loaded expansion valve. This arrangement can provide improved modulation over a wide range of load and pressure drop conditions.

Application

A refrigeration system in which a high side float valve is used ordinarily consists of a single evaporator, compressor and condenser. The operating receiver or a liquid sump at the condenser outlet can be quite small. A full sized receiver is required for pumping out the flooded evaporator. The high side float valve may be used to feed more than one evaporator in a system, under certain conditions, in which case additional control valves are required. One of the disadvantages of the high side float valve system is that the amount of system refrigerant charge is critical. The use of an excessive amount of system charge will cause floodback, while an insufficient amount of system charge will cause a reduction in system capacity.

LOW SIDE FLOAT VALVES

The low side float valve performs the same function as the high side float valve, but it is connected to the low pressure side of the system. When the evaporator liquid level drops, the float opens the valve, allowing refrigerant liquid from the liquid line to flow through the valve port and enter directly into the evaporator or surge drum. In another type of valve design, the refrigerant liquid flows through the valve port, passes through a remote feed line, and enters the evaporator through a separate connection. A typical direct-feed valve construction is shown in Fig. 18.

Selection

Low side float valves are selected in the same manner as the high side float valves discussed previously.

Application

In the low side float valve system, the refrigerant system charge is not critical. The low side float valve can be used in multiple evaporator systems in which some of the evaporators may be controlled by other low side float valves, and some by thermostatic expansion valves.

The float valve, depending on its design, may be mounted directly in the evaporator or surge drum, or it may be mounted in an external chamber which is connected to the evaporator or surge chamber with equalizing lines, i.e., a gas line at the top and a liquid line at the bottom. In the externally mounted type, the float valve is separated from the float chamber by a gland which provides a quiet level of liquid in the float chamber for steady actuation of the valve.

In evaporators with high boiling rates or restricted liquid and gas passages, the boiling action of the liquid will raise the refrigerant level during operation. When the compressor stops or the solenoid suction valve closes, the boiling action of the refrigerant liquid ceases and the refrigerant level in the evaporator drops. Under these conditions, the high pressure liquid line supplying the low side float valve should be shut off by a solenoid liquid valve to prevent overfilling the evaporator. Otherwise, excess refrigerant will enter the evaporator on the *off* cycle and can cause floodback when the compressor starts or the solenoid suction valve opens.

When a low side float valve is used, precautions must be taken to have the float in a quiet liquid level that properly falls in response to an increase in evaporator load, and rises with a decrease in evaporator load. In low temperature systems, particularly, it is important that the equalizer lines between the float chamber and the evaporator, or between the surge drum and the evaporator, be generously sized to eliminate any reverse response of the refrigerant liquid level in the vicinity of the float. Where the low side float valve is located in a non-refrigerated room, the equalizing liquid and gas lines and the float chamber must be insulated in order to provide a quiet liquid level for the float.

SOLENOID VALVES

A solenoid valve is a valve that is closed by gravity, pressure, or spring action, and is opened by the movement of a plunger, caused by the magnetic action of an electrically energized coil, or vice versa. Figs. 19 and 20 show cross-sections of solenoid valves with their principal components identified. The solenoid is composed of the coil and parts that make up the magnetic circuit. The plunger, coil housing, coil plate, and coil sleeves are made of magnetic materials. In the packless type of solenoid valve, the plunger is enclosed in a nonmagnetic enclosing tube.

Solenoid valves, being electrically actuated, may be conveniently operated in remote locations by any suitable electric switch. These valves are always fully open or fully closed; in contrast to motorized valves, which may be designed to operate in a modulating position. They may be used to control the flow of many different fluids, provided due consideration is given to the pressures and temperatures involved, the viscosity of the fluid, and the suitability of the materials used in the valve construction.

Solenoid valves can be divided into the following general types:

1. *Normally-closed solenoid valve.* A valve in which the closure member is moved away from the port to cause the open action when the coil is energized, e.g., a two-way solenoid valve.
2. *Normally-open solenoid valve.* A valve in which the closure member is moved to the port to cause the closing action when the coil is energized, e.g., a two-way solenoid valve.
3. *Multiaction solenoid valve.* A valve which combines in one body the action of one or more normally-open and one or more normally-closed solenoid valves, e.g., a three-way solenoid valve or a four-way solenoid valve.

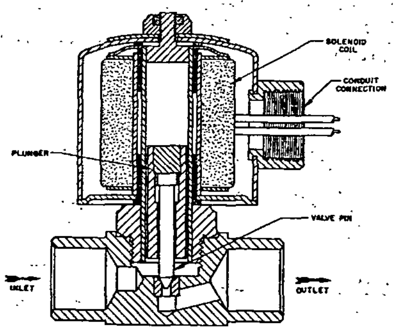

Fig. 19 .... Normally-Closed Direct-Acting Solenoid Valve with the Hammer-Blow Feature

Operation

While all types of solenoid valves are in common use, the normally-closed type is used far more extensively than the others. Therefore, the following discussion pertains to the normally-closed type, unless otherwise specifically stated.

In the normally-closed direct-acting solenoid valve shown in Fig. 19, the power of the solenoid coil, acting on the plunger, pulls the valve pin away from and off the valve port, thereby opening it directly. Since this valve depends solely on the power of the solenoid coil for operation, its port size for a given operating pressure differential is limited by the practical limitations of solenoid coil size.

Fig. 20 shows one of the medium size, *normally-closed, pilot-operated solenoid valves*. In this valve, the solenoid coil, acting on the plunger, does not open the main port directly, but, instead, merely opens the pilot port A. Pressure trapped on top of the piston B is released through the pilot port, thus creating a pressure unbalance across the piston, forcing it upward and opening the main port C. When the solenoid coil is de-energized, the plunger drops and closes pilot port A. Then the pressure above and below the piston equalize again, and the piston drops and closes the main port. In some pilot-operated solenoid valve designs, a diaphragm is used for the main closing member instead of a piston. Ordinarily in medium size valves, the pilot port is located in the main closing member. In the large size valves, where the movement of the closing member is greater, it is frequently necessary to locate the pilot port at a point remote from the main closing member, as a matter of practical design.

Such pilot-operated valves depend on a certain minimum pressure drop across the valve (approximately 0.5 psi or more) to hold the piston or main closure member in the open position. Where it is desirable to keep the valve open without this pressure drop penalty, such as on refrigeration suction lines, the piston may be *mechanically linked* to the solenoid valve pin and plunger, as shown in Fig. 21. The opening and closing actions are the same as before. However, advantage is taken of the increased pulling force of the plunger, as it approaches its stop position in the coil, to hold the piston in the open position, without requiring valve pressure drop for this action.

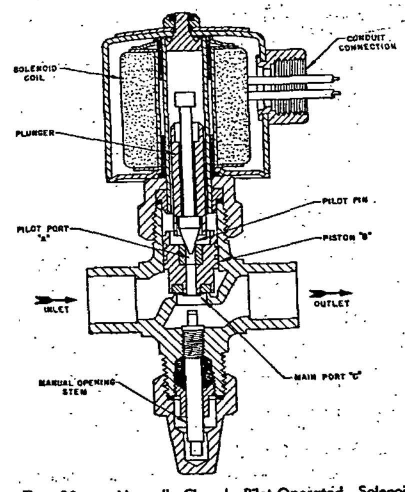

Fig. 20 .... Normally-Closed Pilot-Operated Solenoid Valve with the Hammer-Blow Feature

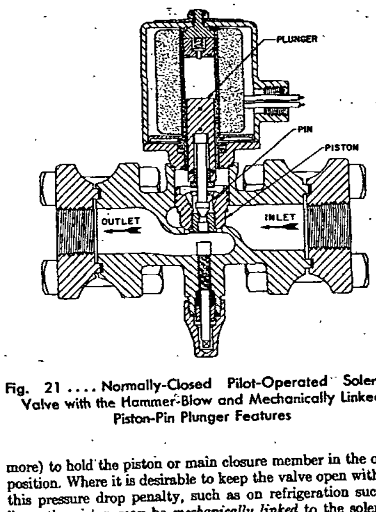

Fig. 21 .... Normally-Closed Pilot-Operated Solenoid Valve with the Hammer-Blow and Mechanically Linked Piston-Pin Plunger Features

In order to obtain the maximum operating pressure differential for a given solenoid pulling power, many valve plungers are constructed so that the plunger is free to gain momentum before it knocks the valve pin out of the valve port with an *impact* or a *hammer-blow* effect. Solenoid valves with the hammer-blow feature must have the full rated voltage, within the customary tolerance of + 10 to − 15 percent, *applied instantaneously* to their coils so that the valves will open under rated conditions. Otherwise they will fail. If, after this valve is in the open position, the line voltage drops below the hold-in voltage value, but not to zero, the plunger will drop and the valve will close. After the line voltage builds up again, the valve will not reopen, whether it is used on alternating or direct current, because the hammer-blow effect is lost. However, in the case of the alternating current valve, the coil will overheat and may burn out under this condition, because the inherent high inrush current continues to flow through the coil when the plunger is not pulled all the way into the coil to close the air gap.

Short-stroke solenoid valves, in which the valve pin is an integral part of the plunger, can be designed to open fully at rated voltage, + 10 to − 15 percent, whether the voltage is applied gradually or instantaneously. Their alternating current coils can be designed against burn-out, even though they may be subjected to low voltage. However, such construction tends to have a lower maximum operating pressure differential than the hammer-blow design.