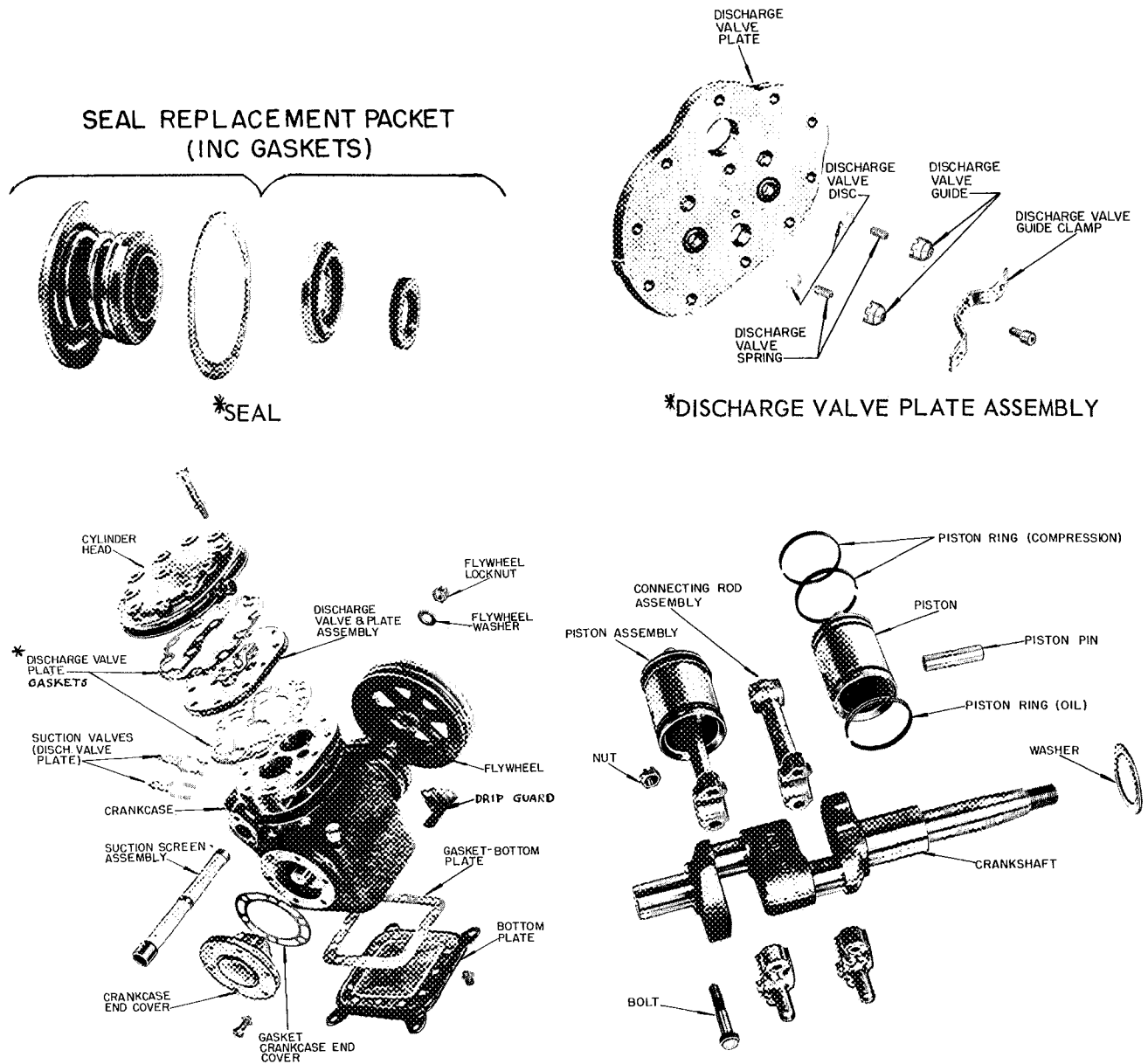


FIG. 5-10 - PURGE COMPRESSOR PARTS

*RECOMMENDED SPARES

NOTE: The recommended spares are for emergency repairs only. If the compressor has badly worn rings, cylinder walls, crank shaft bearings, journal bearings, etc., it is best to obtain a factory exchange compressor which will be covered by a full year warranty.



OPERATION AND MAINTENANCE CONTROLS

19C

19C HERMETIC CENTRIFUGAL REFRIGERATING MACHINE

CHAPTER 6 - CONTROLS AND ELECTRICAL WIRING

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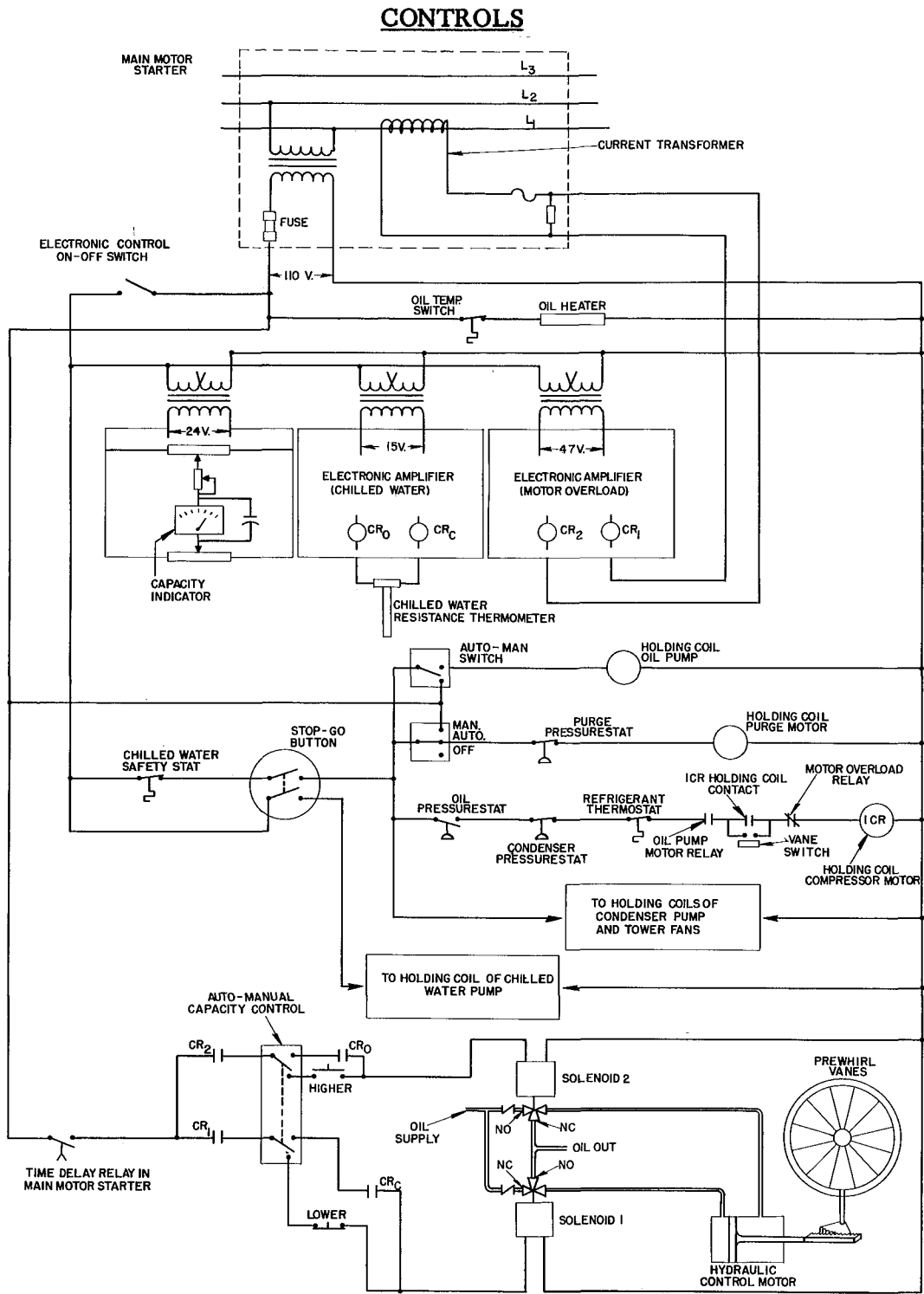


FIG. 6-1 - Control Diagram



GENERAL DESCRIPTION

The control system consists of two controllers, one for chilled water temperature and the other for motor overload, which position the prewhirl vanes through a hydraulic motor. Under normal conditions the cooler leaving water temperature is controlled by the chilled water temperature controller. A resistance element immersed in the chilled water reacts to temperature leaving the cooler. The element is part of a bridge circuit from which signals are strengthened by an electronic amplifier which in turn activates relays. The relays open and close solenoid valves which feed or bleed oil to the hydraulic prewhirl vane motor. When the temperature of the water leaving the cooler increases, the vanes will move toward the "open" position. A decrease in temperature results in a movement toward the closed position.

Motor overload is detected by a current transformer and resistor in the starter. An increase in current flow causes a change in voltage drop across the resistor. The change in voltage is amplified sufficiently to activate relays. The relays can interrupt the circuit ahead of the chilled water control relays and prevent the vanes from opening further or cause them to close.

The console panel includes push button switches for manual operation of the prewhirl vanes, a remote prewhirl vane position indicator, and "safe" lights which indicate the cause of a safety shutdown. A prewhirl vane switch together with an interlocking circuit insures the prewhirl vanes being closed before the compressor motor will start. A time delay relay prevents the prewhirl vanes from opening until the motor attains full speed.

The solenoid valves controlling the hydraulic motor are so arranged that when de-energized they will provide oil pressure to one side of the piston and bleed the other side, closing the vanes. This assures closed vanes in the event of control failure.

The panel on-off switch should be turned on at the beginning of the cooling season and left on until the cooling season is over. To start up the system after the power has been interrupted or if the panel on-off switch has been off, first turn on the panel switch. Next, reset the refrigerant temperature, and condenser pressure reset buttons on the junction module, see Fig. 6-7. This will light the corresponding lights on the console panel. See Fig. 6-4.



For a normal start-up during the cooling season, if the electronic panel switch has been left on, and all "safe" lights (except oil pressure light) on the console panel are lit, it is merely necessary to push the stop-go button. The oil pump will start immediately, oil pressure will build up and close the oil pressure switch and light the oil pressure safety light on the console panel. If auxiliary equipment (such as chilled water and condenser water pumps) is wired into the circuit for full automatic operation, there will be a time delay of approximately 60 seconds to permit these motors to come up to speed before the time delay relay closes and energizes holding coil 1CR in the compressor motor starter.

When holding coil 1CR is energized it closes contact 1CR in the starter and starts the compressor motor. At the same time it also closes another contact 1CR to bypass the vane closed switch.

A time delay relay, set for approximately 90 seconds, permits the compressor motor to come up to speed before the prewhirl vanes start opening.

CHILLED WATER TEMPERATURE CONTROL OPERATION

With the compressor running and the start-up sequence completed as described in preceding paragraphs, the chilled water is controlled by sensing the leaving water temperature with a resistance element. A rise in temperature sends a signal through the chilled water amplifier to position the prewhirl vanes towards open. The chilled water resistance element is part of a bridge circuit and any unbalance in the bridge (caused by a resistance change due to temperature change) is detected by the amplifier. If the water temperature is within $-1/2^{\circ}\text{F}$ of the set point, relay contact CR_C will be closed and relay CR_O will be open. Under this condition, with one 3-way valve energized and the other de-energized, both sides of the hydraulic piston are subjected to oil pressure which keeps the piston in a fixed position. If the water temperature rises above the set point, relay CR_O pulls in and closes solenoid 2 permitting oil to bleed from one side of the piston while pressure on the other side forces the piston open until a new temperature equilibrium position is reached. Relay CR_O will then open, de-energizing solenoid 2 which will open, and pass oil pressure to the hydraulic motor counteracting the oil pressure from solenoid 1. The vanes will then stop in whatever position they happen to be in. A similar action takes place if the water temperature drops below the set point. Relay CR_C will open causing solenoid valve 1 to bleed oil from the hydraulic motor. This allows the oil pressure from solenoid 2 to slowly close the prewhirl vanes until a new temperature equilibrium position is reached.

MOTOR OVERLOAD CONTROL

Motor overload is detected by a current transformer and resistor in the starter. An increase in current flow causes a change in voltage drop across the resistor. The magnitude of change is increased by the electronic amplifier. If the current flow reaches 100% of full motor rating, relay CR2 will open and prevent the vanes from opening further. If the current continues to increase and reaches approximately 104% of full motor rating, relay CR1 will open and cause the vanes to close, reducing the load until the current is down to approximately 103%. Relay CR1 will then close causing the vanes to stop moving. When the current flow drops below 97%, relay CR2 will close and the chilled water control will actuate the prewhirl vanes.

RECYCLE CONTROL

A thermostat with its thermal bulb in the leaving water pass of the cooler acts as a recycle control and low water safety thermostat. If the chilled water temperature drops approximately 5° below the normal set point, the thermostat will open and shut down the compressor motor. The chilled water pump will continue to run and when the temperature of the water rises approximately 15° the thermostat will close and restart the compressor motor.

CAPACITY INDICATOR

A graduated dial on the console panel indicates the proportion of full load capacity at which the machine is operating. This indicator is electrically connected to a variable resistance attached to one of the suction vane arms. Thus the amount of the vane opening is shown by the position of the needle on the dial, marked as the amount of capacity to be expected.

CHILLED WATER THERMOSTAT

A potentiometer with its adjusting knob located on the panel of the console is electrically connected to the chilled water control. It permits variation in the operating temperature of the machine. One division on the dial equals approximately one degree Fahrenheit. When installed, the thermostat is calibrated so the pointer will be approximately at the center of the dial when set for design chilled water temperature. This permits manual adjustment for warmer or colder water.



AUTOMATIC-MANUAL CAPACITY CONTROL

A switch on the console panel allows the operator to put the machine on "thermostatic" or "manual" control. When on "manual" the capacity is controlled through use of the "Higher" and "Lower" (capacity) push buttons. The vanes will move only when one of the buttons is pushed or if the motor overload control closes them. The motor overload control can override the manual signals at any time to prevent overloading the motor.

ELECTRONIC CONTROL ON-OFF

This control switch provides electricity to the modules, and compressor start circuit. The switch is normally left "on" for the operating season so the electronic components are not subjected to alternate cooling and heating stresses.

VANE SWITCH

A switch attached to one of the vane arms is wired into the compressor starter circuit so the circuit can only be completed when the vanes are closed. During operation the switch is bypassed by an auxiliary contact so the vane position may be modulated as necessary. This switch prevents overloading the motor by starting the machine with open prewhirl vanes.

OIL PRESSURESTAT

A differential pressure switch is provided to sense the amount of oil pressure available. The switch closes automatically when the oil pressure builds up to the set point (approximately 12 psi above the oil reservoir pressure) and allows the compressor start circuit to be completed. If the pressure drops to approximately 8 lbs. the switch opens, shutting off the compressor motor. Additional safety is provided by running the compressor motor start circuit through a holding coil in the oil pump starter so the circuit will be open whenever the oil pump is shut down.

CONDENSER SAFETY PRESSURESTAT

A high-limit pressure switch is arranged to interrupt the compressor circuit in the event of high condenser pressure (10 psig.) This switch controls a relay which must be manually reset at the junction module whenever it is tripped, but before resetting, the condition causing the high pressure should be corrected (see condenser Chapter 4).



REFRIGERANT SAFETY THERMOSTAT

A lo-limit temperature switch has its bulb located in the expansion chamber adjacent to the economizer where it can sense the cooler refrigerant temperature. If the refrigerant goes below the set temperature the switch actuates a relay in the compressor start circuit to shut down the compressor. A manual reset at the junction module is provided so the condition causing the shutdown may be corrected before the compressor is restarted. (See Cooler Chapter 3.)

LOW VOLTAGE RESET

An additional potential coil is located in the motor starter to furnish protection from low voltage. If the voltage drops over 10% below standard the coil will drop out a contact in the compressor circuit and stop the motor. Manual reset is required for this safety so that any necessary correction may be made. If this coil drops out many times it is an indication that present circuits are overloaded. (Not shown on drawing).

STOP-GO BUTTON

This button is for starting and stopping the machine. It consists of a double pole switch which stops the machine and lights a red light when pushed off. When pushed on, it starts the machine and lights a green light.

DESCRIPTION OF THE CONSOLE

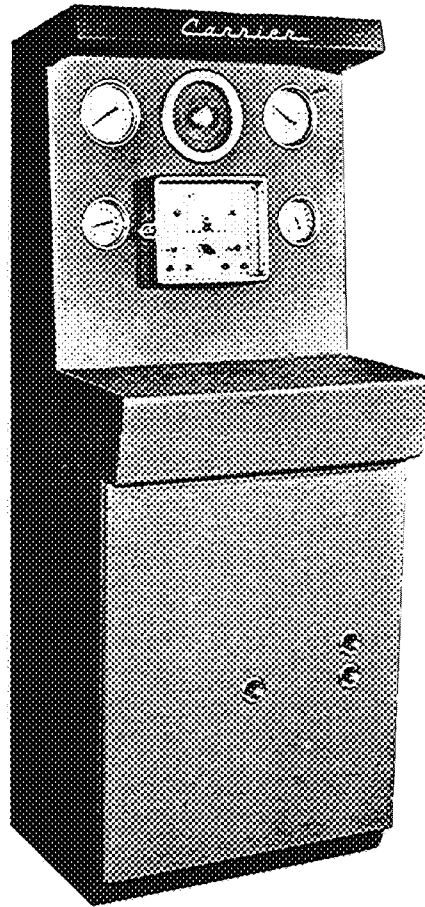


FIG. 6-2 - Typical Control Console

The console houses the main operating controls of the machine. The lower portion of the console also contains the purge machinery.

The upper exposed panel includes the Cooler and Condenser pressure gauges, and Purge Suction and Discharge pressure gauges. The Stop-Go button and the electronic control operating sub-panel with its safety lights are also located on the upper panel.

The central console section with lift up door contains the electronic controls and electrical connections. This includes the chilled water control, the motor overload control, the electrical junctions, and the manual re-set buttons.

The lower section, in addition to the purge, has the oil pump and purge manual - automatic switches.

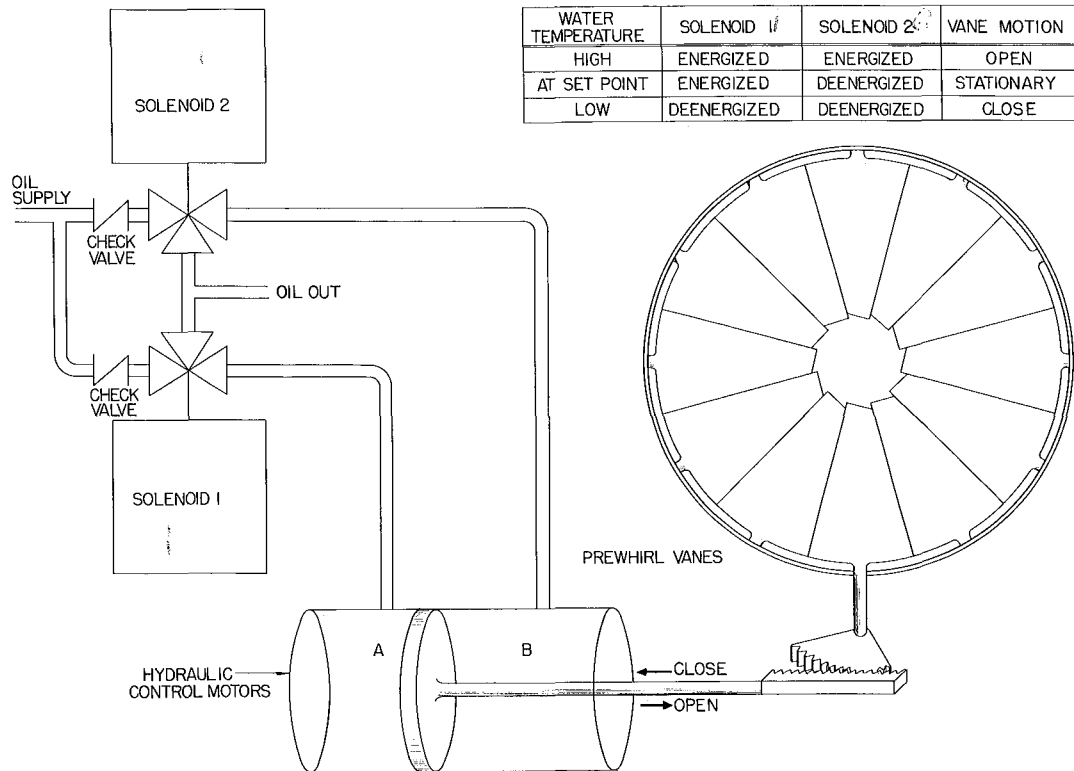


FIG. 6-3 - Vane Operator (Schematic)

The Vane operating mechanism positions the prewhirl vanes as directed by the electronic control. The prewhirl vanes vary the capacity of the machine by controlling the volume and direction of the flow of suction gas to the compressor.

The 16 prewhirl vanes are linked together by a cable and pulley system which is driven through a rack and gear segment by a hydraulic cylinder. The hydraulic cylinder may be opened, held stationary or closed by oil pressure transmitted through the two solenoid valves. The three-way solenoid valves are connected to opposite ends of the cylinder and to both the oil pressure and drain lines.

To open the cylinder both valves are energized. This allows oil pressure through valve 1 and drains through valve 2, forcing the piston open. The cylinder may be held indefinitely at any position by energizing only valve 1. Pressure is then supplied to both sides of the cylinder. The check valves prevent any pressure difference from moving the piston. When both valves are de-energized the oil bleeds through valve 1 and pressure is supplied through 2. Thus, the vanes close when the system is de-energized, making it a "fail safe" arrangement.

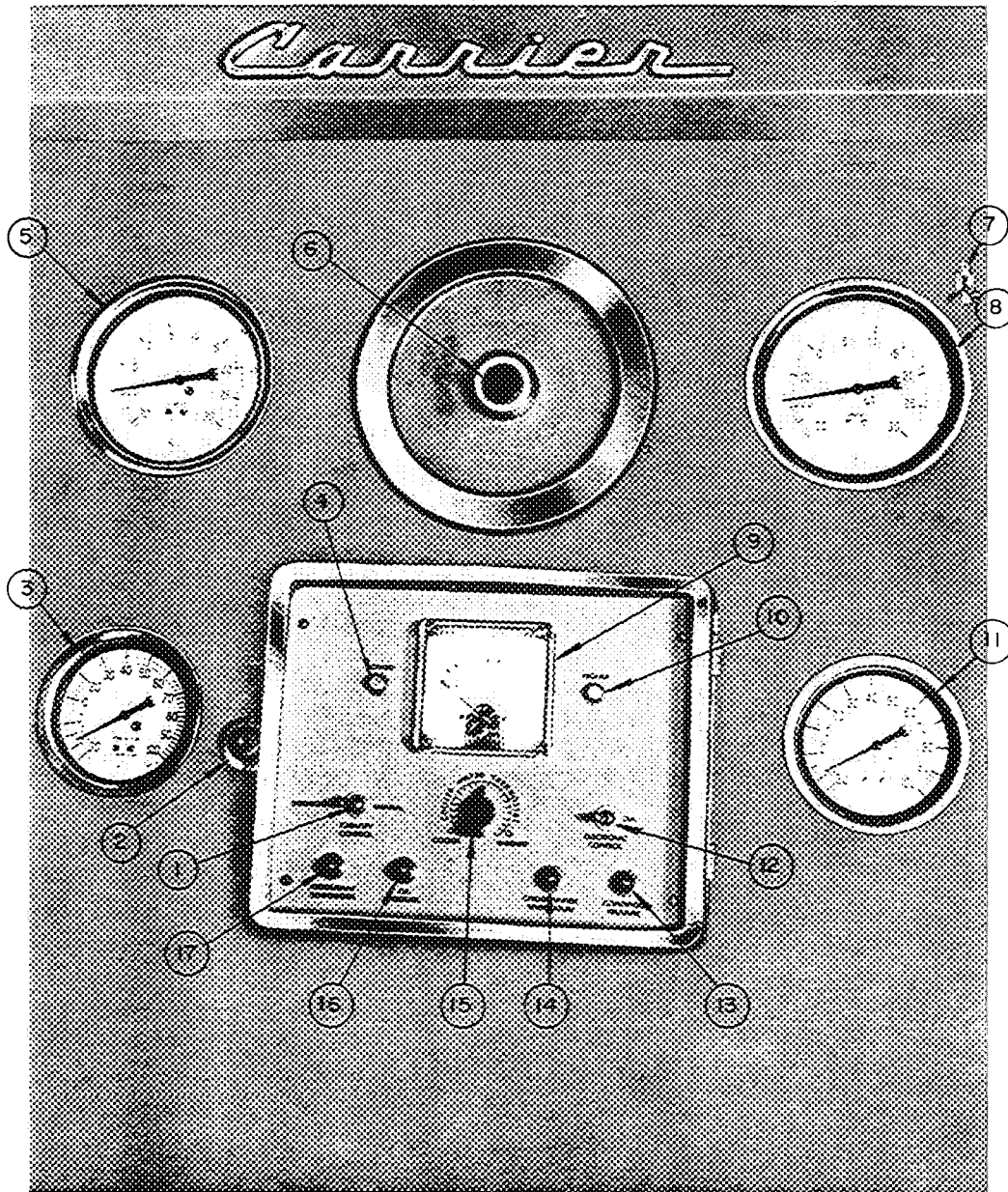


Fig. 6-4 - Console Panel

- | | |
|--|--|
| 1. Capacity Control "Thermostatic" "Manual" Switch | 10. Push Button - "Higher" Capacity |
| 2. Lock | 11. Purge Discharge Pressure Gauge |
| 3. Purge Suction Pressure Gauge | 12. "Electronic Control" "On-Off" Switch |
| 4. Push Button - "Lower" Capacity | 13. "Condenser Pressure" Safety Light |
| 5. Cooler Pressure Gauge | 14. "Chilled Water Temperature" Safety Light |
| 6. Stop-Go Button | 15. "Chilled Water Thermostat" |
| 7. Panel Light Switch | 16. "Oil Pressure" Safety Light |
| 8. Condenser Pressure Gauge | 17. "Refrigerant Temperature" Safety Light |
| 9. Capacity Indicator | |

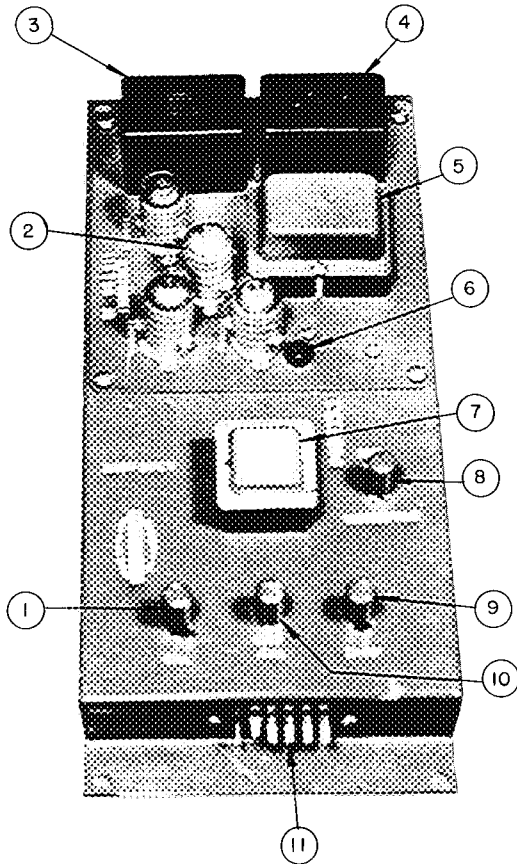


FIG. 6-5 - Electronic Module -
Chilled Water

1. Calibration Adjustment Screw.
Set by Installing Engineer.
Do Not Reset.
2. Vacuum Tubes
3. Relay CRc
4. Relay CRo
5. Amplifier Transformer
6. Test Jack
7. Bridge Transformer
8. Throttle Adjustment Screw.
(Factory Adjusted - Do Not Reset.)
9. "Differential" Adjustment Screw.
(Factory Adjusted - Do Not Reset.)
10. Capacity Balance Adjustment Screw.
Set by Installing Engineer - Do Not
Reset.
11. Plug In Terminals

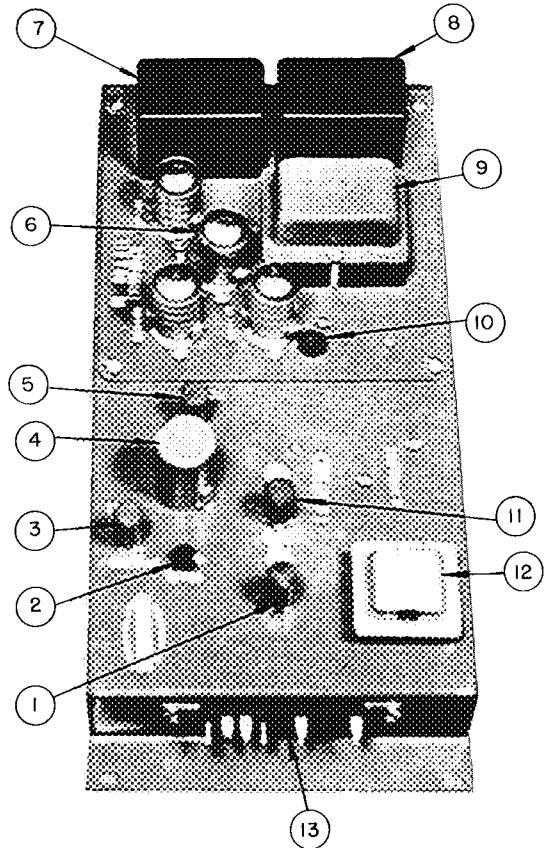
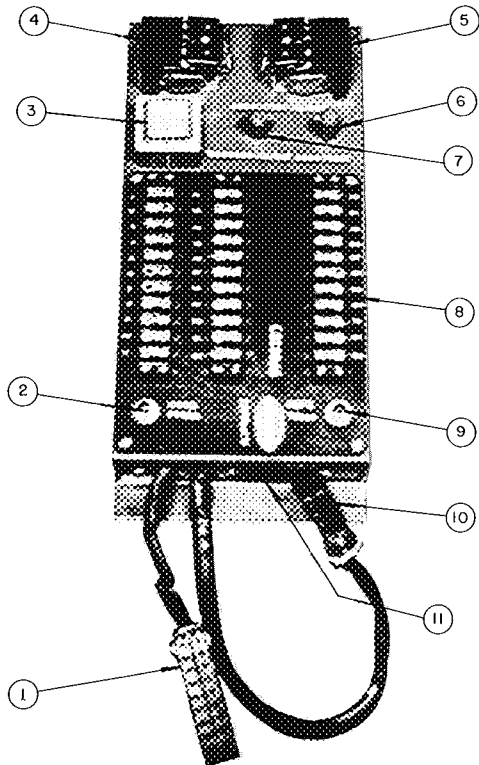


FIG. 6-6 - Electronic Module -
Motor Overload

1. Adjustment Screw
Factory Set - Do Not Reset
2. Transistor
3. Differential Adjustment Screw No. 2
Factory Set - Do Not Reset
4. Transistor Power Supply
5. Differential Adjustment Screw No. 1
Factory Set - Do Not Reset
6. Vacuum Tubes
7. Relay CR2
8. Relay CR1
9. Transformer
10. Test Jack
11. Calibration Adjustment Screw
Set by Installation Engineer -
Do Not Reset
12. Transformer
13. Terminal Connector.



1. Terminal Connector (To Motor Module)
2. Reset Button - Condenser Pressure Safety Cutout
3. Transformer
4. Condenser Pressure Safety Cutout Relay
5. Refrigerant Safety Cutout Relay
6. "Span" Adjustment Screw. Set by Installing Engineer - Do Not Reset.
7. "Zero" Adjustment Screw. Set by Installing Engineer - Do Not Reset.
8. Terminals
9. Reset Button - Refrigerant Safety Cutout.
10. Terminal Connector - To Chilled Water Module.
11. Terminal Connector - To Console Sub Panel.

FIG. 6-7 - Junction Module

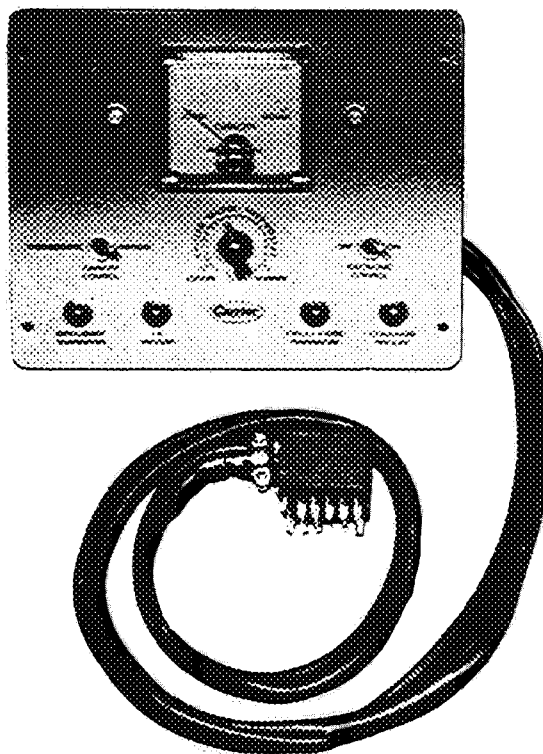


FIG. 6-8 - Sub Panel Console
(NOTE: Also See Fig. 6-4.)

WIRING

STARTERS

Function The function of a motor starter is to complete the electrical connection between the supply line and the motor (load). Due to the fact that electrical motors on startup draw much more than normal amounts of current, it is usually necessary to utilize a type of starter which limits the starting current in some manner. If this is not done, other circuits in the building may be affected.

ACROSS-THE-LINE STARTER

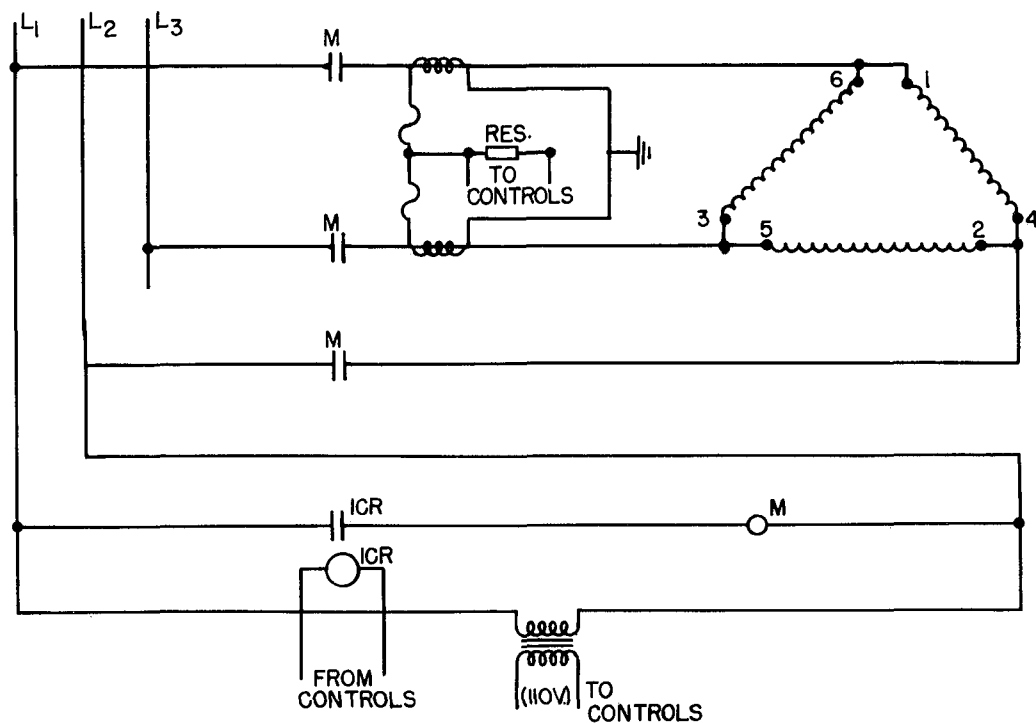


FIG. 6-9 - Wiring Diagram - Across-The-Line Starter

Principle An across-the-line starter is the most simple and economical to use where high starting current is allowable. It consists of a single set of connectors which operate to put full line voltage across the regular motor windings when a starting signal is given.

Operation The contacts ICR are first closed when the electronic control starting circuit is completed through the #1 control relay. This energizes coil M so that the M contactors are pulled in. The M contactors allow full voltage across the motor windings immediately.

TWO-STEP PRIMARY RESISTOR STARTER

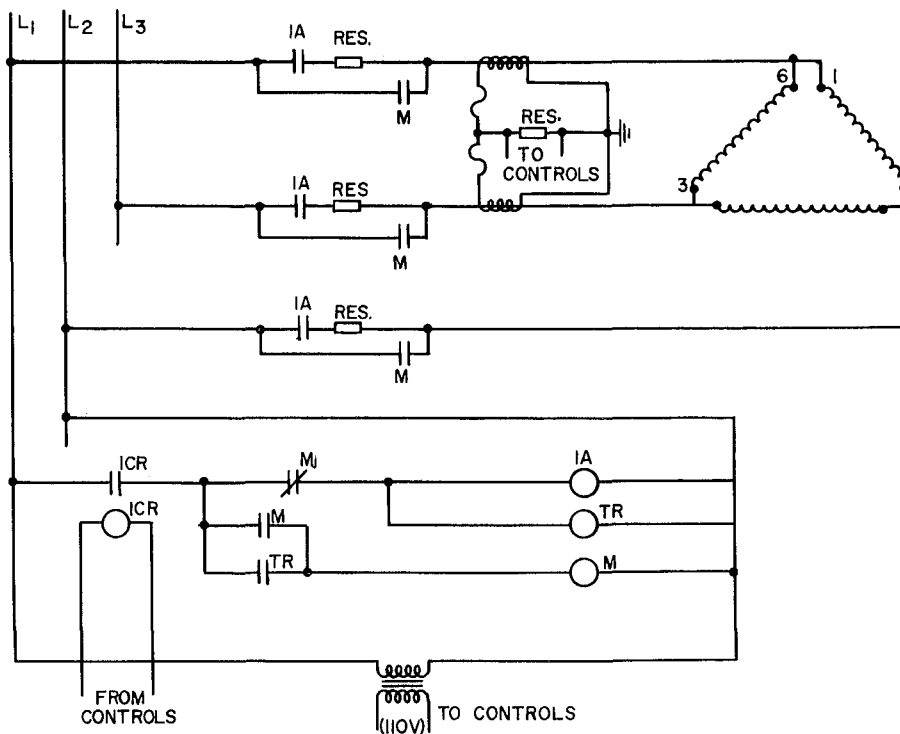


FIG. 6-10 - Wiring Diagram - Two-Step Primary Resistor Starter

Principle This type starter limits the starting current by inserting extra resistance in series with the motor winding during the acceleration period.

Operation Completion of the electronic control starting sequence will energize number one control relay and pull in ICR contacts. This energizes coil 1A, which pulls in contacts 1A and forms a connection from the line to the motor windings through the resistors. The completed line allows limited current to pass through the resistors to start the motor. The ICR closing also energizes the Time Delay Relay coil TR. After a suitable time delay the coil TR pulls in contact TR. This allows the energizing of coil M, which pulls in the main contactors, M, bypassing the resistors and allowing full current to go to the motor.

STAR-DELTA STARTER (Closed Transition)

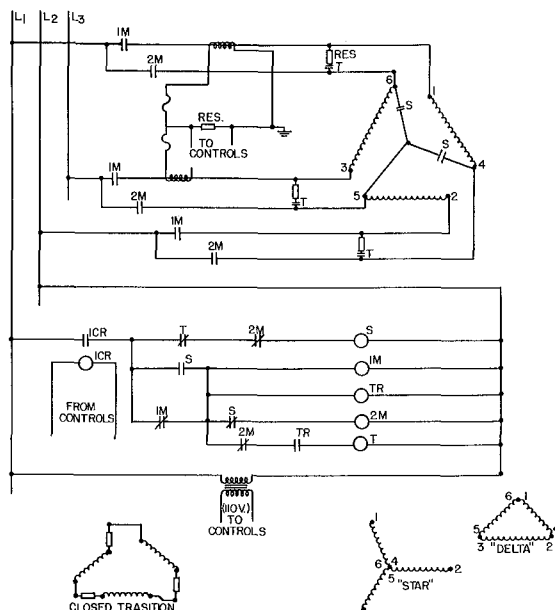


FIG. 6-12 - Wiring Diagram - Star-Delta Starter (Closed Transition)

Principle The star-delta starter with closed transition is used when reduced current starting is required and open transition is not permitted. A closed transition inserts an additional set of resistors in series with the windings for the period of change-over from star to delta. This smooths out the current flow during the transition.

Operation Completion of the electronic control starting sequence will energize ICR control relay and pull in ICR contacts. This energizes relay S, which pulls in the main contacts to form the center of the star circuit. Auxiliary S contacts energize coils 1M and TR and open the circuit to coil 2M. Coil 1M pulls in main contacts which supply line voltage to one side of each motor winding. This completes the star circuit so the motor starts in star with low current. The Time Delay Relay TR, although energized at the same time as 1M, waits a set time period, about 90 seconds, before pulling in the TR contacts. This wait allows the motor to get up to speed so that the planned shift to delta does not draw excess current. The closing of the TR contact energizes the T coil. The closing of the T contacts in each of the three motor circuits connects the windings in a modified delta with an extra resistance in series. At the same time the normally closed T contact opens and de-energizes the S coil. This opens the S contacts, removing the star connection, within a few cycles after the T contacts make the modified delta. The extra series resistance prevents extreme surges of current during the fraction of a second that both connections are made. The normally closed S contact drops in also, so that coil 2M is energized. The 2M contacts then close, bypass the resistors, and connect the second side of the motor directly to alternate power lines, thereby forming the complete delta or operating circuit.



MAINTENANCE

CONTROLS

Electronic Modules Operator maintenance of the electronic modules is limited to tube replacement, connection-tightening, and general cleaning.

Tubes should be replaced yearly at the spring start-up to insure uninterrupted operation during the cooling season. There are only two types of tubes. However, when replacing, each tube should be removed, checked for number, and replaced with a new tube of like number, before the next tube is removed. This will prevent mixup. If at any time during the year trouble develops and it is noticed that a tube is not warm, it should be replaced. However, this should not be necessary if the tubes are replaced yearly.

It is important that the control compartment be kept clean and free of dust. The control relays in the rear of each module may not operate properly if they become dusty so they deserve special attention. Vacuum the whole compartment each spring and more often if necessary.

All electrical connections should be tight when the machine is installed and should remain so. If any loose screw or plug connectors are noted, they should be tightened as soon as the electricity is off. Remember the electronic control switch isolates the control modules only, and leaves electricity in the junction module. Control modules can be easily replaced just by plugging in a new one. However, if the trouble appears to be in the module and new tubes do not correct it a Carrier Service Engineer should be called to inspect and correct the condition.

Safety Instruments All safety instruments must have yearly checks of setting and operation. Instructions for adjustments can be found inside the instrument cases.

Oil Pressurestat The normal setting of the oil pressurestat allows the switch to close at approximately 12 psi differential and open at approximately 8 psi differential.

The stat should be checked with the compressor off and oil pump running. Check the difference between the cooler pressure gauge and the oil pressure gauge. The cooler pressure gauge reads inches of mercury vacuum. To get the approximate reading of 8 or 12 psi mentioned above, multiply the inches of vacuum by .489 to convert to psi and add the result to the positive oil pressure shown on the gauge.



The oil pressurestat and the oil pressure regulator are both located behind the rear cover under the compressor motor. (See Compressor Chapter). Regulate the oil pressure and check the drop out and pull in points of the oil pressure switch. These should be adjusted at the oil pressurestat if not set correctly.

Refrigerant Safety Thermostat The refrigerant low temperature cut out may be checked in two ways. The simplest is to remove the bulb from the economizer well and place it in a cool bath equipped with an accurate glass thermometer. Gradually add ice to bring the temperature down to 34°F, at which point the switch should open.

A more positive check is achieved by running the compressor on manual with a low load so that the chilled water temperature goes down. This requires placing an accurate glass thermometer in the well provided near the refrigerant bulb well. Block the chilled water control closed so that the low temperature may be reached. It is important that both the refrigerant and chilled water temperatures be watched carefully so that neither reaches 32°F or lower at any time.

Chilled Water Recycle & Safety Control The chilled water recycle and safety control should cut out at approximately 5°F below the normal operating temperature (design point) or at 36°F, whichever is higher. This control may be checked using either of the methods listed under refrigerant temperature control. Particular care must be given to temperatures while this is done to avoid any danger of freeze-up. It is important that this instrument cut out ahead of the refrigerant safety thermostat, otherwise the machine will not recycle.

Condenser Pressurestat The condenser high pressure cut-out may be checked by running the machine and shutting off the condenser water pump to build up the head pressure. The pressurestat should be set to shut the machine down when the condenser pressure reaches 10 psig.

Another method is to disconnect the pressurestat and apply an external source of adjustable pressure. The purge compressor can be used for this purpose but care must be taken to prevent air entering the machine and to avoid excess pressure which may rupture the pressurestat bellows.



STARTERS

Open the isolating switch ahead of the starter before attempting any maintenance.

On all contacts the air gap surfaces should be cleaned and the movable armature bearing should be oiled before initial operation and periodically as found necessary thereafter. Rust, corrosion, dirt, etc. may collect during prolonged shutdown or while operating, due to moisture, fumes or dust and prevent proper release.

Air breakers should need no attention for the first few years except a light oil bearing lubrication. Oil breakers should have tank lowered - contacts checked and oil renewed at beginning of each season or once a year.

All main current connections of solderless type such as clamp lugs should be tightened every six months. Keep all parts free of excessive dirt or dust.

Recommended Spares

For Controls:

- 2 - Green Light Bulbs for Stop-Go Button
- 2 - Red Light Bulbs for Stop-Go Button
- 4 - Neon Lights for Safety Controls
- 4 - Vacuum Tubes - 12AX7
- 4 - Vacuum Tubes - 12AV7

For Starters:

Starters vary according to the electrical requirements for each job. Supplies and spares should be considered with other electrical supplies for the plant.



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REFRIGERATING MACHINE

CHAPTER 7 - OPERATION

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GENERAL

1. The "Electronic Control" switch should be left "On" during the cooling season.
2. The purge switch should normally be in the "Automatic" position during the operating season so it will run any time the machine is running.

STARTING

After Extended Shutdown

1. Check compressor oil level.
2. Close main circuit breakers or disconnects.
3. Push low voltage reset button at starter.
4. Place "Electronic Control" switch in "On" position. This switch is on the electronic panel. The Stop-Go button should now turn red and the "Chilled water temperature" safety light should come on.
5. Press "condenser pressure" reset button located on junction module. The "Condenser pressure" safety light should come on.
6. Press "Refrigerant Temperature" reset button located on junction module. The "Refrigerant Temperature" safety light should come on.
7. Open water shut off valve supplying oil cooler.
8. Open all valves in chilled water and condenser water circuits which may have been closed.
The machine can now be started to same as after daily shutdown.

After Daily Shutdown

If the auxiliary equipment such as chilled water pump, condenser water pump and cooling tower fan are not wired into the control console circuit it will be necessary to start these items before starting the compressor.

If auxiliary equipment is wired for fully automatic operation it will only be necessary to press the stop-go button.



OPERATION AND MAINTENANCE OPERATION

19C

19C HERMETIC CENTRIFUGAL

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REFRIGERATING MACHINE

CHAPTER 7 - OPERATION

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GENERAL

1. The "Electronic Control" switch should be left "On" during the cooling season.
2. The purge switch should normally be in the "Automatic" position during the operating season so it will run any time the machine is running.

STARTING

After Extended Shutdown

1. Check compressor oil level.
2. Close main circuit breakers or disconnects.
3. Push low voltage reset button at starter.
4. Place "Electronic Control" switch in "On" position. This switch is on the electronic panel. The Stop-Go button should now turn red and the "Chilled water temperature" safety light should come on.
5. Press "condenser pressure" reset button located on junction module. The "Condenser pressure" safety light should come on.
6. Press "Refrigerant Temperature" reset button located on junction module. The "Refrigerant Temperature" safety light should come on.
7. Open water shut off valve supplying oil cooler.
8. Open all valves in chilled water and condenser water circuits which may have been closed.
The machine can now be started to same as after daily shutdown.

After Daily Shutdown

If the auxiliary equipment such as chilled water pump, condenser water pump and cooling tower fan are not wired into the control console circuit it will be necessary to start these items before starting the compressor.

If auxiliary equipment is wired for fully automatic operation it will only be necessary to press the stop-go button.



The button will immediately change from red "stop" to green "go". The oil pump will start and as soon as pressure is approximately 12 lb the "oil pressure" safety light will come on.

The compressor will then start and come up to speed in one or more steps according to the type starter used.

After the compressor is up to speed the prewhirl vanes will start to open, assuming the "capacity control" is on "thermostatic".

STOPPING

1. Press "stop-go" button.
2. Stop auxiliary equipment if it is not wired into control console circuit for fully automatic operation.

MANUAL OPERATION

The capacity of the machine can be manually controlled by throwing the "capacity control" switch from "thermostatic" to manual and operating the "higher" and "lower" capacity push buttons.

The occasion for this would be:

1. To pull the temperature of the water down below the automatic setting without disturbing the automatic setting.
 - A. To set safety stat cutout points.
 - B. To overcool building prior to anticipated heavy load.
2. To check operation of electronic control by manually pulling temperature off control point and switching back to "thermostatic" to see if it will return to control point.
3. To control capacity of machine in emergency if electronic chilled water module is out of operation.



OPERATOR'S DUTIES

The primary duties of the operator of a typical application are:

1. Start and stop machine as required seasonally, weekly or daily.
2. Maintain complete records of the operating conditions including all temperatures, pressures, and control positions - also refrigerant and oil levels and amount of each added or withdrawn.
3. Inspect and maintain the equipment and furnish the necessary servicing such as lubrication, painting and simple adjustments.
4. Secure equipment during shutdown to prevent damage by freezing or other hazards.

Extended Shutdown

The precautions to be taken during extended shutdown are outlined in the chapter covering each major component of the machine.

Lubrication

The oil level, oil pressure and bearing temperatures should be maintained as outlined in Chapter 2.

Intermediate Season Operation

During intermediate season, or if the machine is operated during winter, the condensing water temperature may drop very low. The piping and controls may be arranged to automatically bypass the cooling tower under this condition. If automatic control is not provided it will be necessary to make manual adjustments to keep the entering condensing water temperature from dropping below 65F. Shutting off the cooling tower fans will help keep the temperature up.



Inspection and Maintenance

The items which are normally inspected and maintained by the operator are shown in the chapter on each major part of the machine.

For thorough inspection and assurance of uninterrupted operation during the cooling season, periodic inspection or a service inspection contract can be obtained from your nearest Carrier Branch office.

Record of Operating Conditions

Temperatures, pressures, etc. are a good indication of the condition of the machine and can be a valuable help to the service engineer. For this reason, and also to encourage the operator to more closely observe actual operating conditions, it is recommended that a log similar to the one shown in Fig. 7-1 be kept.

It is most important that a log of the initial operation be kept. After that if no log is kept the items shown on the log sheet should be observed occasionally, and any sharp changes investigated.

Recommended Spares

The recommended spares for each major part of the machine are listed in each chapter. In addition to these it is recommended that a supply of refrigerant and oil be kept on hand.

