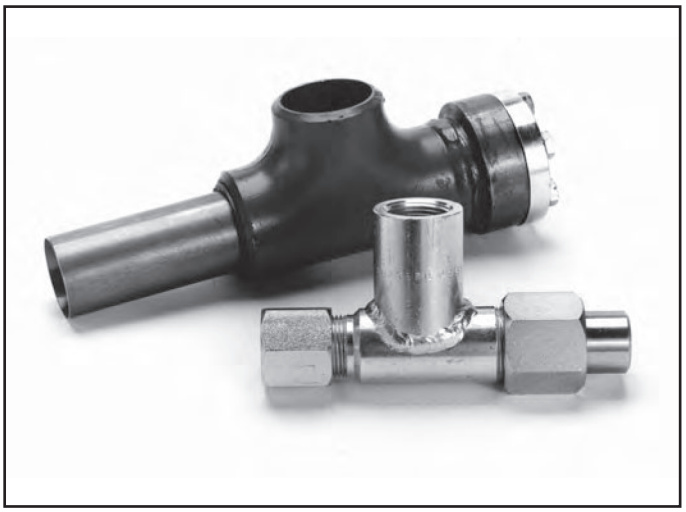
For Ammonia (R717) and Halocarbon Refrigerants

Features

- No Moving Parts
- All Steel Construction
- Brass Construction Available for Halocarbons
- Aids High Efficiency Heat Transfer
- Reduces Refrigerant Charge
- Minimum Maintenance
- Interchangeable Nozzles
- 5TR to 300TR (Ammonia)
- 1TR to 100TR (Halocarbons)
- DWP—400 PSI



Description

The **Phillips®** Recirculating Injector is a simple device that uses the energy of high-pressure refrigerant to get maximum heat transfer in an evaporator.

The usual application is the fixed charge type, that is, a single compressor with a single evaporator. Phillips Recirculating Injectors find their greatest use with ice builders, milk coolers, Baudelot-type chillers, farm tanks, slush freezers, and many types of freezing plates.

Design Function

The "fixed charge" injector system operates with the entire charge of refrigerant in the evaporator and the surge drum. The condenser or receiver is always empty except for the refrigerant being condensed and passing through the liquid line to the evaporator.

The Phillips Recirculating Injector uses the energy of the fluid as it expands through the nozzle and acts like a liquid pump, recirculating the extra liquid from the surge drum through the evaporator and back to the surge drum with the gas evaporated in the tubes or plates.

A liquid indicator should always be installed in the liquid line and will usually show some gas bubbles moving with the liquid during normal operation. The gas in the liquid line indicates that the condenser is empty, as it should be, with the entire charge in the low side. A liquid seal in the liquid line, i.e., no gas and all liquid, indicates trouble such as:

Design Function (continued)

A. A partially or completely plugged injector nozzle orifice.

B. A nozzle orifice that is too small for the refrigeration load.

C. A refrigerant overcharge, which, if appreciable, can cause the liquid seal observed at the liquid indicator.

Selection

The recirculation rate is estimated at 2 times the evaporation rate for the selections shown in the tables. The best results are obtained with appropriate evaporator designs embodying a low-pressure drop.

The effects of an over-sized throat are an increase in the amount of liquid recirculation and a reduction in the injector discharge head. The reverse applies to an under-sized throat.

The effects of an undersized nozzle are an increase in the amount of liquid recirculation and a decrease in the injector discharge energy. Avoid under-sizing the nozzle, as this reduces system capacity, raises the head pressure, and causes loss of oil return.

The return of oil, an integral part of a Phillips Recirculating Injector system, is treated elsewhere in this bulletin. With R22 and R502, an external oil/halocarbon bleed into the suction line is usually required.

Selection (continued)

Single Outlet Injector

1. Choose the mixing tube based on the evaporating temperature, load, and refrigerant.
2. Select the nozzle capacity to handle the load at the lowest condensing temperature and the highest evaporating temperature.
3. Choose the Phillips Injector that incorporates the desired nozzle and throat.

Multiple Outlet Injector

1. Choose a distributor size for each circuit, taking into account the load, suction temperature, refrigerant, and tube length.
2. Select the nozzle capacity to handle the load at the lowest condensing temperature and the highest evaporating temperature.
3. Choose the Phillips Injector that incorporates the desired nozzle and distributor outlets.

Consult the factory for recommendations on special evaporator designs or for other refrigerants.

Instructions for Fixing

(For Halocarbon Refrigerants)

The Phillips Recirculating Injector as applied in its simplest form is a highly efficient recirculating system with no moving parts. The system operates on a fixed or critical charge of refrigerant. Basic elements are a properly designed surge drum, a Phillips Injector selected to suit the application, and a liquid/suction line heat exchanger. An evaporator pressure regulator may also be applied to facilitate oil return. The evaporator design must be such that there is not an excessive pressure drop through its circuits, as the injector will not pump if the pressure drop is too great. One or more Phillips Level Eyes® on the surge drum allows a visual check of the refrigerant level.

Initial Charge

Estimate the initial refrigerant charge at 25% of the coil volume. Charging of the system should be done under normal load until the liquid level in the surge drum is at or between the Level Eyes. Stop charging and let the system operate while checking the compressor discharge temperature and liquid sub-cooling through the heat exchanger.

Final Fixing of Charge

It is important that the final fixing of the refrigerant level be done when the system is running with a normal load on the evaporator. It is most convenient to connect the refrigerant cylinder to a valve on the surge drum so

Instructions for Fixing Charge (continued)

that changes in the liquid level can be observed immediately while charging.

If there is too much refrigerant in the system, some liquid may be carried into the machine. The best indication of this is oil foaming in the crankcase in conjunction with a depression of the temperature of the compressor discharge. Remove refrigerant from the system until the discharge temperature and the liquid level are normal.

Oil Return with Refrigerants 22 & 502

Although Phillips designs the surge drum for some oil/refrigerant pick-up internally, it is essential with the above refrigerants that an external bleed arrangement be provided to ensure oil return to the compressor on a continual basis. The warm liquid from the condenser passing through the heat exchanger on its way to the injector dries out the liquid refrigerant part of the bleed before it enters the compressor. (See typical oil/refrigerant bleed arrangements elsewhere in this bulletin.) A discharge line oil separator is recommended.

Fixing Oil Charge

Oil must be added to the system in the range of one-half to one gallon of oil to each drum of refrigerant (125 lbs. of R22). It may take several days of running time to stabilize the crankcase oil level.

Partial Load Operation

When the refrigeration load is expected to vary greatly and may be at 50% of maximum or less during some periods, it is necessary to add a small downstream regulator. The regulator is needed to keep a certain minimum load on the condensing unit in order to assure oil return.

This regulator will by-pass hot gas either downstream of the injector outlet or into each of multiple injector outlets, such as on vertical plates. The regulator should be set to feed hot gas at about 5 PSIG below the setting of any backpressure regulator in the suction line.

If the condensing unit is equipped with a capacity control, we recommend that the capacity control be set to operate below the full open setting of the downstream regulator or approximately 7 to 10 PSIG below the normal operating suction pressure.

Note: The information given in this bulletin is based on the best data available from the laboratory as well as field tests. However, no warrantee of performance is implied. The best combination of nozzle and throat is most easily determined by operational test of the equipment.

Application Diagrams

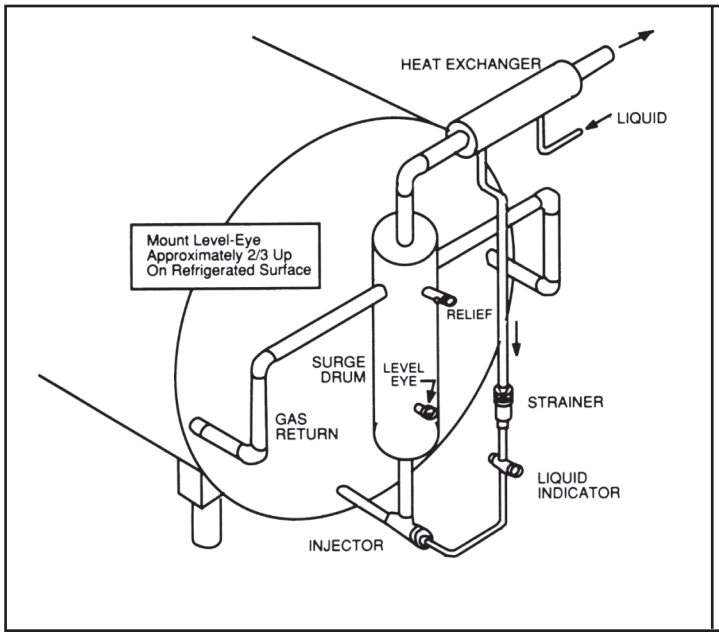


Figure 1: Bulk Tank Fitted with Phillps Recirculating Injectors

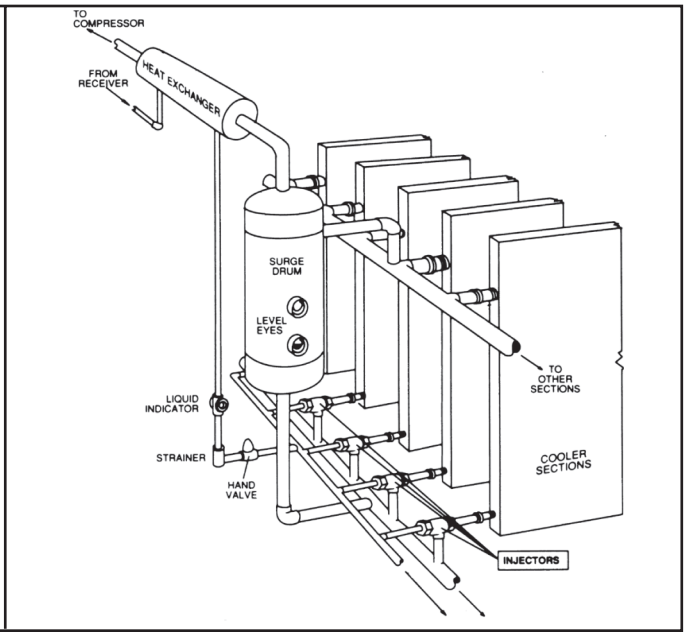


Figure 2: Multiple Chiller Sections fitted with Injectors

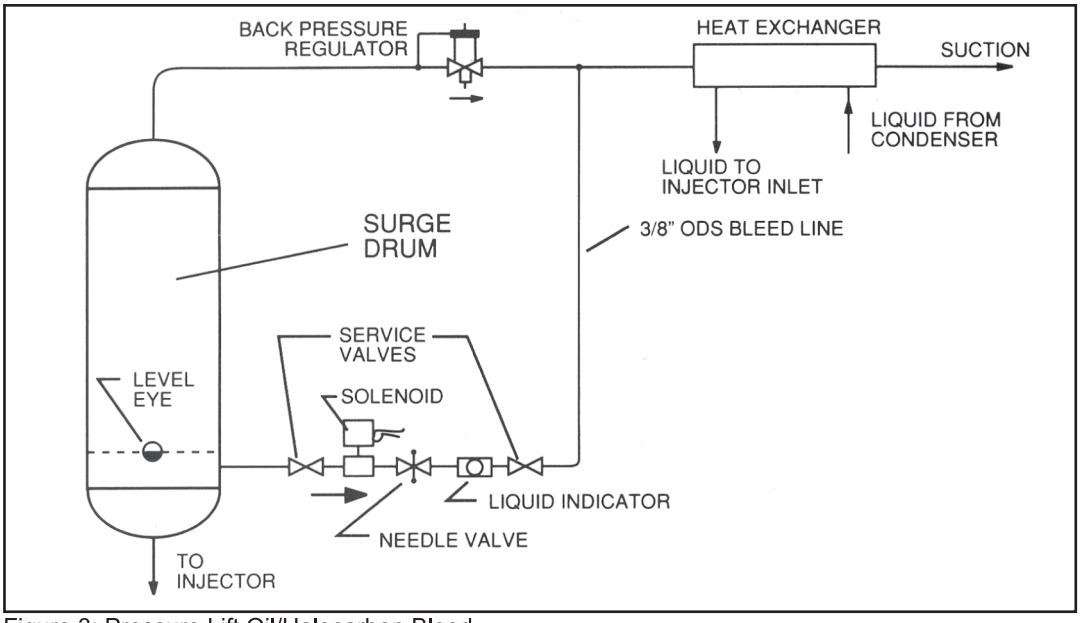


Figure 3: Pressure Lift Oil/Halocarbon Bleed

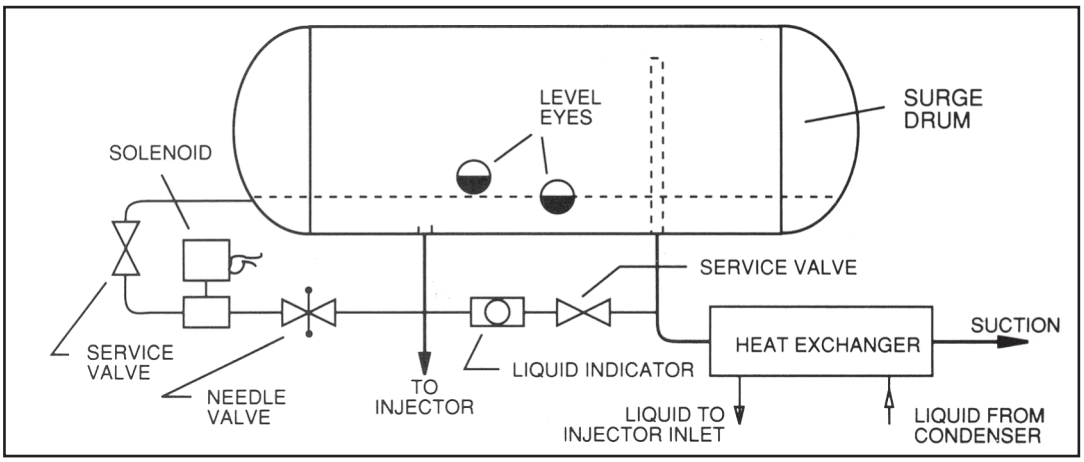


Figure 4: Gravity Flow Oil/Halocarbon Bleed

NOZZLES–HALOCARBONS
NOMINAL TONS AT 95°F CONDENSING, 20°F EVAPORATOR

NOZZLE NO.	56	54	52	50	48	44	40	36	31	29	23	16	7	1
SIZE (IN.)	.047	.055	.064	.070	.076	.086	.098	.107	.120	.136	.154	.177	.201	.228
R22	1.2	1.6	2.2	2.7	3.1	4.0	5.2	6.1	7.8	9.9	12.8	17.0	21.8	28.0
R502	.82	1.1	1.5	1.9	2.2	2.8	3.7	4.3	5.5	7.1	9.0	11.9	15.4	19.8
INJECTOR AVAILABILITY	2020-SL (BRASS) : 2075 WCB (STEEL)													
	2100 WCB & 2100 WCBA (STEEL)													
	//////////						2100 SL (BRASS)							

Note: R12 ratings are approximately 0.57 times R22 ratings.

MULTIPLIERS FOR HALOCARBON NOZZLE CAPACITY

SUCTION TEMP (°F)	CONDENSING TEMPERATURE (°F)											
	70		80		90		95		100		110	
	R22	R502	R22	R502	R22	R502	R22	R502	R22	R502	R22	R502
40	.89	.86	.94	.95	1.00	1.01	1.03	1.03	1.05	1.02	1.09	1.04
20	.87	.85	.93	.92	.97	.99	1.00	1.00	1.02	.99	1.04	1.01
5	.85	.84	.90	.90	.94	.95	.96	.97	.97	.95	1.01	.97
-10	.82	.83	.87	.87	.91	.89	.93	.93	.95	.89	.97	.94
-40	.77	.80	.81	.83	.84	.84	.86	.85	–	–	–	–

MULTI-OUTLET DISTRIBUTOR AVAILABILITY

O.D.C. TUBING	NUMBER OF OUTLETS	
	2020-SLD	2100-SLD
3/16"	5–10	–
1/4"	3–5	–
5/16"	3	–
3/8"	–	4–7
1/2"	–	4–11

SINGLE OUTLET MIXING TUBE (THROAT)–NOMINAL TONS

THROAT		3/16"		1/4"		5/16"		3/8"		1/2"		5/8"		3/4"	
REFRIGERANT		R22	R502	R22	R502	R22	R502	R22	R502	R22	R502	R22	R502	R22	R502
SUCTION TEMPERATURE (°F)	40	2.0	1.8	3.6	3.1	5.7	4.8	8.2	7.0	14.5	12.4	22.6	19.4	32.5	27.8
	30	1.8	1.5	3.1	2.6	4.9	4.1	7.1	5.9	12.6	10.4	19.7	16.4	28.3	23.4
	20	1.5	1.3	2.6	2.2	4.1	3.5	5.9	5.0	10.5	8.9	16.4	13.8	23.7	19.9
	10	1.2	1.1	2.2	1.8	2.4	2.9	4.9	4.1	8.8	7.3	13.7	11.4	19.6	16.4
	0	1.1	.91	1.9	1.6	3.0	2.4	4.3	3.5	7.7	6.2	12.0	9.7	17.3	13.9
	-10	.89	.75	1.6	1.3	2.5	2.0	3.6	2.9	6.4	5.1	9.9	8.0	14.2	11.5
	-20	.76	.62	1.3	1.1	2.1	1.7	3.0	2.4	5.4	4.3	8.4	6.7	12.1	9.5
	-30	.59	.51	1.0	.87	1.6	1.4	2.3	2.0	4.2	3.5	6.5	5.4	9.4	7.8
	-40	.46	.40	.81	.69	1.3	1.1	1.8	1.5	3.2	2.7	5.1	4.3	7.4	6.2
INJECTOR AVAILABILITY		2020-SL, 2075WCB								//////////					
		//////////						2100WCB, 2100WCBA							
		//////////								2100-SL					

Note: R12 ratings are approximately 0.534 times R22 ratings.

DISTRIBUTOR TUBE CAPACITY–NOMINAL TONS (O.D. TUBE)

THROAT		3/16"		1/4"		5/16"		3/8"		1/2"	
REFRIGERANT		R22	R502	R22	R502	R22	R502	R22	R502	R22	R502
SUCTION TEMPERATURE (°F)	40	.47	.4	1.00	.86	1.8	1.5	2.8	2.4	5.5	4.7
	30	.41	.34	.87	.72	1.5	1.3	2.4	1.9	4.8	4.0
	20	.34	.29	.73	.61	1.3	1.1	2.0	1.6	4.0	3.4
	10	.29	.24	.60	.50	1.1	.9	1.7	1.3	3.5	2.8
	0	.25	.20	.53	.43	.94	.76	1.5	1.1	3.0	2.3
	-10	.21	.17	.44	.35	.78	.63	1.2	.93	2.5	1.9
	-20	.18	.14	.37	.29	.67	.52	1.0	.77	2.0	1.6
	-30	.14	.11	.29	.24	.51	.43	.81	.63	1.6	1.3
	-40	.11	.09	.22	.19	.40	.34	.63	.50	1.2	1.1

O.D.C. TUBING CAPACITY FACTORS

% NOMINAL LOAD	150	125	100	75	50
MAX. TUBE LENGTH	17"	23"	36"	62"	120"

MIXING TUBE RECIRCULATING RATES

% THROAT LOAD	150	100	75	50
% RECIRCULATION	33	100	167	300

STEEL RECIRCULATING INJECTORS–SELECTION (R717 & HALOCARBONS)

INJECTOR NUMBER	BODY SIZE (IPS)	NOMINAL TONS @ 20°F EVAPORATOR			NOZZLE NO. OR DIA. (IN.)	THROAT DIA. (IN.)	OTHER AVAILABLE NOZZLES
		R717	R22	R502			
2075WCB	3/4	23			40	3/8	56 to 31
			7.8	5.5	31		
2100WCB & WCBA	1	50/32			23	5/8, 1/2	56 to 16
			17	11.9	16		
2125WA	1-1/4	70			16	3/4	23
			28	19.8	1		
2150WA	1-1/2	120			1/4	1	1/8, 3/16
			40	29	9/32		
2200WA	2	200			5/16	1-1/4	1/4
			63	45	3/8		
2250WA	2-1/2	315			13/32	1-1/2	11/32
			100	72	15/32		

R717 SINGLE OUTLET MIXING TUBE CAPACITY

SUCTION TEMP. (oF)	NOMINAL TONS–THROAT SIZE @ 2:1 CIRC. RATE							
	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
40	4.8	12.4	19.8	28.0	49.6	77.8	112.2	198.2
30	4.2	10.4	16.8	23.6	42.0	65.6	94.4	168.4
20	3.4	8.8	13.8	19.6	35.0	54.4	78.8	140.0
10	2.8	7.0	11.0	15.6	28.0	43.4	62.8	111.8
0	2.2	5.6	9.0	12.6	22.6	34.8	50.6	90.0
-10	1.84	4.6	7.4	10.6	18.8	29.4	42.4	75.4
-20	1.38	3.6	5.4	8.0	14.1	22.0	31.8	56.6
-30	1.06	2.6	4.2	6.2	10.8	16.8	24.2	43.2
-40	0.82	2.0	3.4	4.6	8.2	13.0	18.8	33.4

NOMINAL TONS R717 (AMMONIA)

NOMINAL TONS AT 95°F CONDENSING +40°F to -40°F EVAPORATOR															
NUMBER	59	56	54	52	50	48	44	40	36	31	29	23	16	7	1
R717	3.9	5.0	7.0	9.3	11.3	13.4	17.0	22.1	26.0	33.3	42.6	54.6	72.3	93	120

MULTIPLIERS FOR R717 NOZZLE CAPACITIES FOR OTHER CONDENSING TEMPERATURES

CONDENSING TEMPERATURE °(F)	45	55	65	75	85	95	105
MULTIPLIER	.61	.69	.77	.85	.93	1.00	1.09

R717 NOZZLE CAPACITY MULTIPLIERS FOR REDUCED PRESSURE AT NOZZLE INLET–WARM LIQUID SUPPLY

TEMPERATURE REDUCTION ACROSS REGULATOR	10°	20°	30°	40°	50°	60°
MULTIPLIER	.87	.74	.61	.49	.37	.26

Dimensions

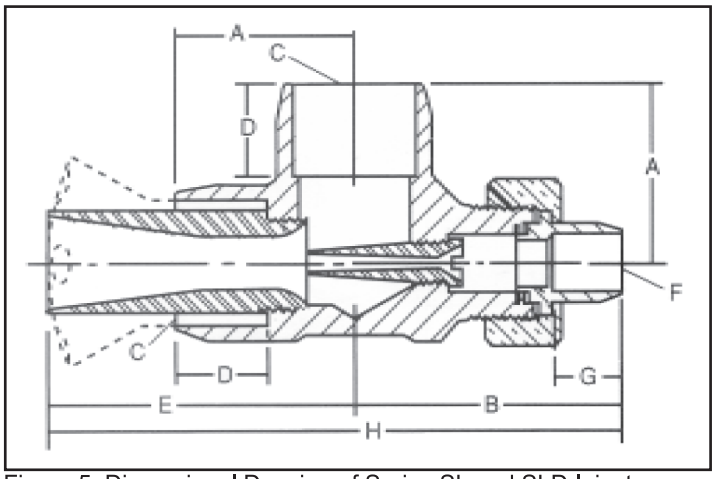


Figure 5: Dimensional Drawing of Series SL and SLD Injectors

PHILLIPS SERIES "SL" AND "SLD" INJECTOR DIMENSIONS (Inches)

INJECTOR MODEL	A	B	C (O.D.C)	D	E	F (O.D.C.)	G	H	SHIPPING WT. (LBS.)
2020-SL	1.31	2.00	3/4	.69	2.15	3/8	.5	4.15	0.8
2020-SLD					*			5.78†	1.0
2100-SL	1.94	2.88	1-3/8	1.0	4.07	5/8	.75	6.94	2.4
2100-SLD					*			9.09†	3.8

*Variable–consult factory † Maximum

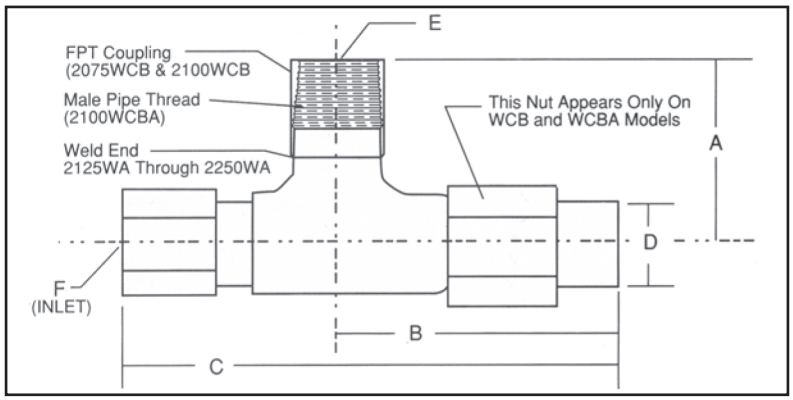


Figure 6: Dimensional Drawing of Steel Recirculating Injectors

STEEL RECIRCULATING INJECTORS–DIMENSIONS (Inches)

INJECTOR MODEL	A	B	C	D	E (IPS)	F (IPS)	F (ODC)	SHIPPING WT. (LBS.)
2075WCB	2.13	3.63	6.38	0.99	3/4 (FPT)	3/8, 1/2	5/8	2.15
2100WCB	2.69	4.00	7.25	1.25	1 (FPT)	3/8, 1/2	5/8	3.55
2100WCBA	2.69	4.00	7.25	1.25	1 (MPT)	3/8, 1/2	5/8	3.60
2125WA	1.88	3.25	5.87	1.25	1-1/4	1/2	5/8	4.15
2150WA	2.25	3.94	7.38	1.44	1-1/2	3/4	7/8	6.50
2200WA	2.50	6.37	11.75	1.88	2	3/4	1-1/8	11.38
2250WA	3.00	6.31	12.50	2.31	2-1/2	1	1-3/8	13.20

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