SECTION 5

COMMERCIAL REFRIGERATION

UNIT 25

SPECIAL REFRIGERATION SYSTEM COMPONENTS

UNIT OBJECTIVES

After studying this unit, the reader should be able to

- Distinguish between mechanical and electrical controls.
- Explain how and why mechanical controls function.
- Describe an automatic pumpdown system.
- Define low ambient operation.
- Describe electrical controls that apply to refrigeration.
- Describe off-cycle defrost.

UNIT OBJECTIVES

After studying this unit, the reader should be able to

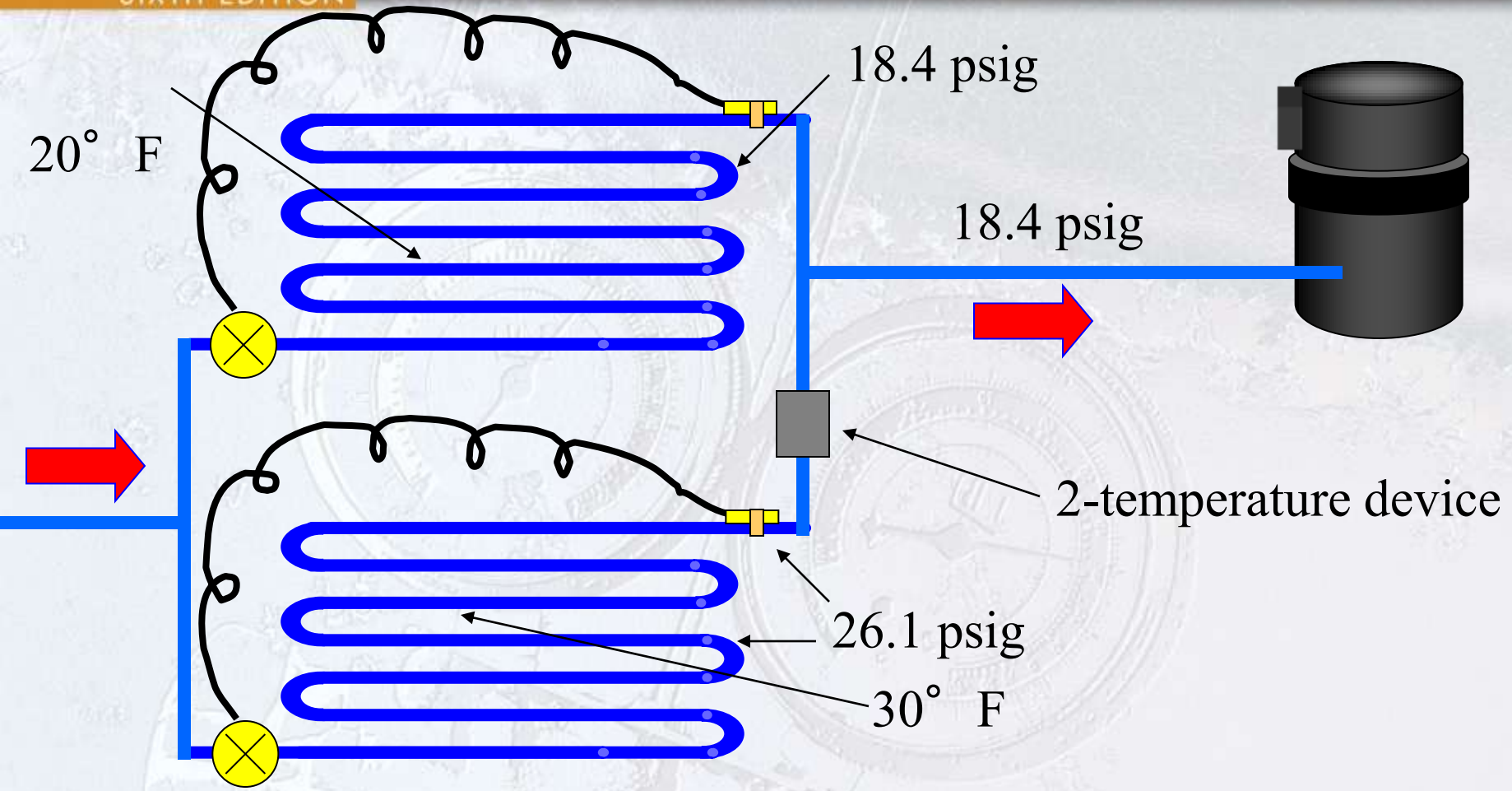
- Describe random and planned defrost.
- Explain temperature-terminated defrost.
- Describe the various refrigeration accessories.
- Describe the low-side components.
- Describe the high-side components.

THE FOUR BASIC COMPONENTS

- Compression systems must have a compressor, condenser, expansion device, and evaporator
- Other components enhance system operation
- Controls can be electrical, mechanical, or electromechanical devices
- Mechanical controls start, stop or modulate fluid flow to increase system effectiveness

TWO-TEMPERATURE CONTROLS

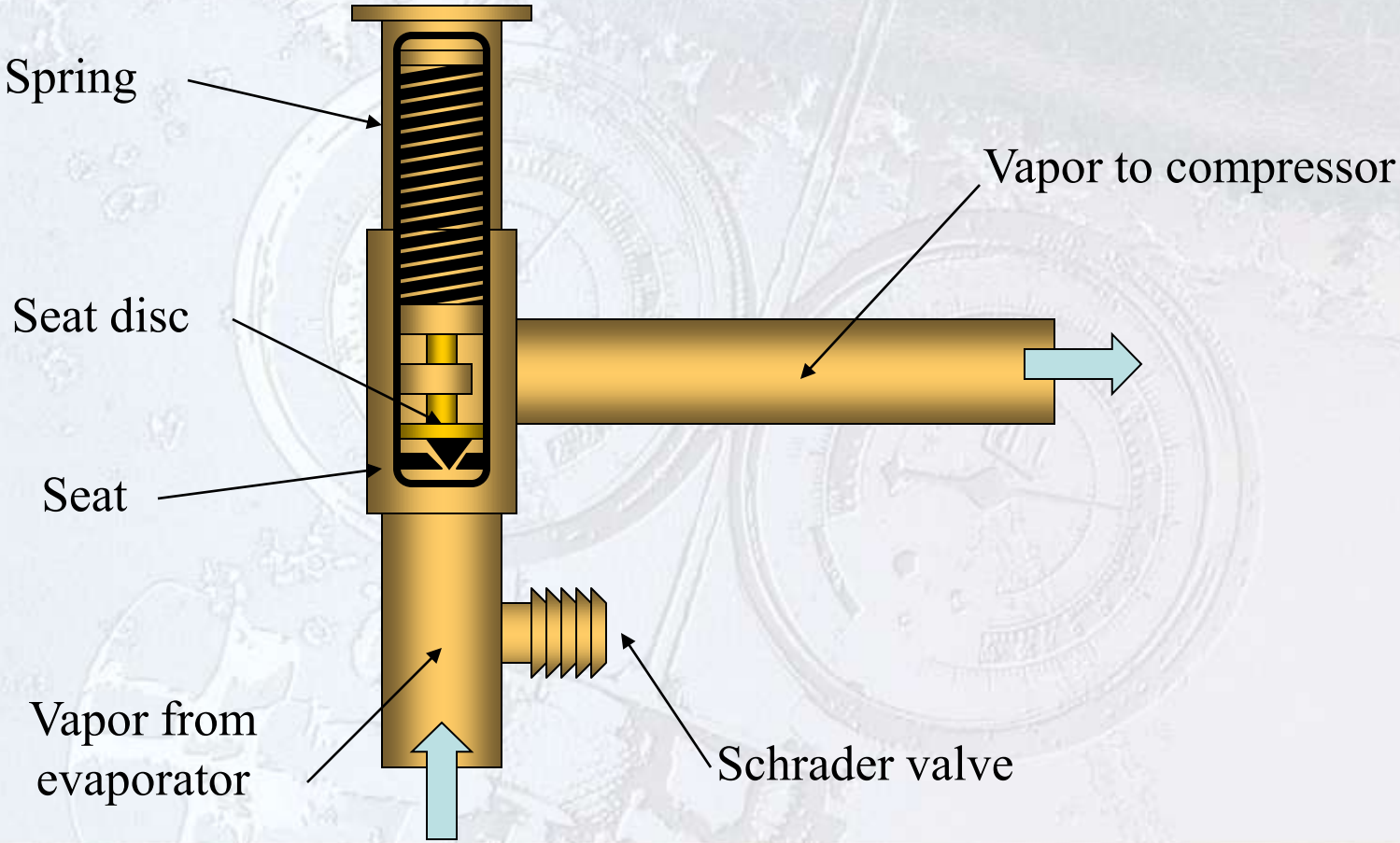
- Two-temperature operation is utilized when there are multiple evaporators in the system
- These evaporators typically operate at different temperatures
- The pressures in these evaporators are therefore different
- Two-temperature operation is normally accomplished with mechanical valves



EVAPORATOR PRESSURE CONTROL

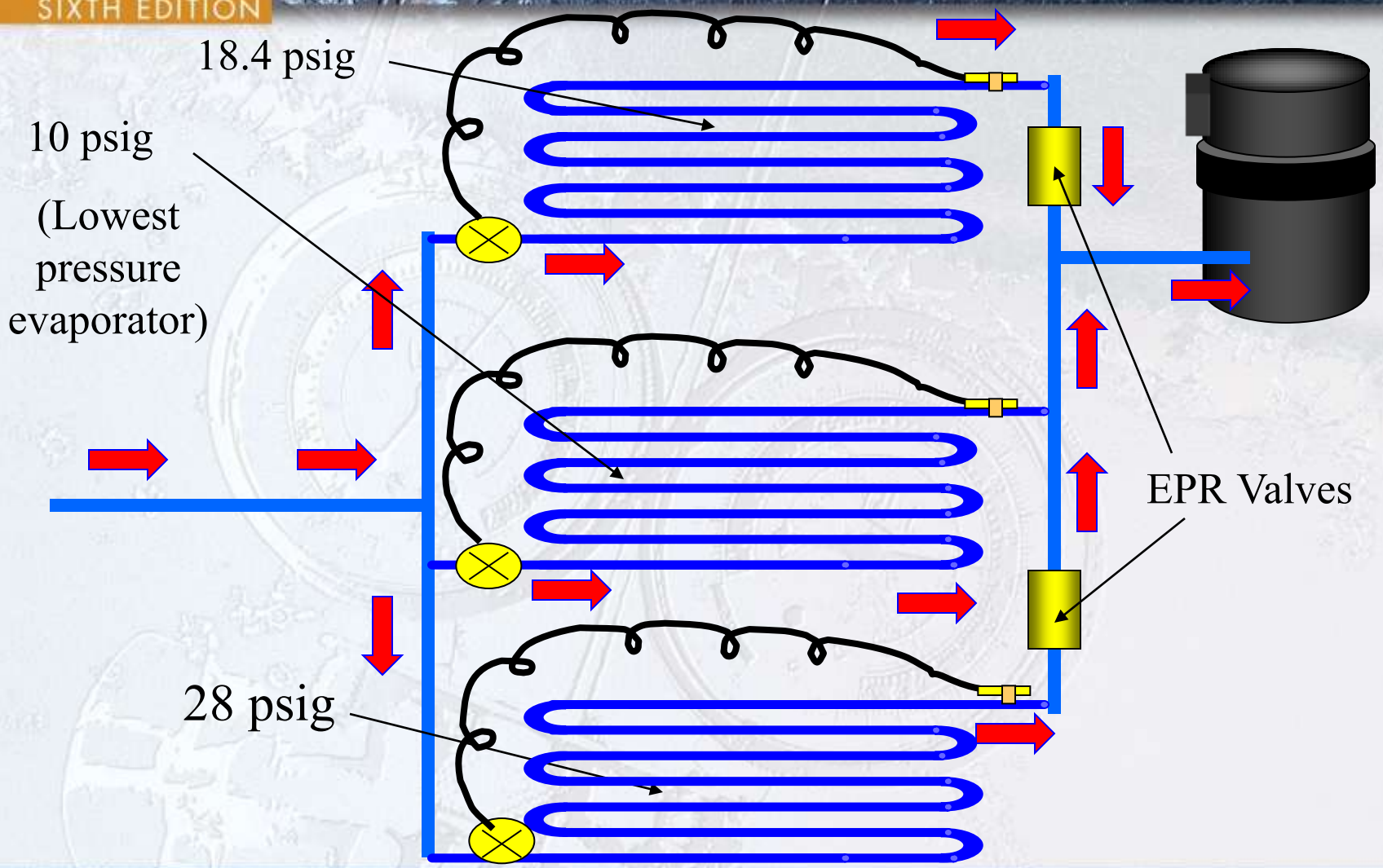
- Evaporator pressure regulator (EPR)
- Prevents the pressure in an evaporator from dropping below a predetermined pressure
- Two pressures control the valve
  - Spring pressure – pushes to close the valve
  - Evaporator pressure – pushes to open the valve
- Evaporator superheat may be high when the EPR is closed

THE EVAPORATOR PRESSURE REGULATOR



MULTIPLE EVAPORATORS

- An EPR is needed in the suction line of each evaporator except the lowest temperature coil
- EPR valves are equipped with Schrader valves to read evaporator pressure
- Multiple EPRs can be set at different pressures so each evaporator can be maintained at a different temperature



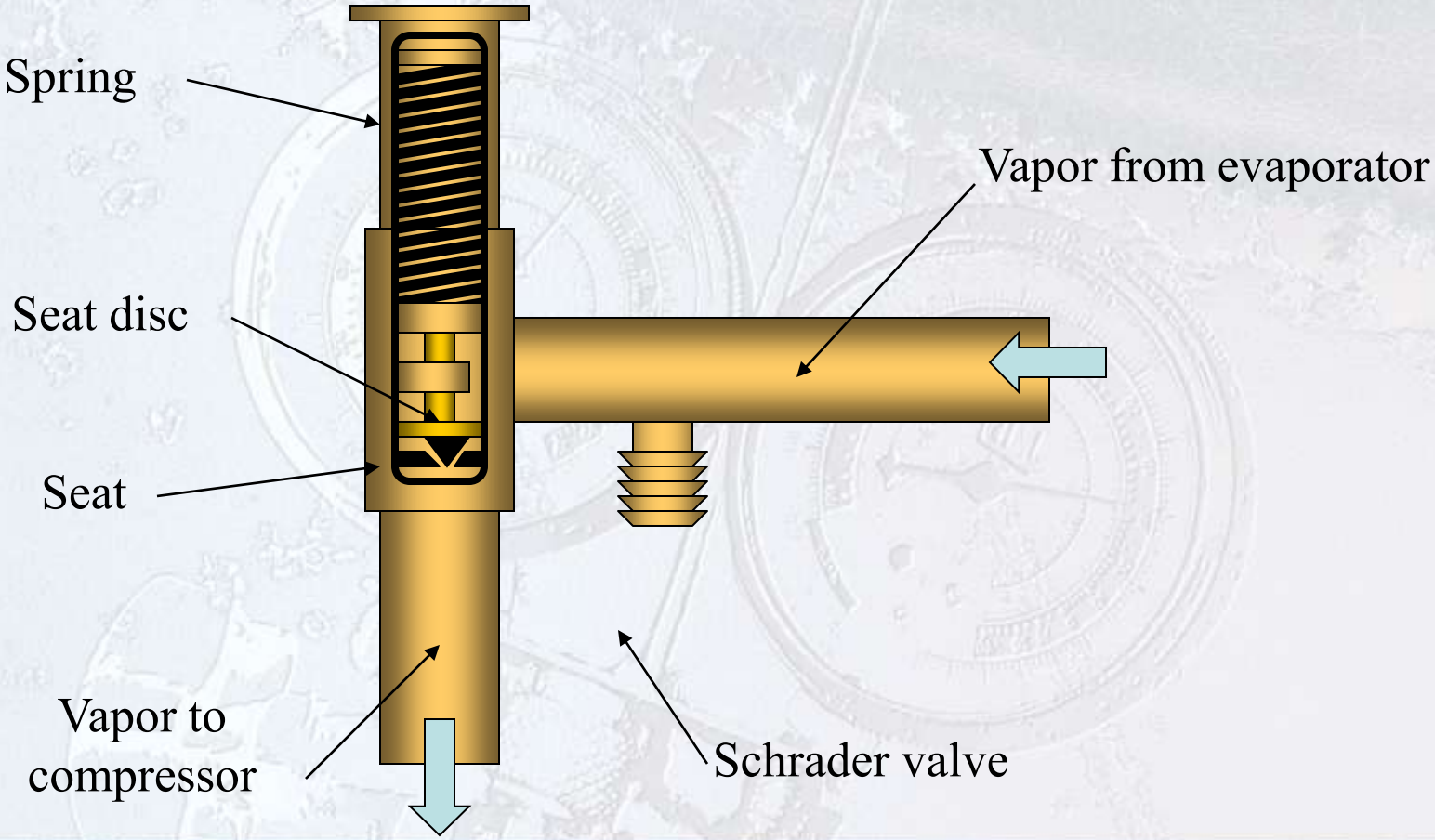
ELECTRIC EVAPORATOR PRESSURE REGULATOR (EEPR) VALVES

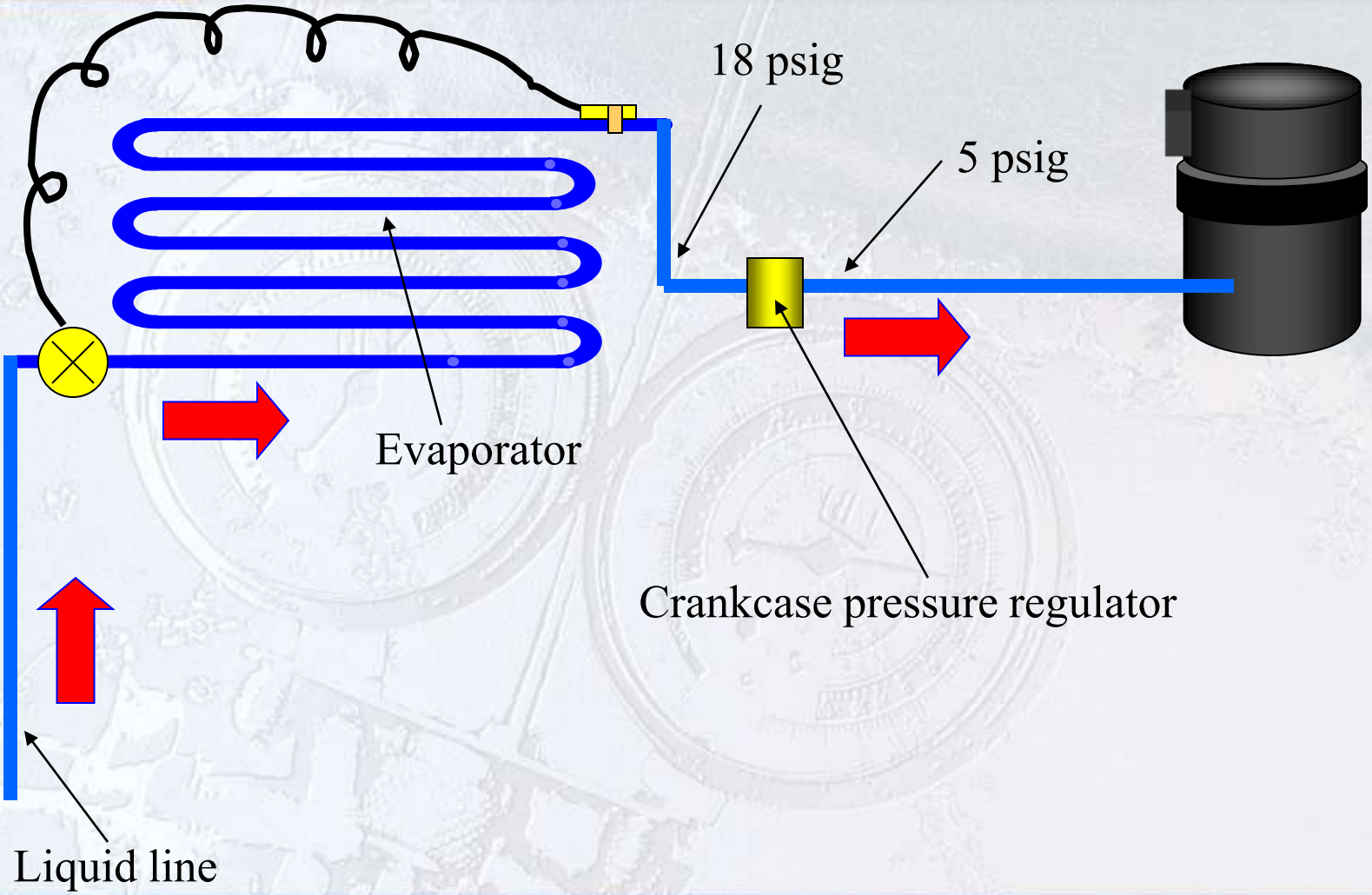
- Provide more accurate control
- Located at the evaporator outlet
- Used on single or multiple evaporator systems
- Microprocessor senses case discharge air temperature
- Designed to maintain discharge air temperature in the refrigerated case
- Controlled by a bipolar step motor

CRANKCASE PRESSURE REGULATOR (CPR)

- Located close to the compressor
- Prevents compressor from overloading on start-up
- Provides a limit to the pressure that can enter the compressor
- Referred to as a close on rise of outlet (CRO) valve
- Resembles an EPR valve

THE CRANKCASE PRESSURE REGULATOR





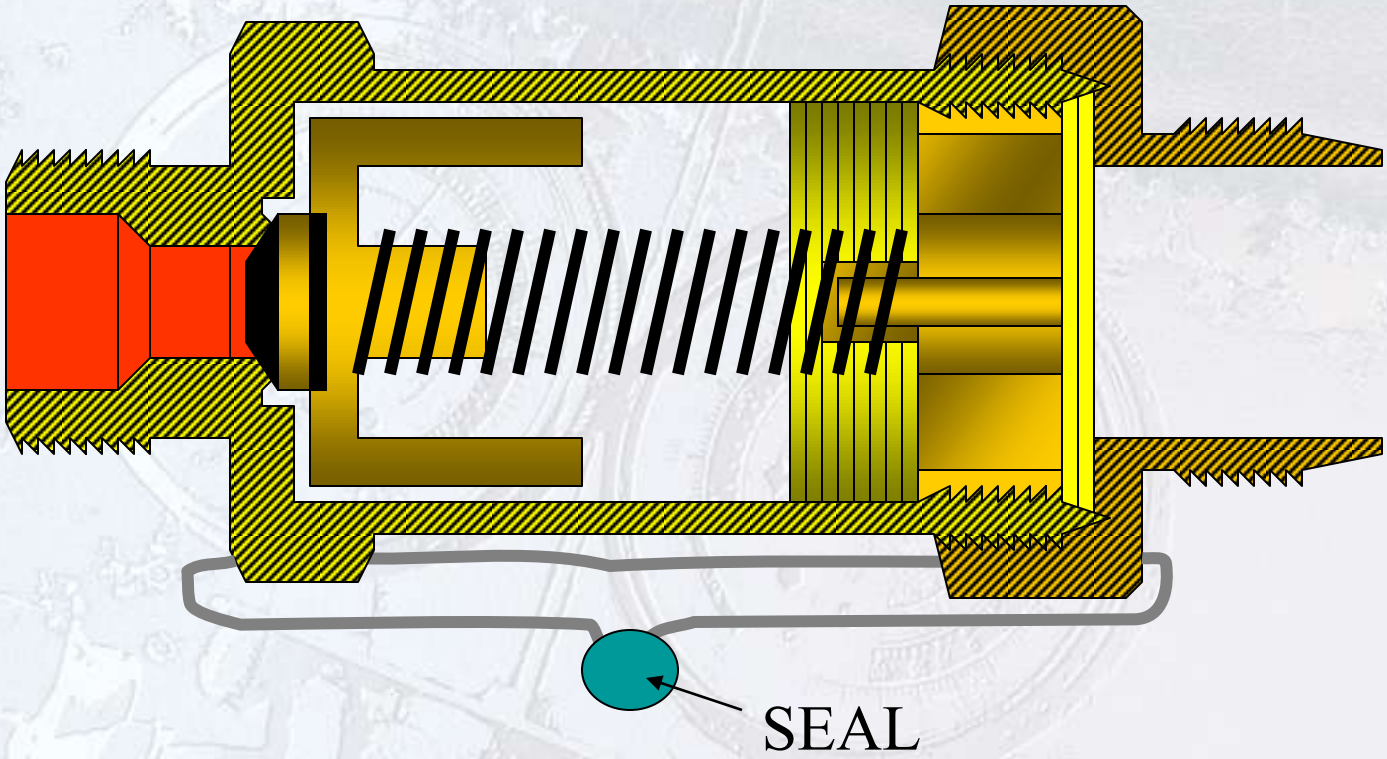
ADJUSTING THE CPR VALVE

- Valve is best adjusted under a high load condition
- An ammeter should be used when setting the valve
- Excessive amperage indicates that too much refrigerant is entering the compressor
- Turning the adjusting screw into the valve reduces the refrigerant pressure returning to the compressor
- Turning the screw out of the valve increases the refrigerant pressure returning to the compressor

RELIEF VALVES

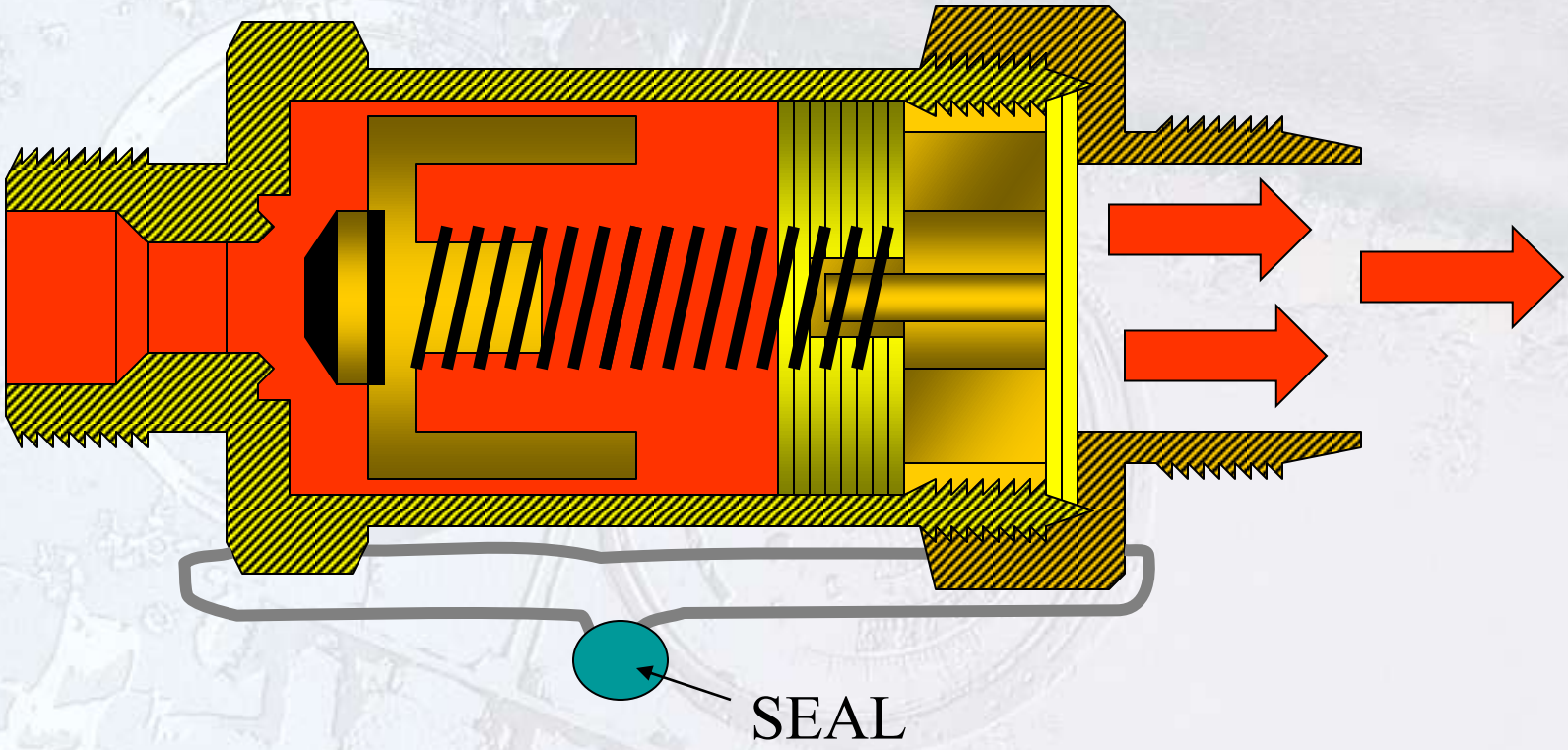
- Release refrigerant from a system when a high-pressure condition exists
- Spring-loaded type
  - Located in the vapor space
  - Resets after opening
- One-time type
  - Fittings filled with low-temperature solder
  - Usually located in the suction line near the compressor

SPRING-LOADED RELIEF VALVE



VALVE IN THE CLOSED POSITION

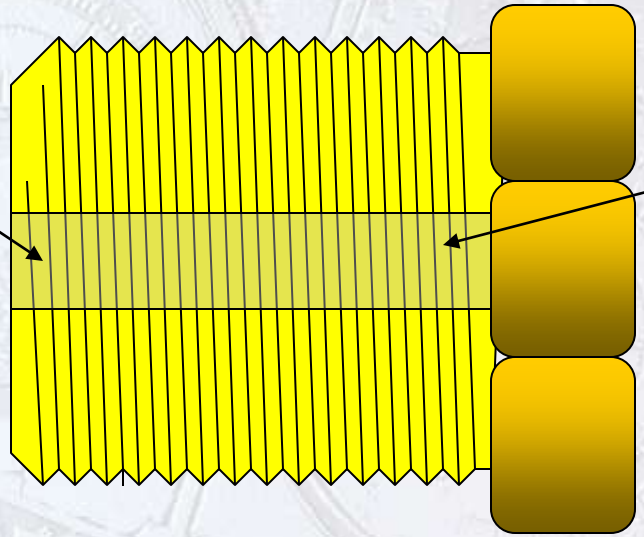
SPRING-LOADED RELIEF VALVE



VALVE IN THE OPEN POSITION

ONE-TIME RELIEF VALVE

Hole drilled through the relief valve



Hole is filled with a low temperature solder

LOW AMBIENT CONTROLS

- Used on refrigeration systems that are operated year round to maintain head pressure
- Fan cycling, fan speed control, air volume control, condenser flooding
- Intended to simulate design operating conditions
- Help to keep the system's operating pressures within desired ranges

FAN CYLING HEAD PRESSURE CONTROL

- Device opens on a drop in head pressure, turning condenser fan off
- Device closes on a rise in head pressure, turning condenser fan on
- Fan cycling causes large variances in the head pressure
- Best used on systems with multiple fans

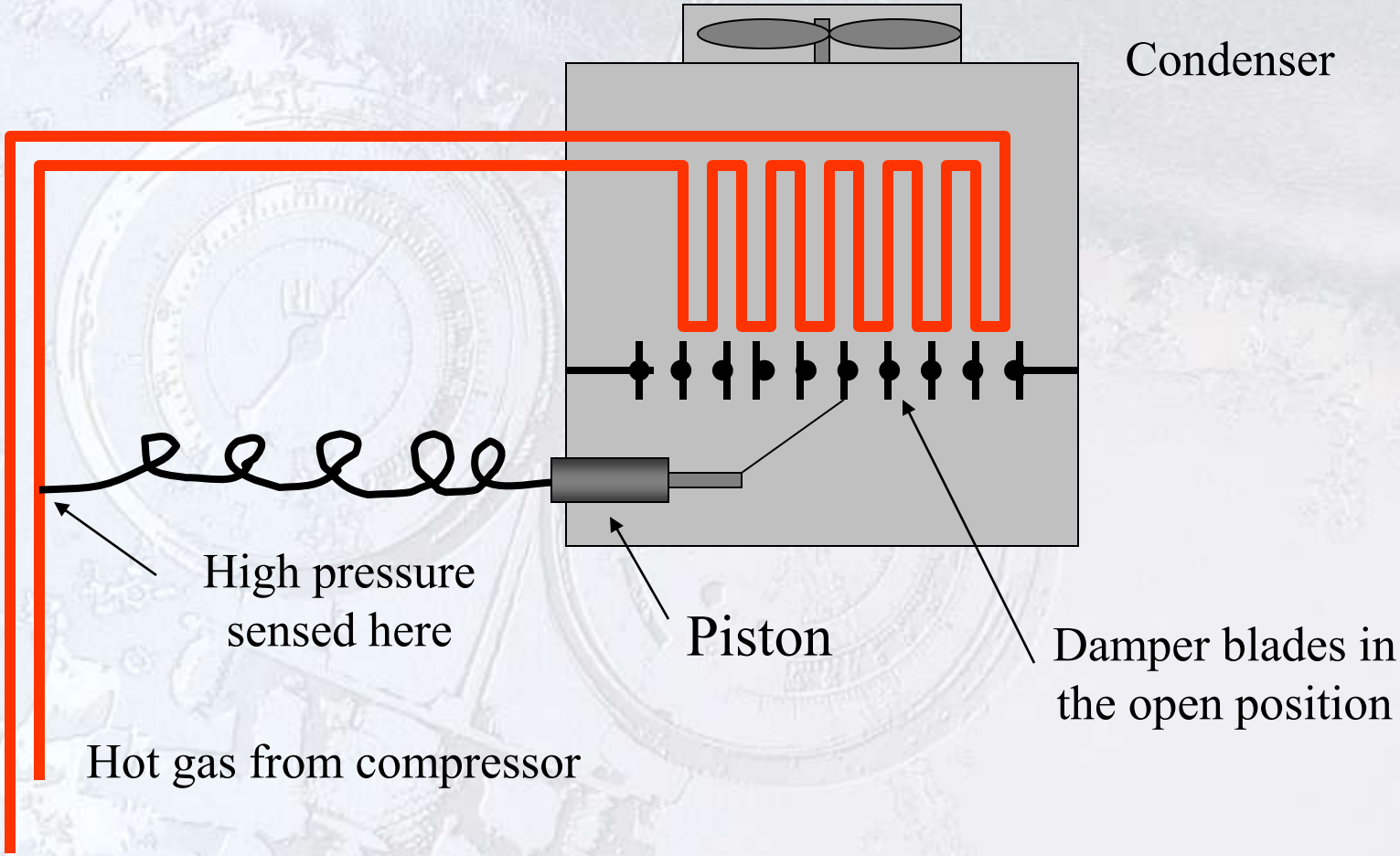
FAN SPEED CONTROL FOR CONTROLLING PRESSURE

- As the outside temperature drops, the fan slows down to reduce the amount of airflow through the condenser coil
- As the outside temperature rises, the fan speeds up to increase airflow through the condenser
- Some controls monitor the refrigerant's condensing temperature

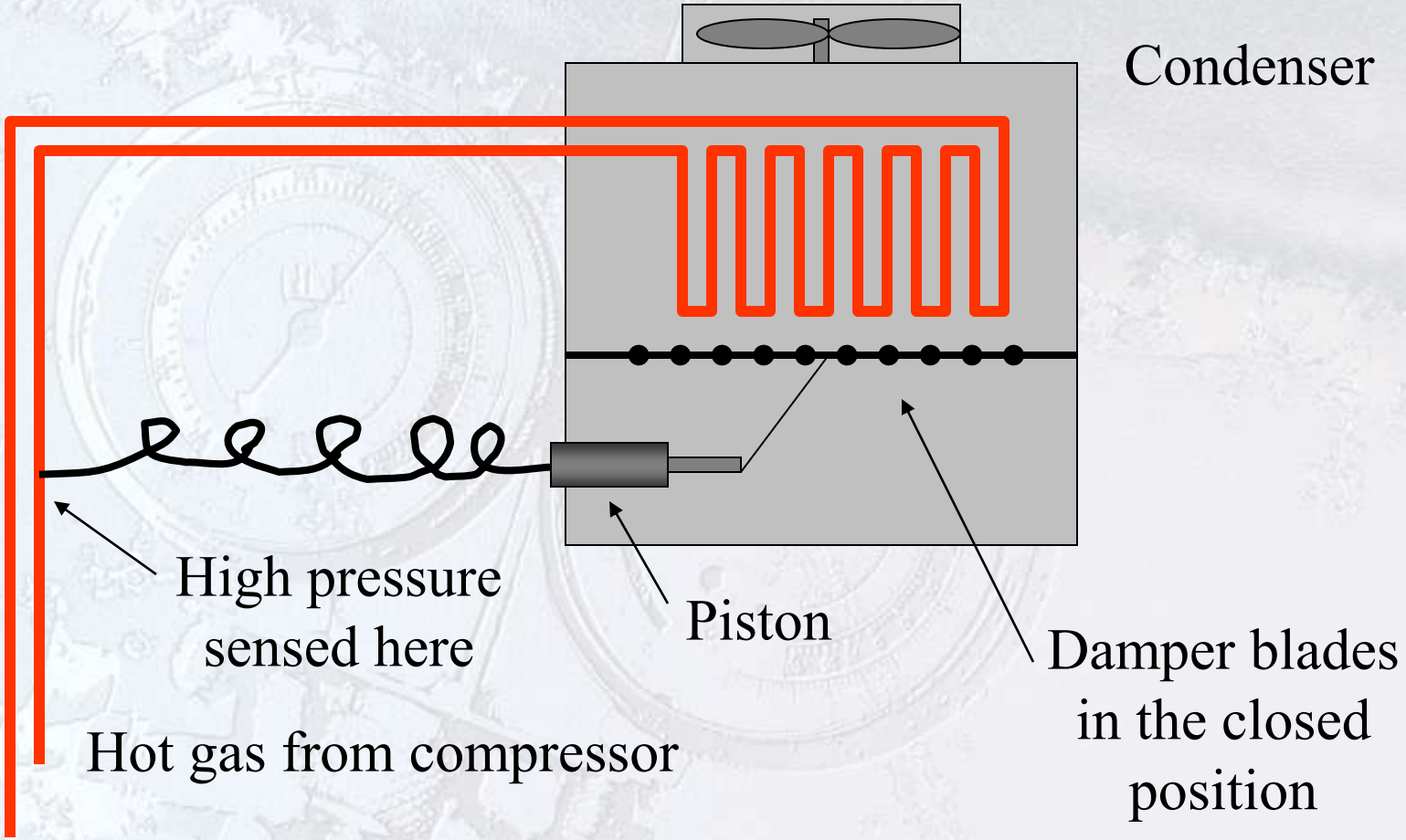
AIR VOLUME CONTROL FOR CONTROLLING PRESSURE

- Utilizes piston-controlled shutters and/or dampers
- As the head pressure drops, the shutters close, reducing airflow through the condenser
- Reduced airflow causes the head pressure to rise
- During periods of warm ambient temperatures, the dampers are fully open to maximize airflow through the condenser coil

WARM AMBIENT TEMPERATURE

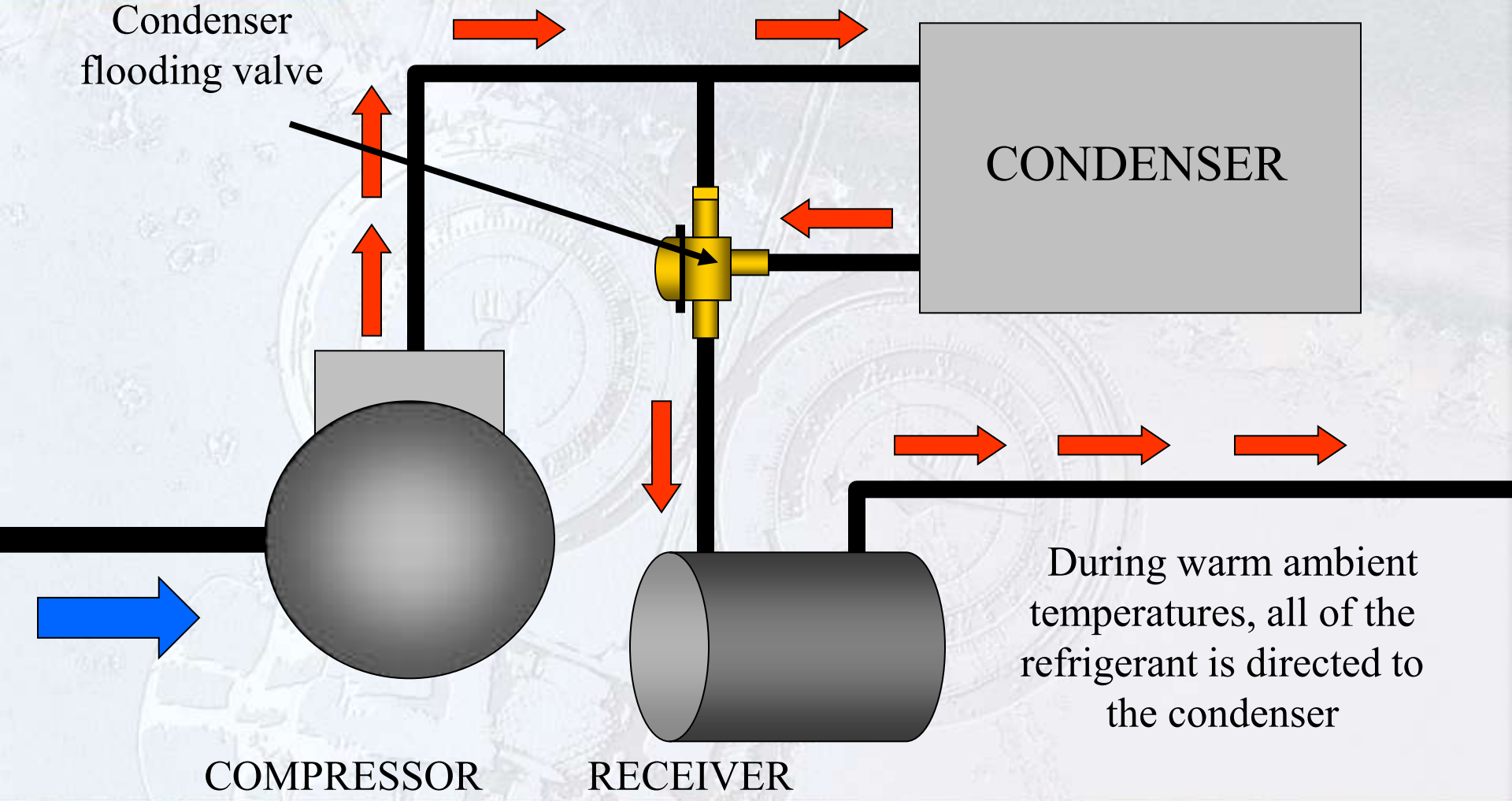


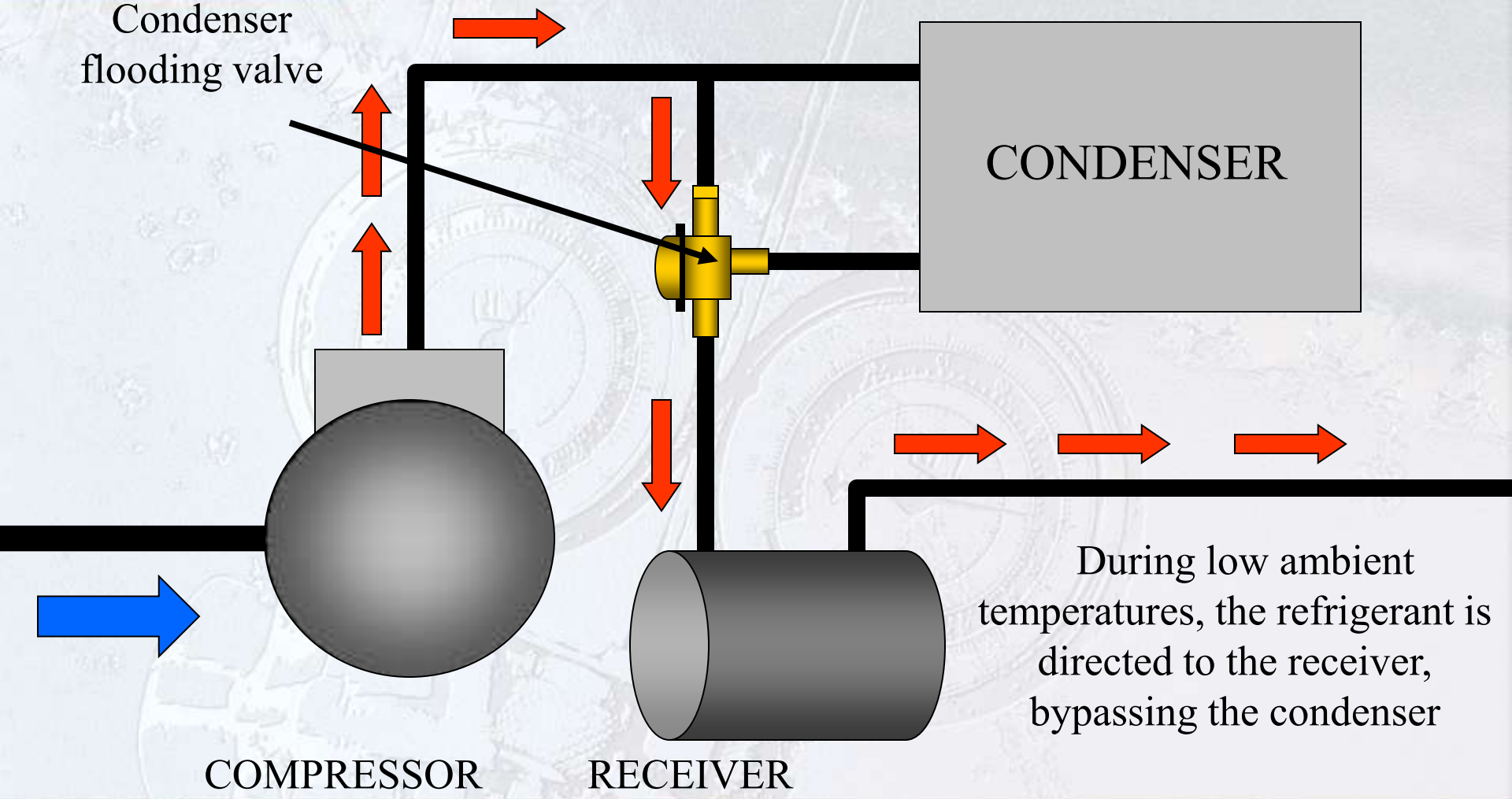
LOW AMBIENT TEMPERATURE



CONDENSER FLOODING FOR CONTROLLING HEAD PRESSURE

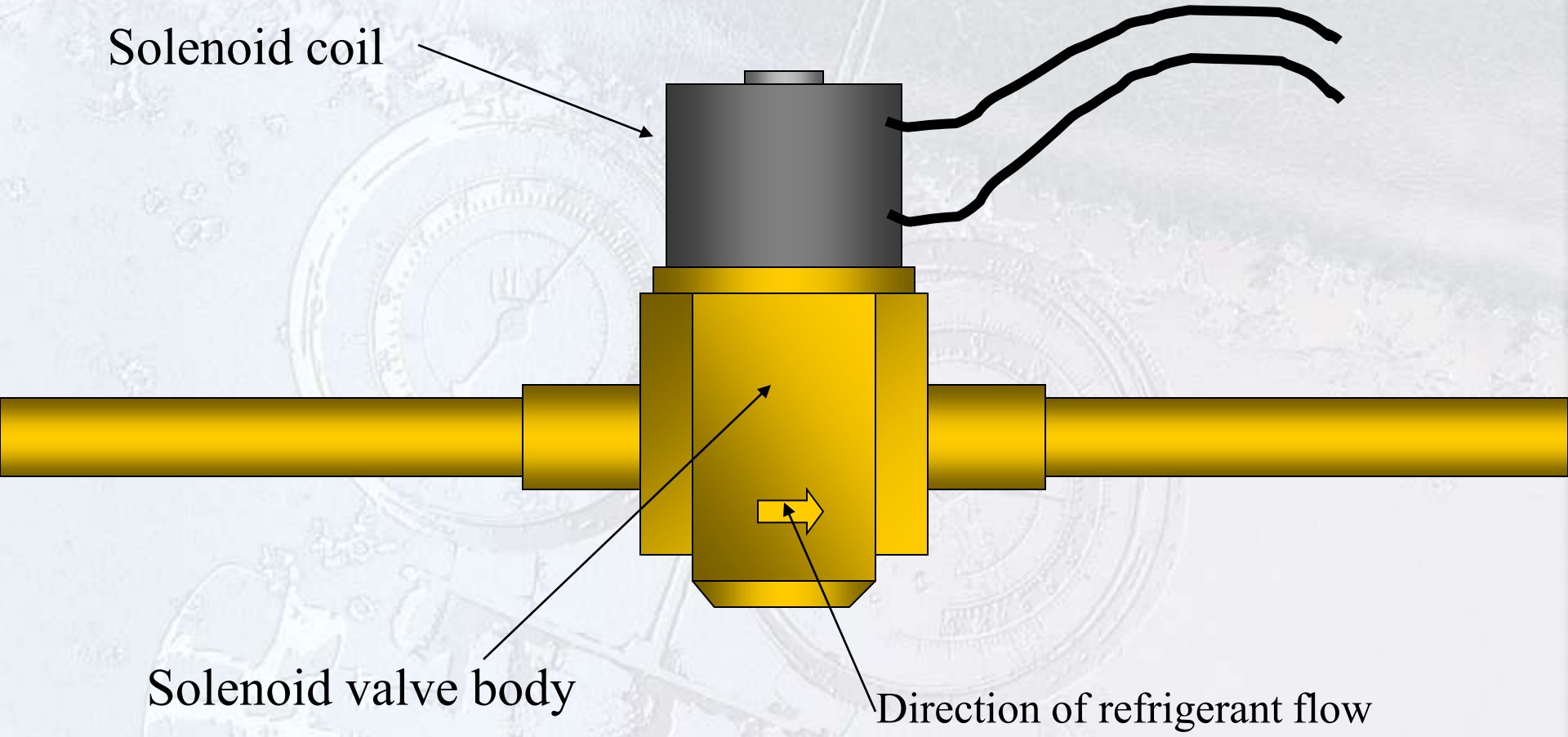
- Flooding valves cause liquid refrigerant to move from the receiver to the condenser, reducing its effective surface area, in cold weather
- Systems with flooding valves have oversized receivers to hold excess refrigerant charge in warm weather
- The valve is closed when outdoor temperature is high (all refrigerant is directed to the condenser)



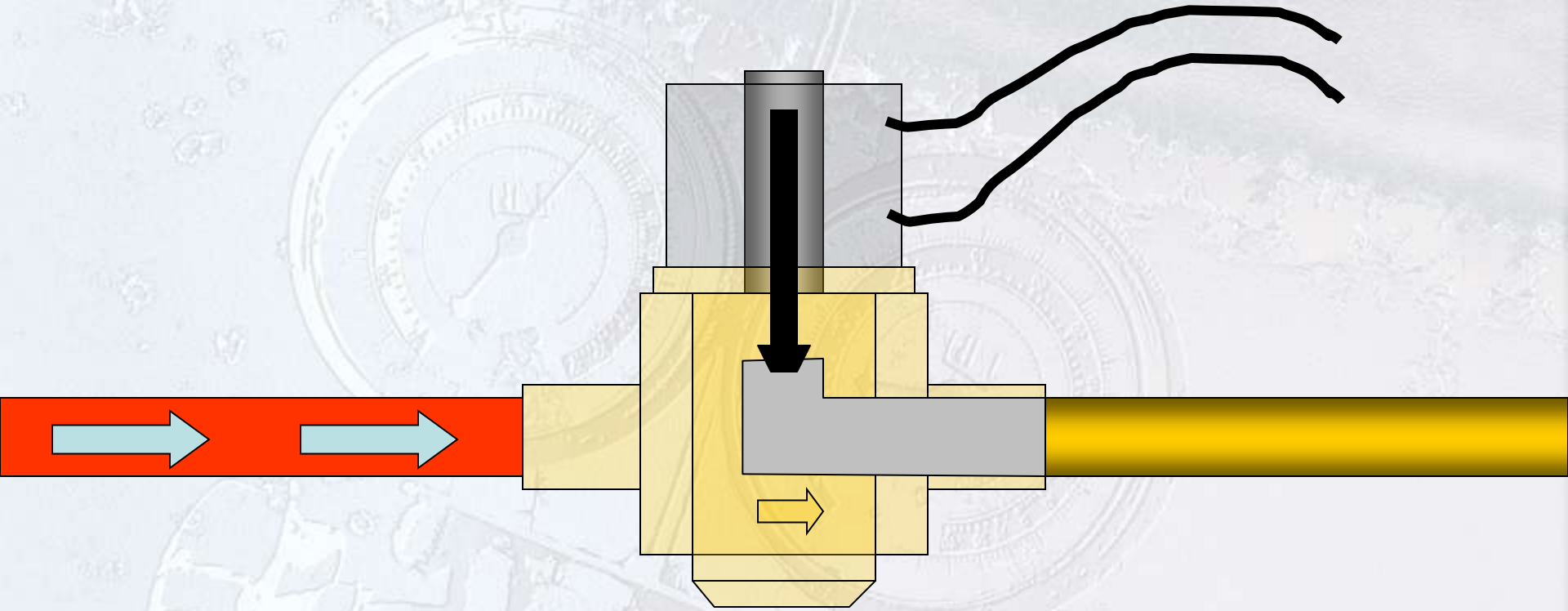


THE SOLENOID VALVE

- Used to start or stop refrigerant flow
- Normally open (NO) or normally closed (NC)
- Snap-acting valves (open or closed)
- Valves must be installed with the arrow pointing in the direction of flow
- Often used in conjunction with automatic pump down cycles
- Valve position controlled by a solenoid coil

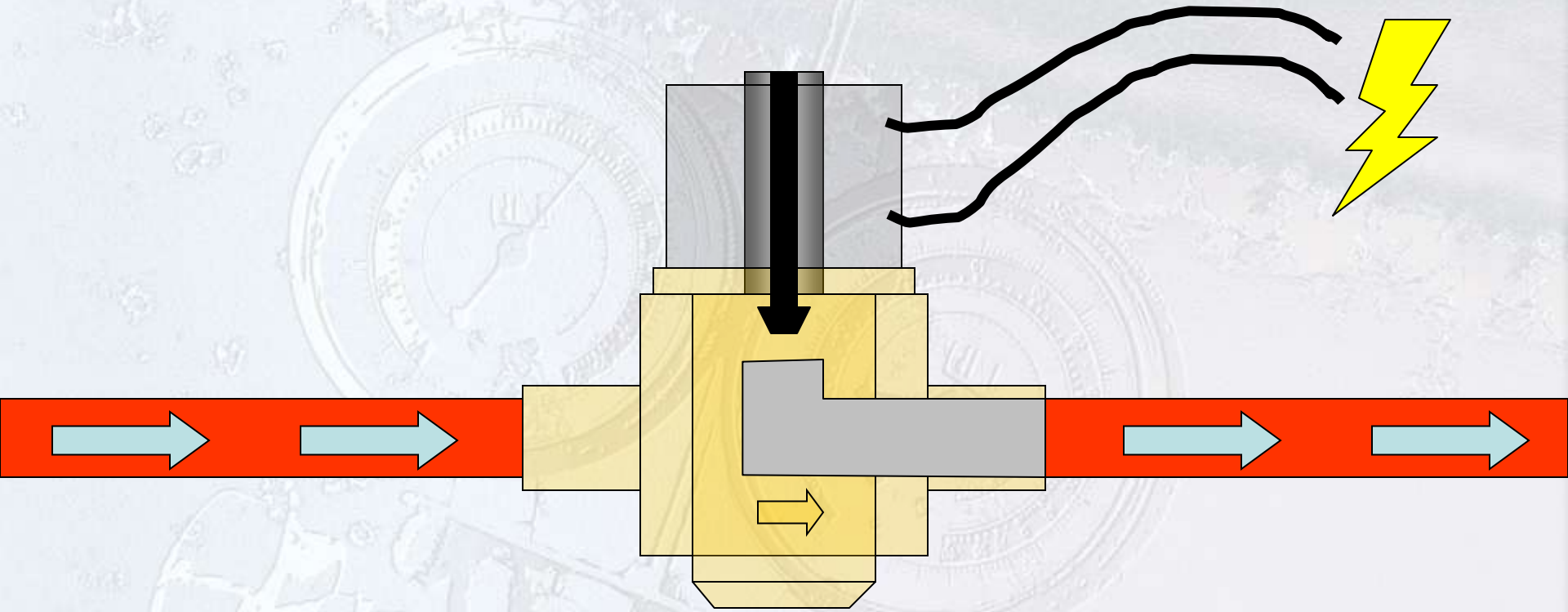


NORMALLY CLOSED VALVE WITH COIL DE-ENERGIZED



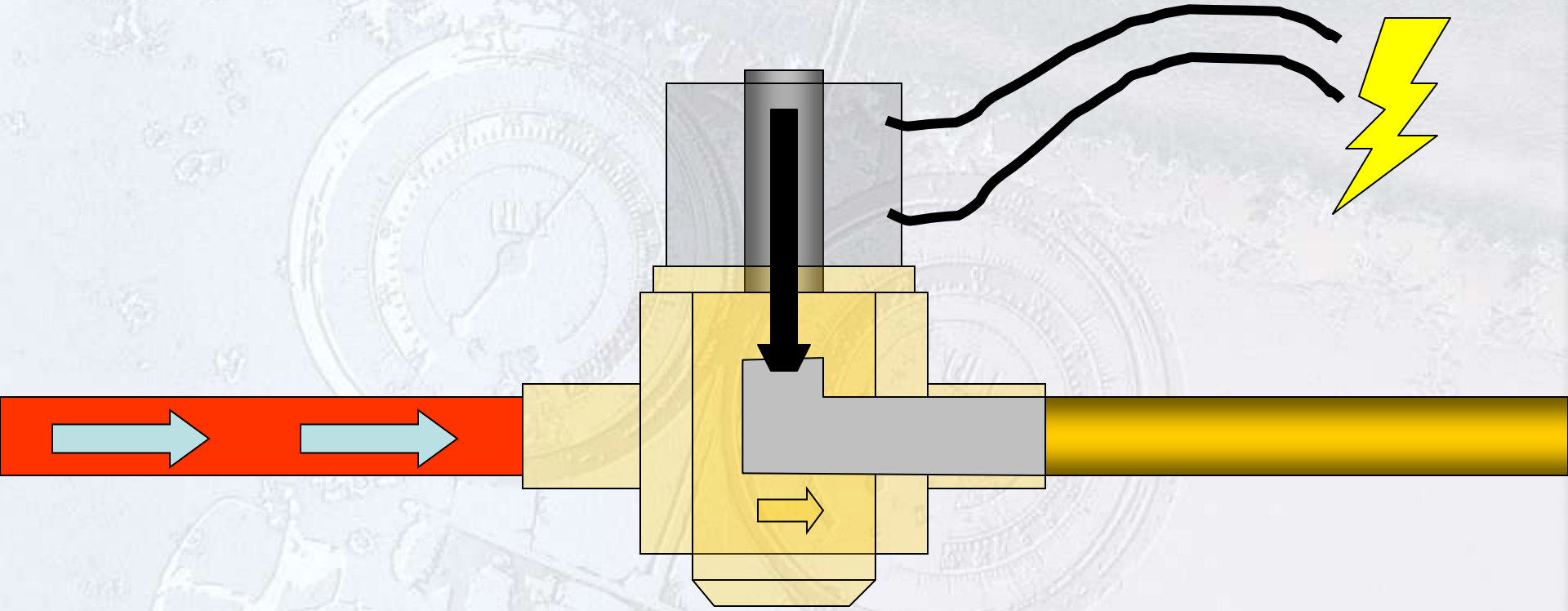
VALVE IS IN THE CLOSED POSITION

NORMALLY CLOSED VALVE WITH COIL ENERGIZED



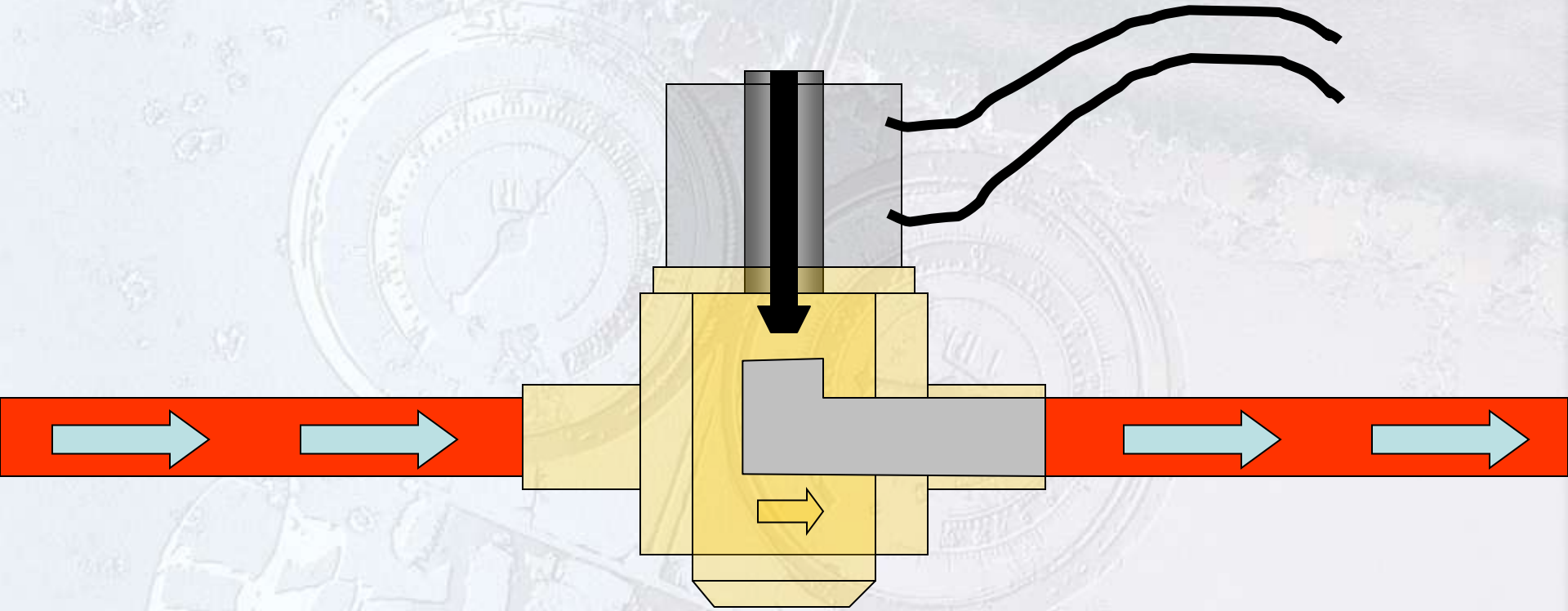
VALVE IS IN THE OPEN POSITION

NORMALLY OPEN VALVE WITH COIL ENERGIZED



VALVE IS IN THE CLOSED POSITION

NORMALLY OPEN VALVE WITH COIL DE-ENERGIZED



VALVE IS IN THE OPEN POSITION

PRESSURE SWITCHES

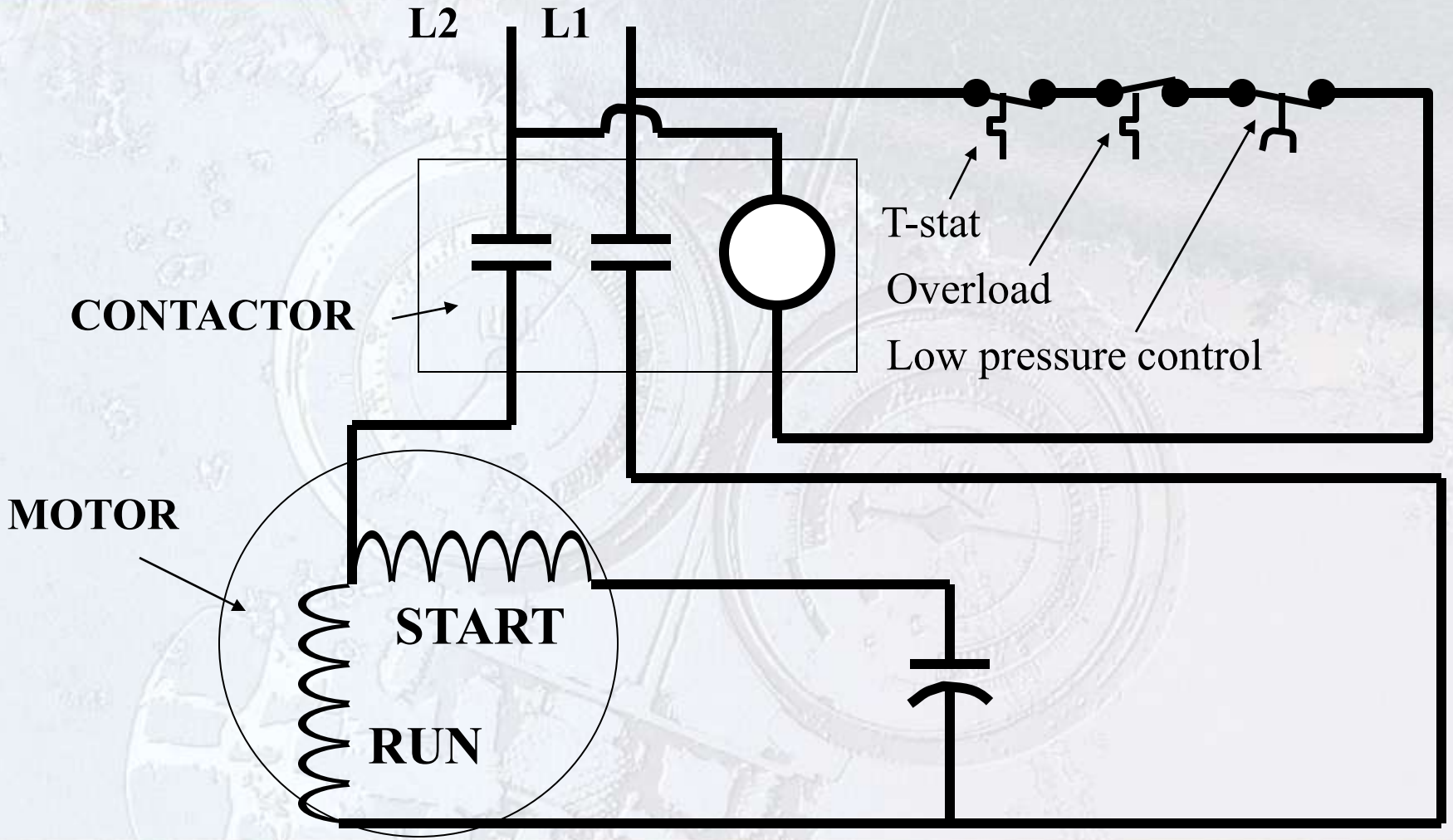
- Start and stop current flow to components
- Low pressure switch – Closes on a rise in pressure
- High pressure switch – Opens on a rise in pressure
- Low ambient control – Closes on a rise in pressure
- Oil safety switch – Opens on a rise in pressure

LOW-PRESSURE SWITCH

- Can be used as low-charge protection and space temperature control
- Low-charge protection
  - Cut-out pressure set well below normal operating pressure
  - Cut out pressure should be set above atmospheric pressure to prevent atmosphere from being pulled into the system
  - Prevents system from operating in a vacuum
  - Control is normally reset automatically

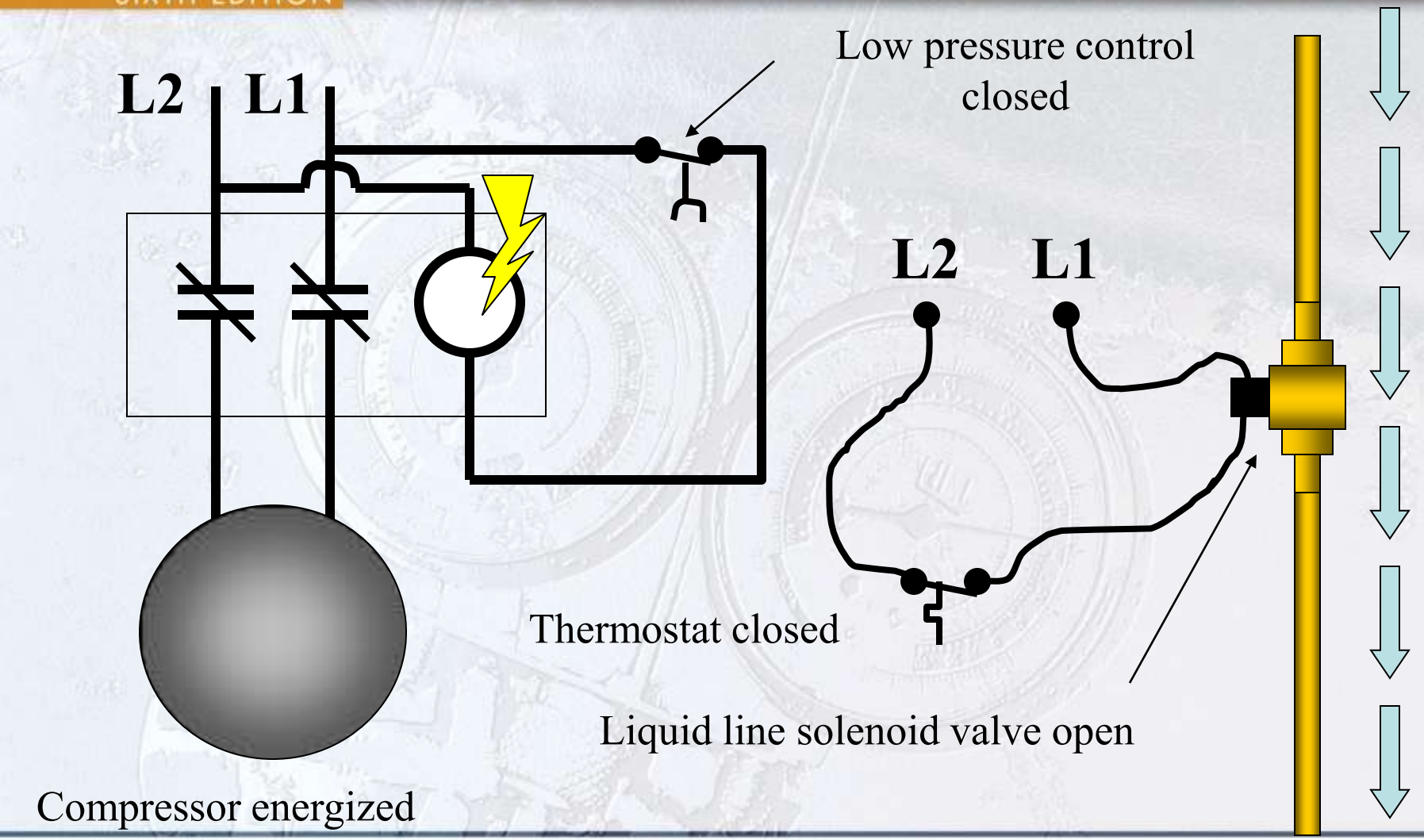
LOW-PRESSURE CONTROL APPLIED AS A THERMOSTAT

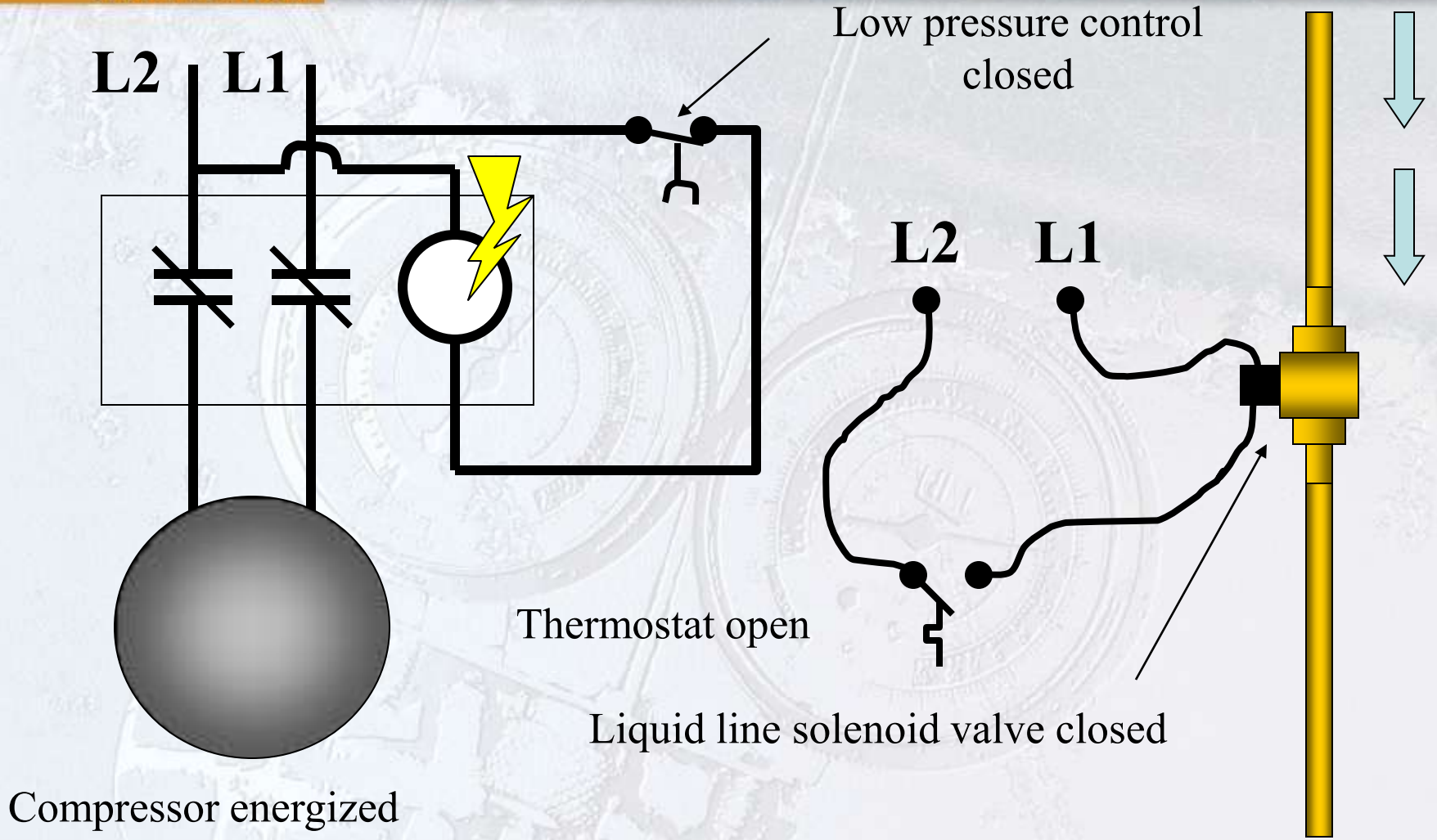
- Control will cut off the compressor when the pressure equals the system pressure that corresponds to a temperature about 15˚ cooler than desired box temperature
- Control is rated by pressure range and current draw of the contacts

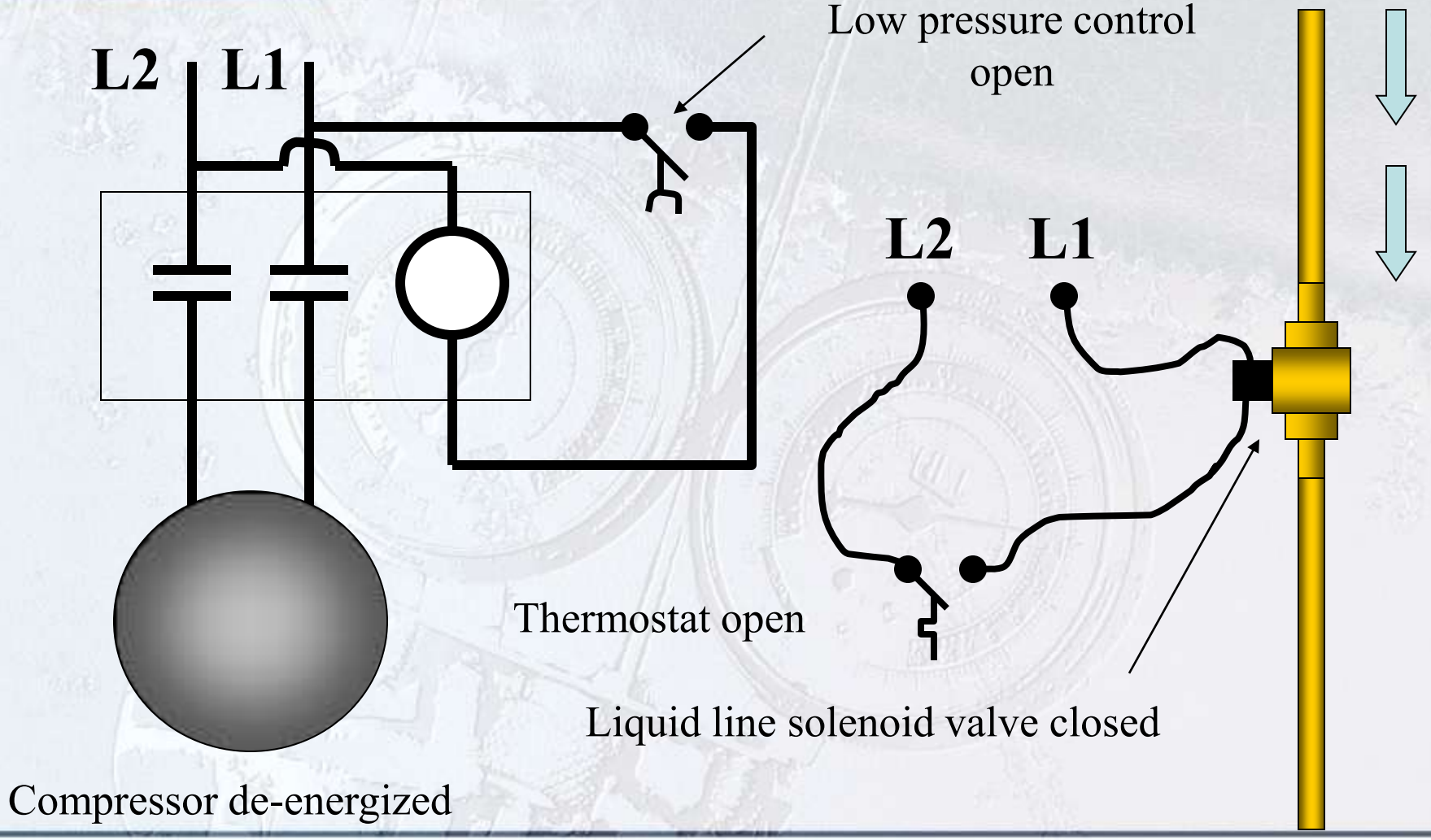


AUTOMATIC PUMP-DOWN SYSTEMS – (SHUTDOWN) SEQUENCE OF OPERATION

- Normally closed liquid-line solenoid valve controlled by a thermostat
- Thermostat opens when desired box temperature is reached
- The solenoid is de-energized and closes
- Compressor continues to pump refrigerant
- The suction pressure drops
- Low-pressure control opens when suction pressure drops
- Low-pressure control controls compressor operations

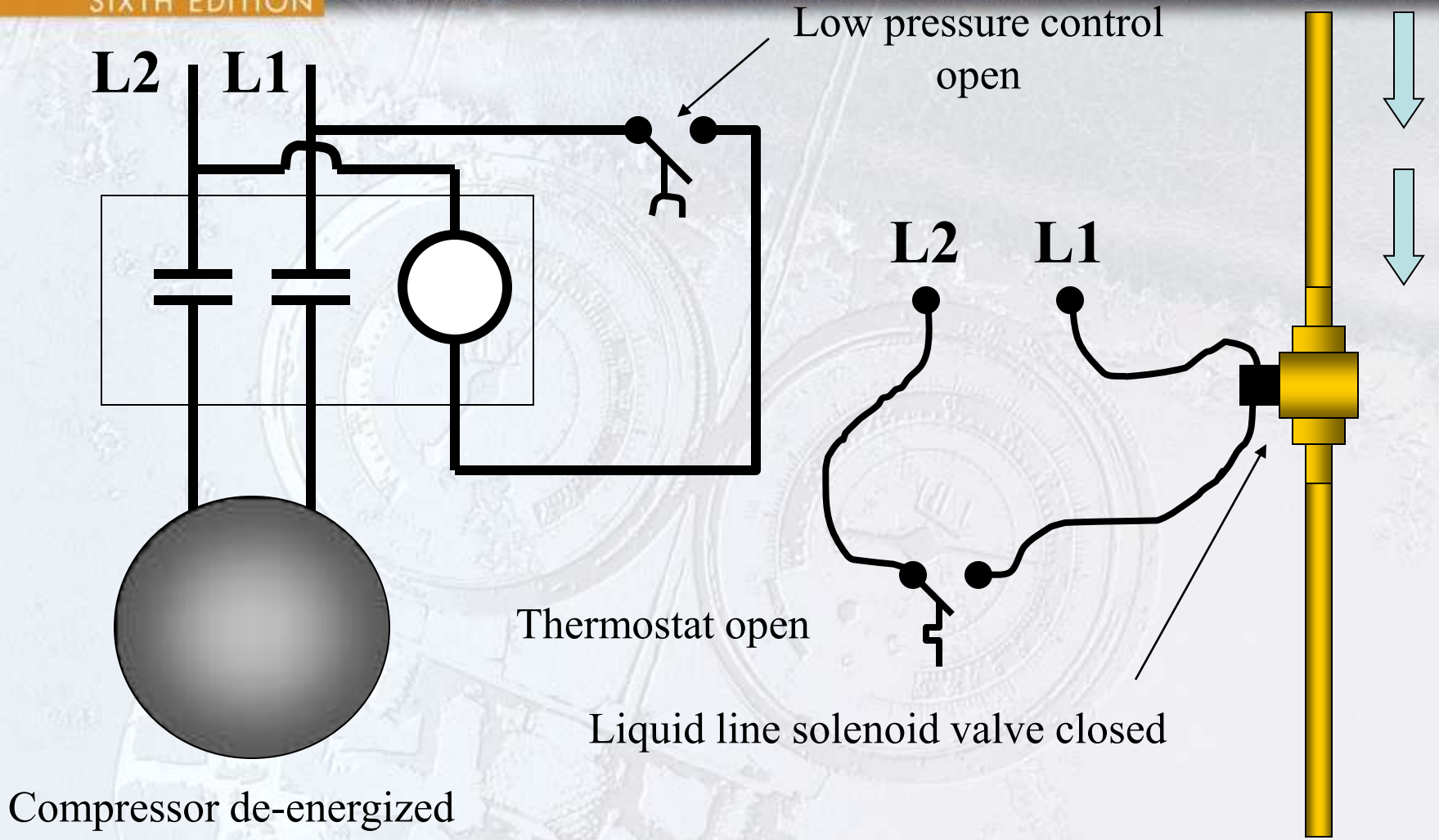


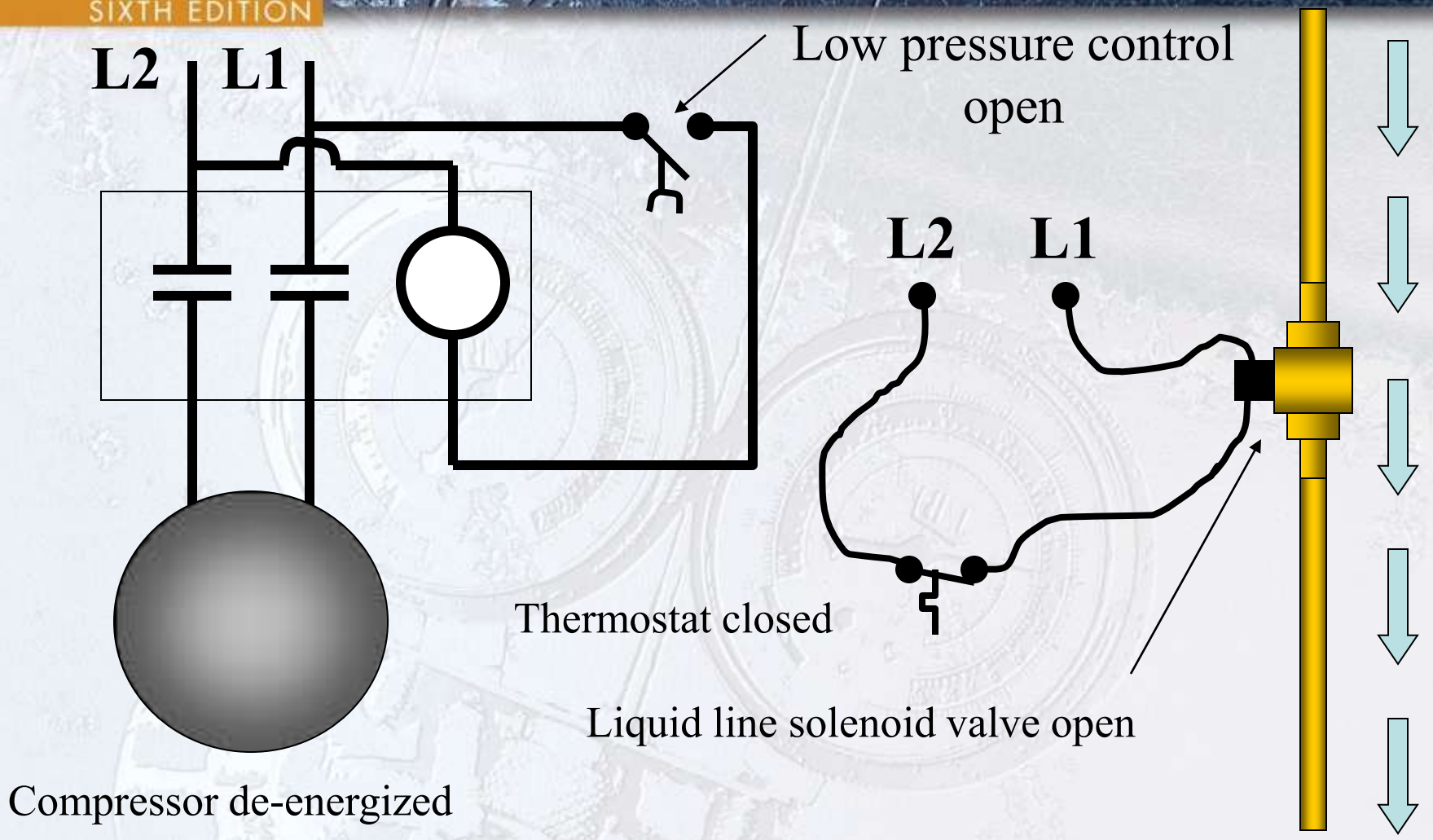


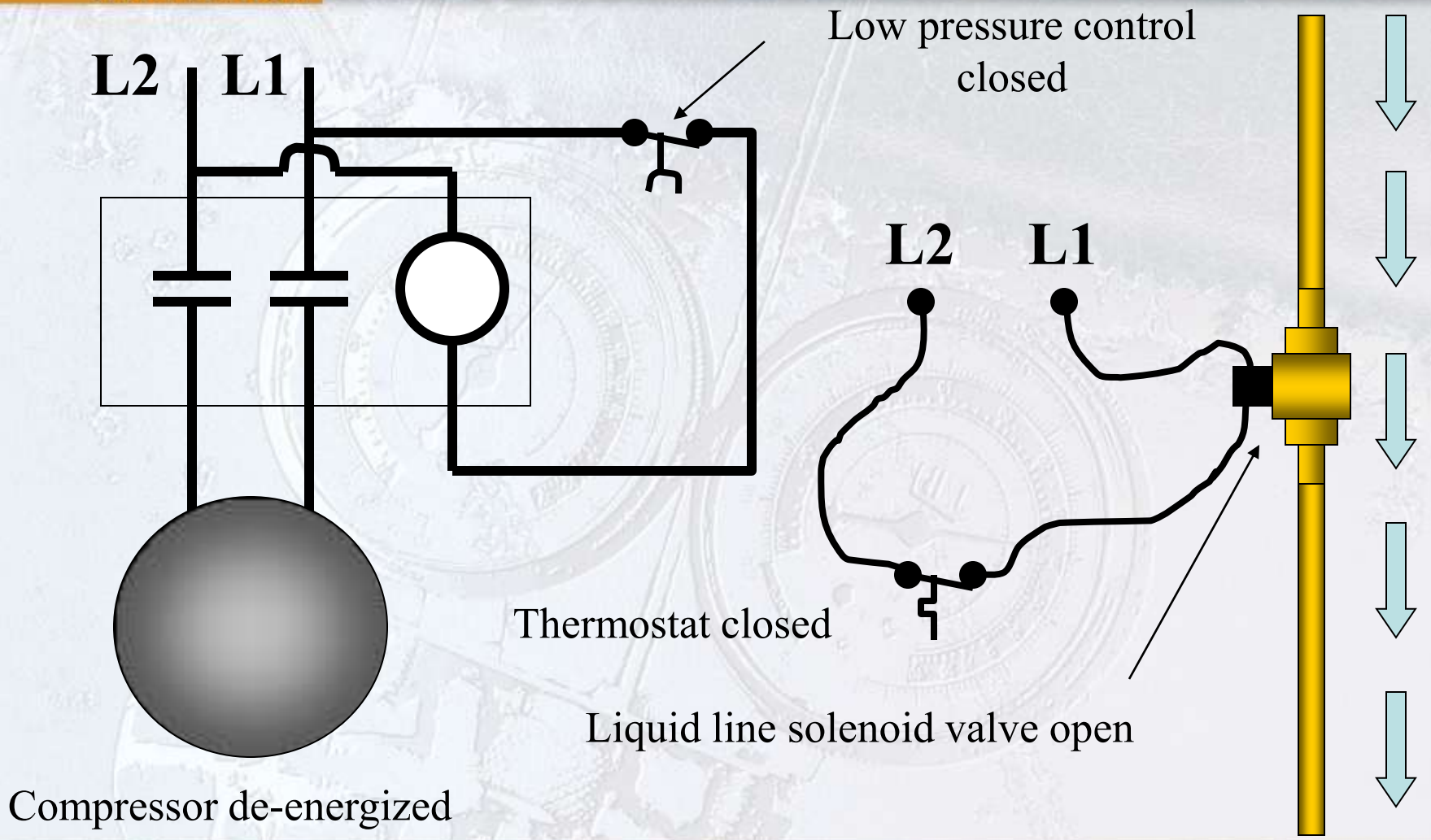


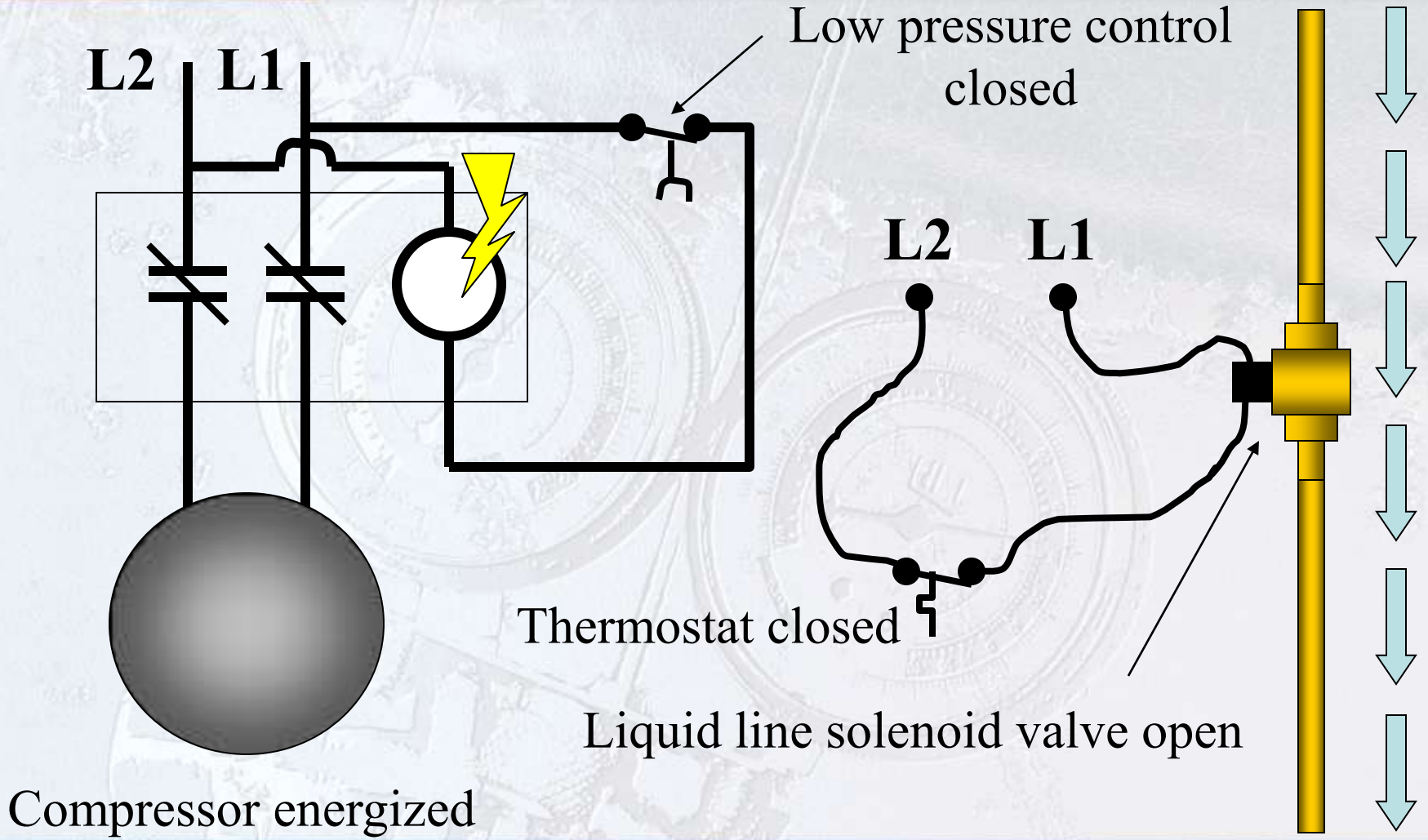
AUTOMATIC PUMP-DOWN SYSTEMS – (STARTUP) SEQUENCE OF OPERATION

- When the box temperature rises, the thermostat closes
- The liquid-line solenoid is energized
- Refrigerant flows to the evaporator
- The compressor is still off
- When the low-side pressure increases, the low-pressure control closes
- The compressor is once again energized









HIGH-PRESSURE CONTROL

- Prevents compressor from operating at high head pressures
- Control opens on a rise in pressure
- Can be automatically or manually reset
- Should be set at a pressure higher than the normal operating head pressure
- Manual reset controls provide better equipment protection

LOW-AMBIENT FAN CONTROL

- Starts and stops the condenser fan motor in response to head pressure
- Starts the condenser fan motor when the head pressure rises
- This setting should be lower than the set point on the high-pressure control

OIL PRESSURE SAFETY CONTROL

- Larger compressors are equipped with oil pumps
- Oil pump is connected to the compressor crankshaft
- Oil is forced through holes in the crankshaft
- Measures net oil pressure
- Net oil pressure = pump outlet pressure – suction pressure
- Control uses a double bellows
- Has a time delay built into the control to allow oil pressure to build up

DEFROST CYCLE (MEDIUM-TEMPERATURE REFRIGERATION

- Typical box temperature ranges from 34° F to 45° F
- Coil temperatures are normally 10° to 15° F cooler than the box
- Coil will be operating below 32° F but box will be above 32° F
- Air in box is used to defrost the coil in the off cycle

RANDOM OR OFF-CYCLE DEFROST

- Coil defrosts using box temperature air compressor cycles off on the thermostat
- Evaporator fan will continue to run while the compressor is off
- Air in box defrost coil
- Coil defrosts whenever compressor cycles off

PLANNED DEFROST

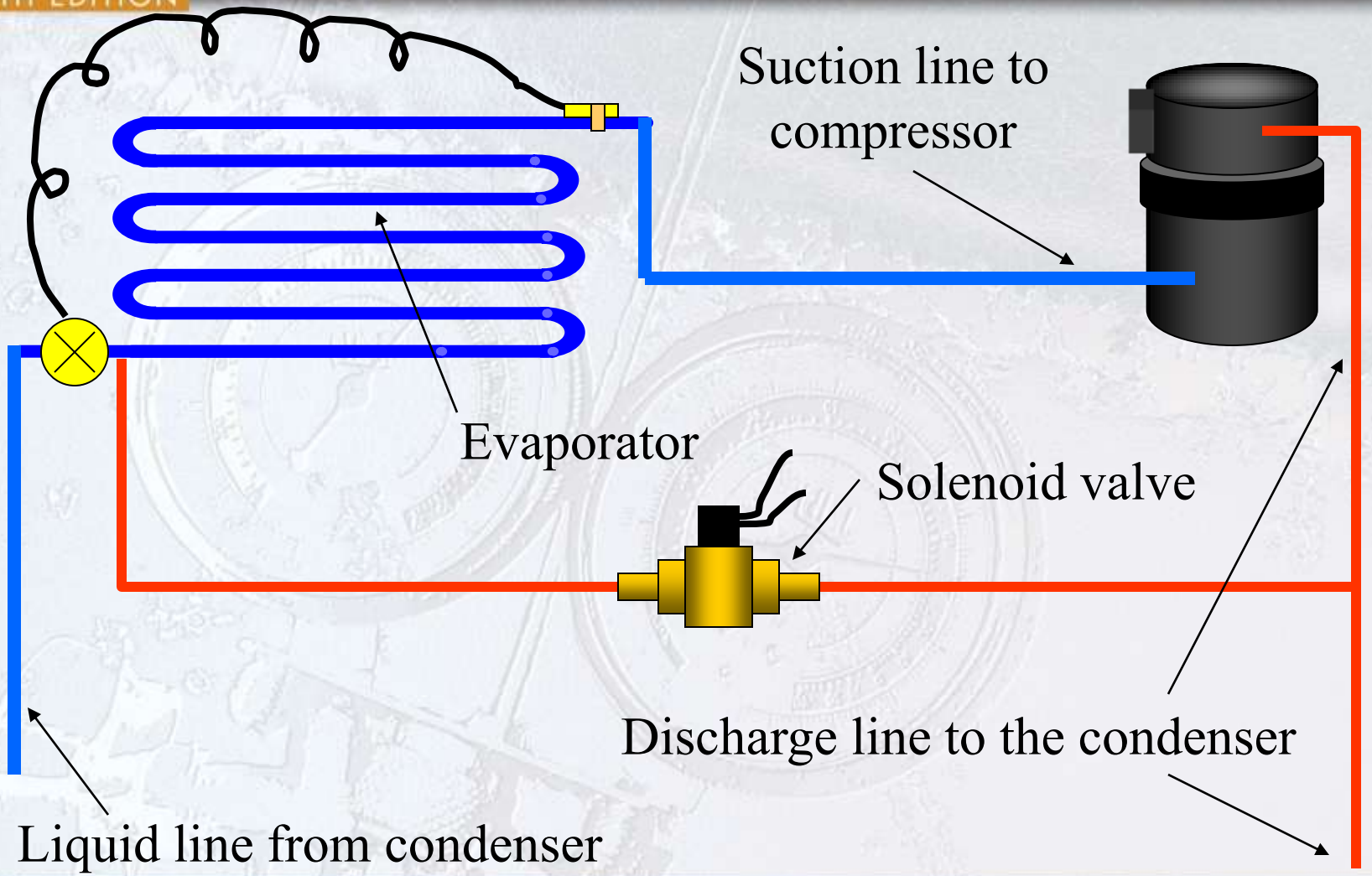
- Defrost is controlled by a timer
- System goes into defrost at predetermined times
- Defrost cycle is initiated during low load periods
- Systems in retail establishments often go into defrost when the store is closed

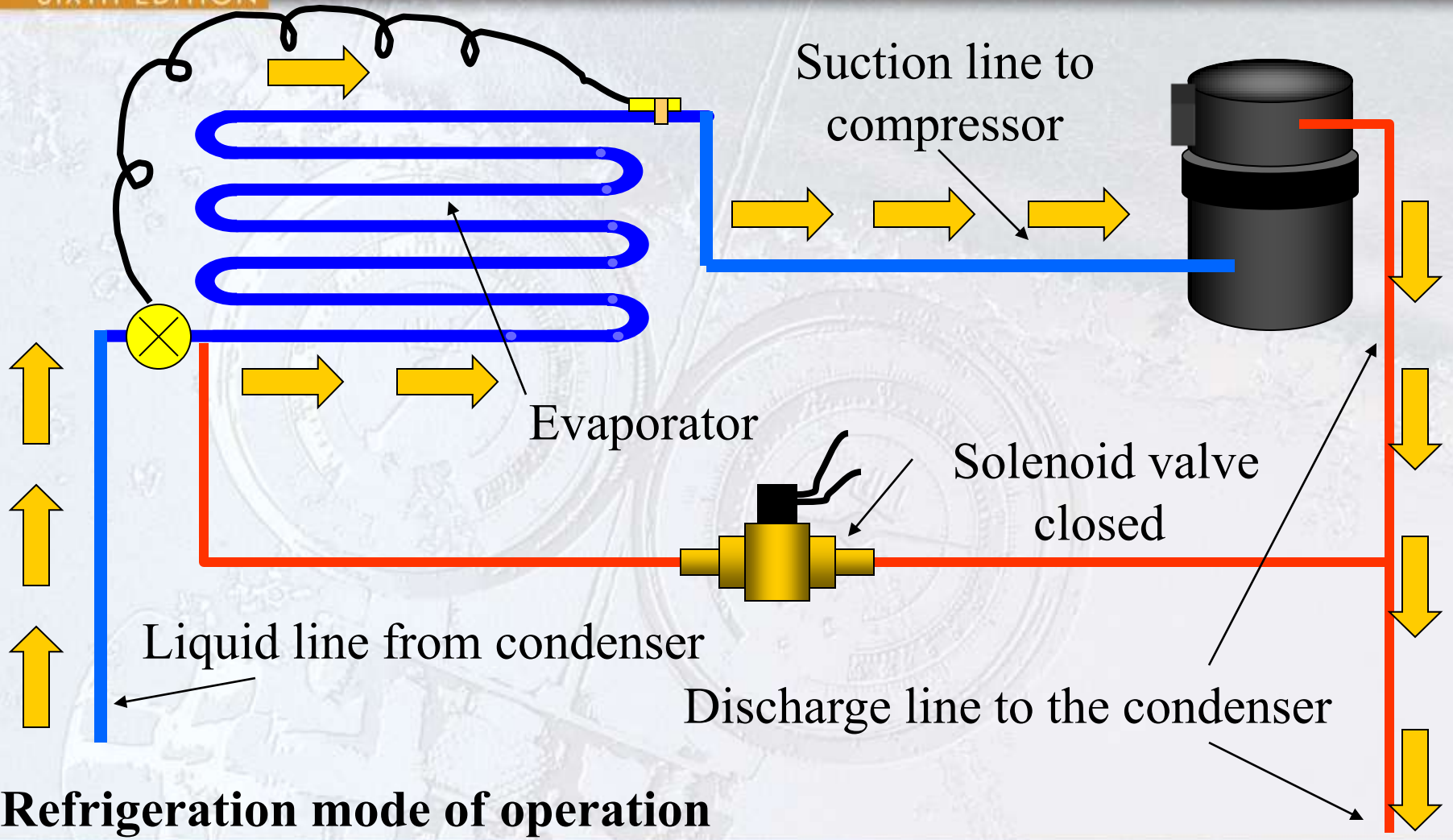
LOW-TEMPERATURE EVAPORATOR DESIGN

- Box and coil temperatures are both below 32° F
- Coil is defrosted using internal or external heat
- Air in the box cannot be used to defrost the evaporator coil
- Internal heat – Hot gas from the compressor
- External heat – Electric strip heaters

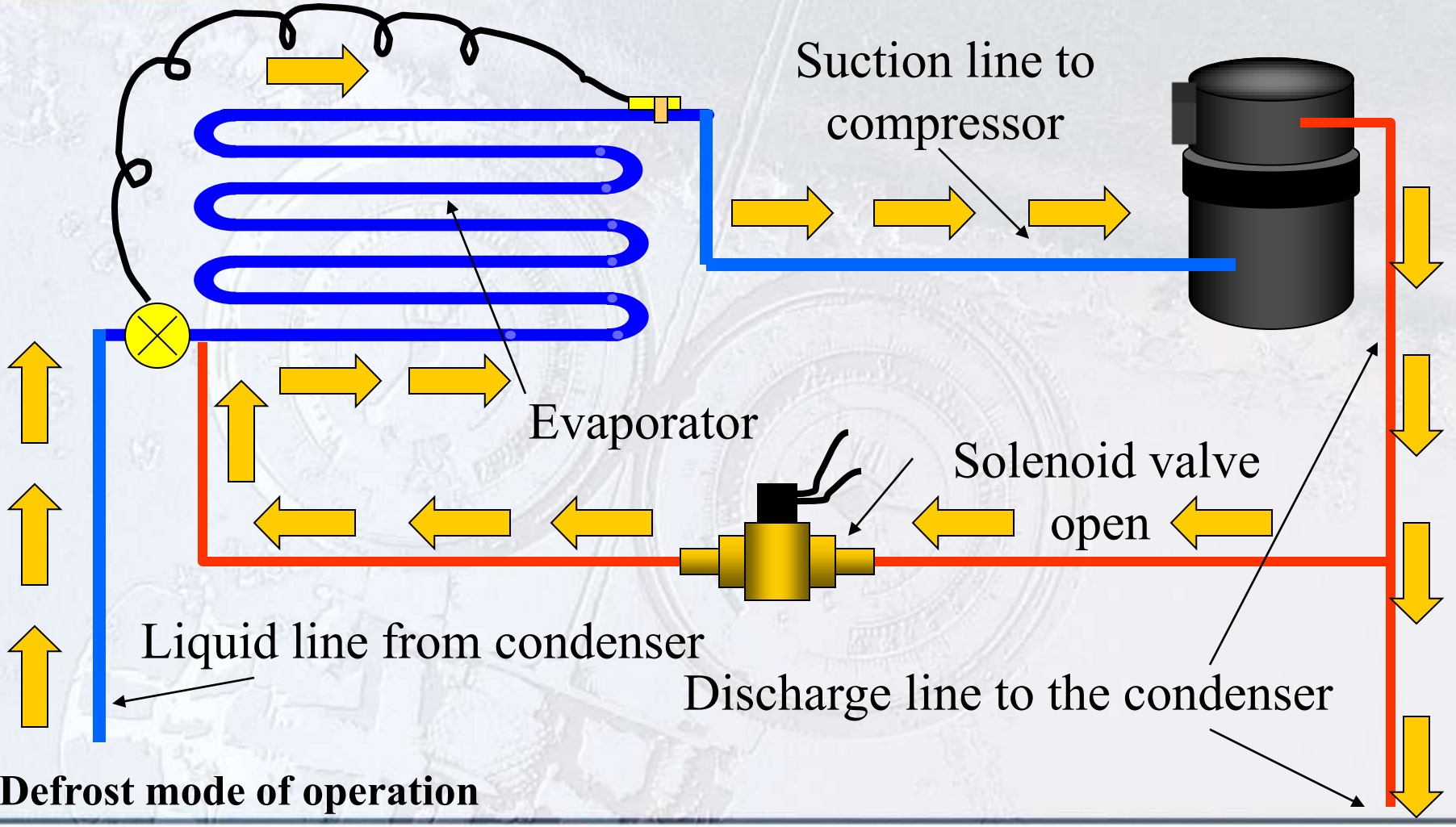
DEFROST USING INTERNAL HEAT (HOT GAS DEFROST)

- Uses hot gas from the compressor's discharge
- Discharge gas is directed into the evaporator
- Utilizes a hot gas solenoid defrost is initiated by a timer
- Defrost is terminated by either time or coil temperature
- Evaporator fan is de-energized during defrost
- Compressor runs during defrost
- Refrigerant condenses in the evaporator





Refrigeration mode of operation



Defrost mode of operation

EXTERNAL HEAT TYPE OF DEFROST

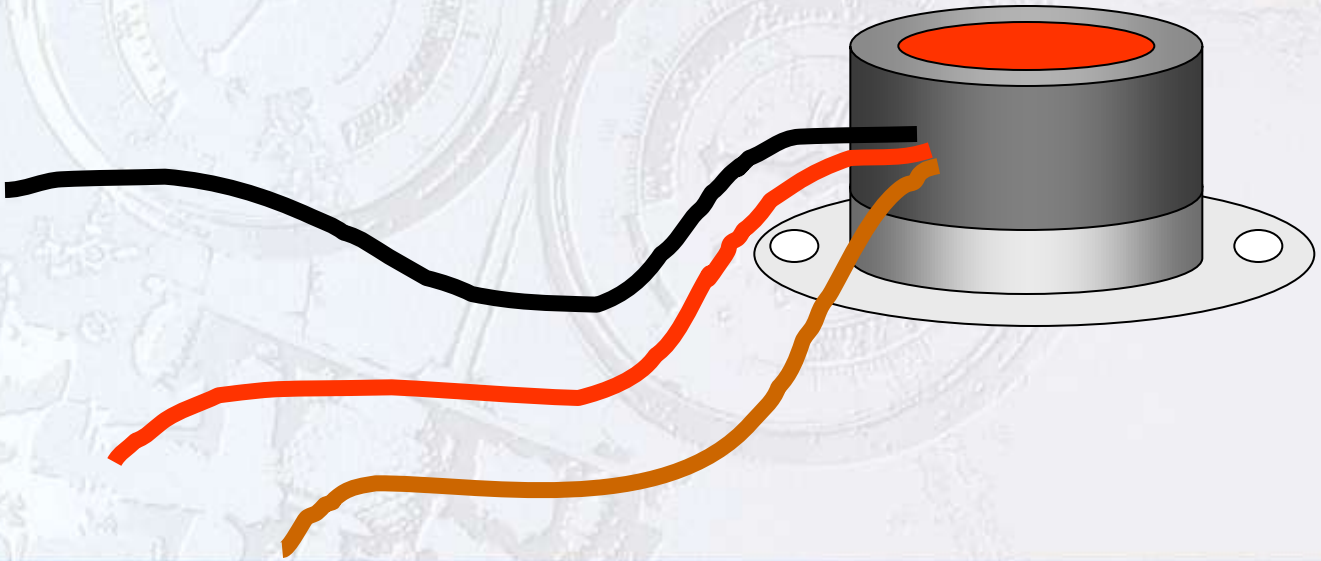
- Usually accomplished with electric heaters mounted to the evaporator coil
- Defrost is initiated by a timer
- Defrost is terminated by either time or coil temperature
- Evaporator fan is de-energized during defrost
- Compressor is de-energized during defrost

DEFROST TERMINATION AND FAN DELAY CONTROL

- Single pole, double throw switch
- Terminates defrost when frost has all been removed
- Delays evaporator fan start until coil temperature drops
- When ice has been removed, the evaporator surface temperature increases
- The control senses this increase in temperature and the system is put back into refrigeration mode mechanically
- When the coil temperature drops to the set point temperature, the fan is energized

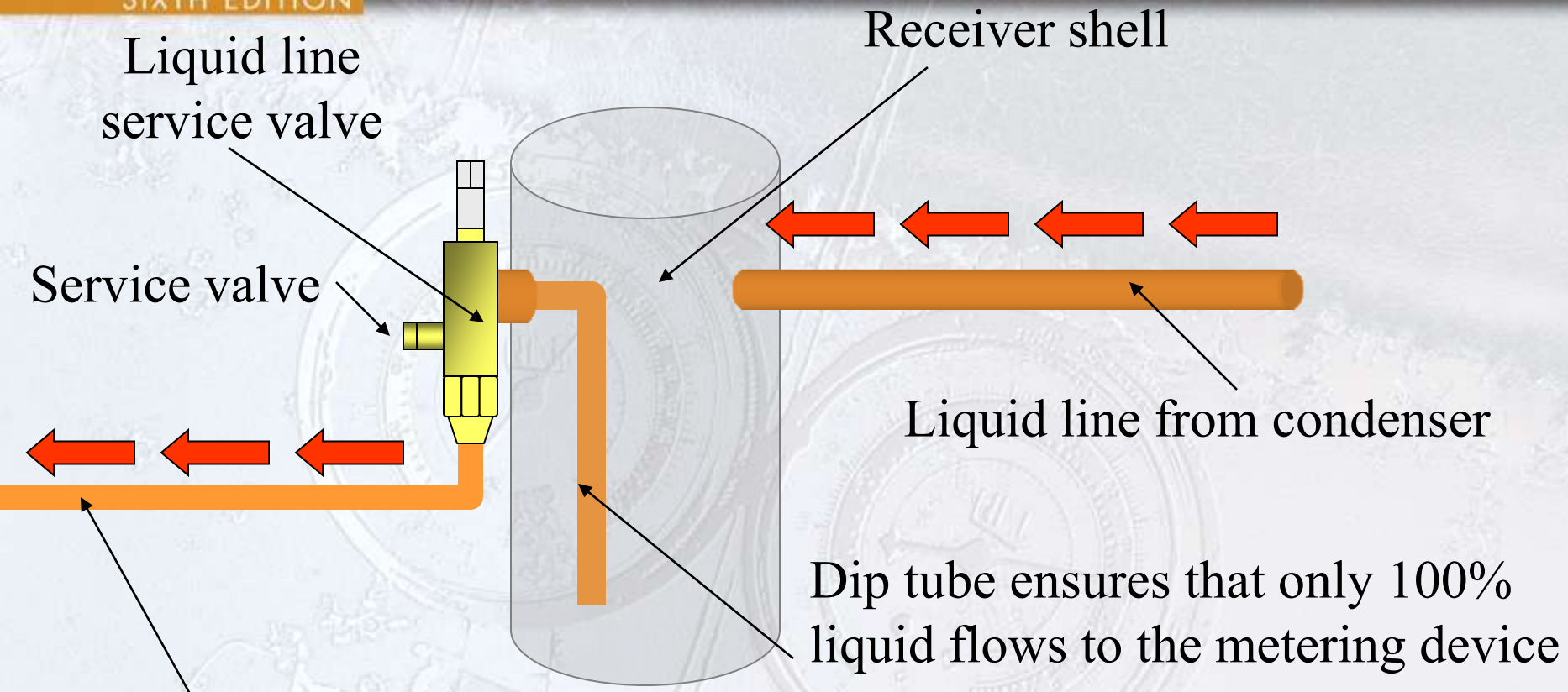
DEFROST TERMINATION AND FAN DELAY CONTROL

Single pole, double throw switch



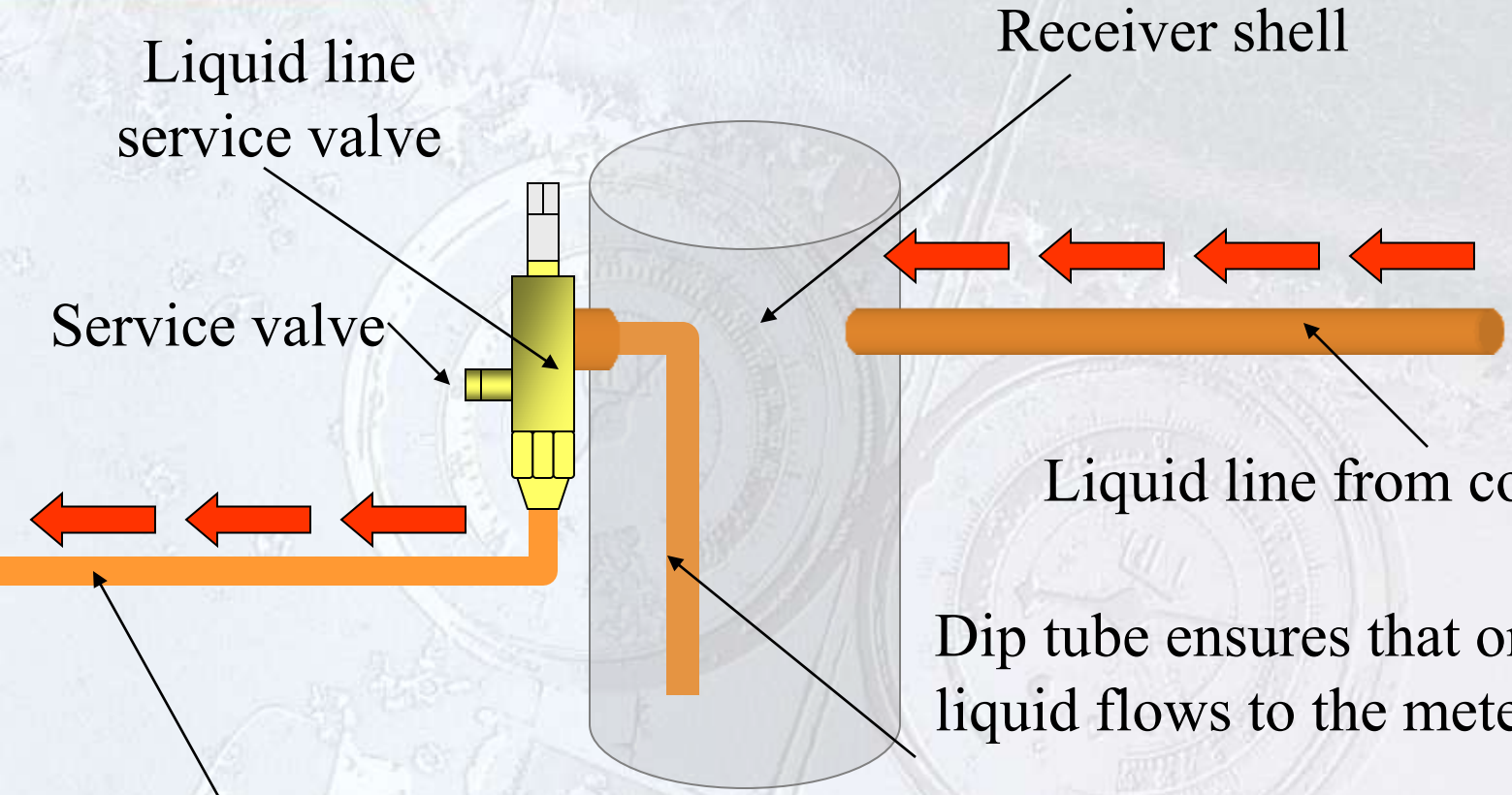
RECEIVERS

- Located in the liquid line
- The device stores liquid refrigerant
- Refrigerant leaves the receiver as 100% liquid
- A dip tube is used to remove the liquid from the bottom
- Must be used on systems with condenser flooding valves
- Found on systems with automatic or thermostatic expansion valves
- Not found on critically charged (capillary tube) systems

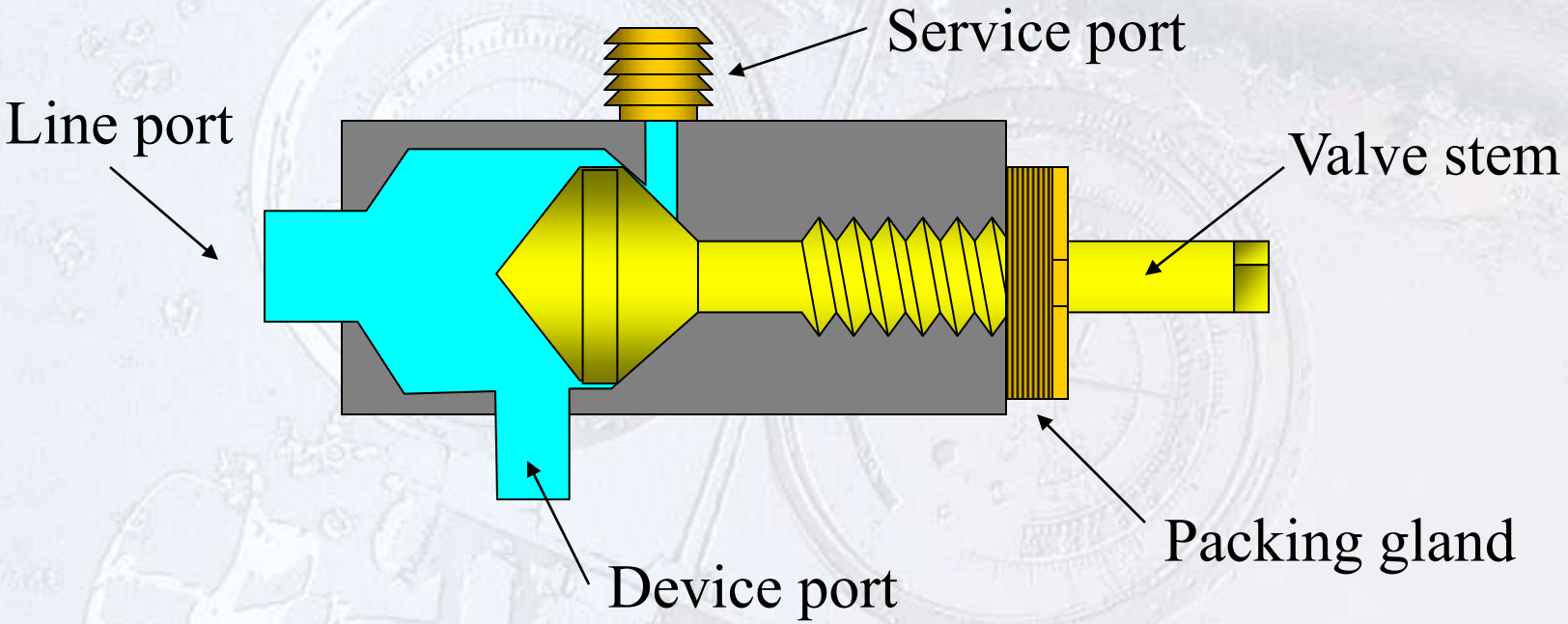


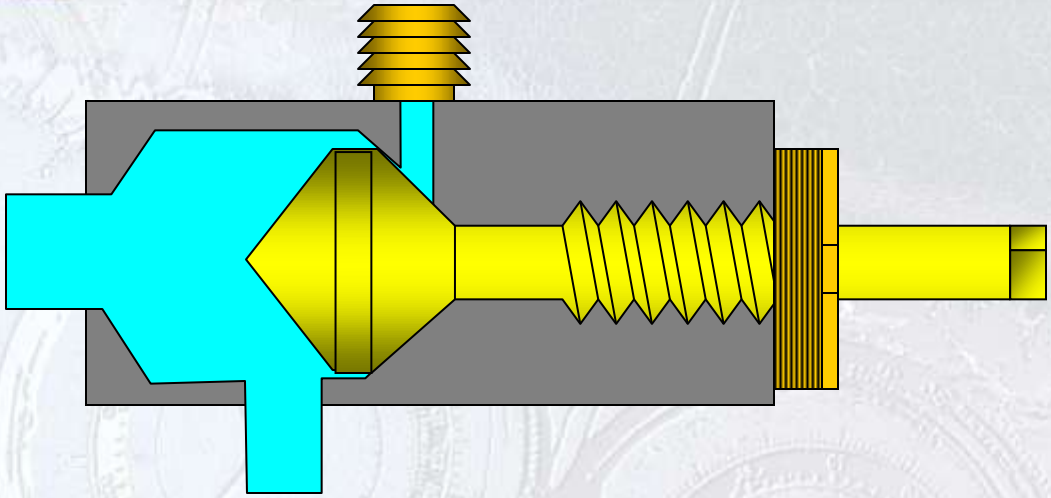
THE KING VALVE ON THE RECEIVER

- Located in the liquid line between the receiver and expansion device
- Under normal operating conditions, the valve is back seated
- Valve can be front seated in order to pump system down
- Has a service port to enable the technician to take pressure readings
- Valve must be cracked off the back seat to take pressure readings



SERVICE VALVES

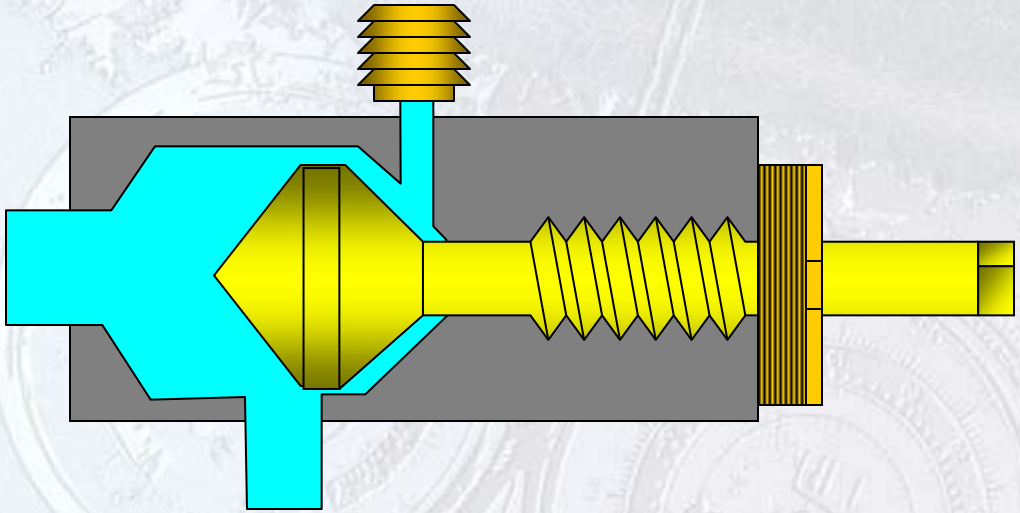




Backseated Position

- Service port is sealed, line port is open to the device port
- Normal operating position

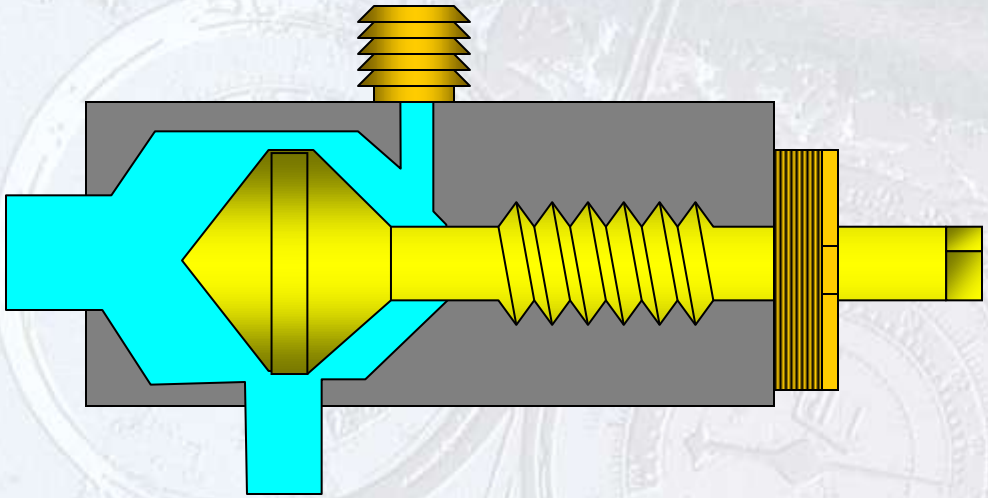
SERVICE VALVES



Cracked off the Backseat Position

- Service port is open to the line port and device port
- Position used for taking system pressure readings
- Position used for adding or removing system refrigerant

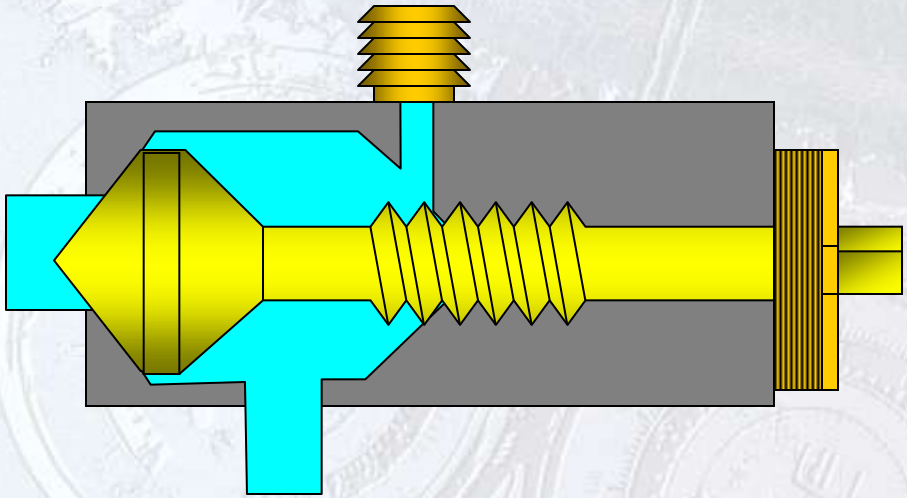
SERVICE VALVES



Midseated Position

- Service port is open to the line port and device port
- Position used for system evacuation and leak checking

SERVICE VALVES



Frontseated Position

- Service port is open to the device port
- Line port is sealed off
- Position used for pumping the system down

FILTER DRIERS

- Located in the liquid line
- Removes dirt, moisture, and acid from the refrigeration system
- Desiccant – Activated alumina, molecular sieve, silica gel
- Can be permanent or replaceable core type
- Connected to system with either solder joints or flare connections

REFRIGERANT CHECK VALVES

- Allows refrigerant to flow in only one direction
- Can be either the ball type or magnetic type
- Must be installed with the arrow pointing in the direction of refrigerant flow
- Installed at the outlet of the lowest temperature coil on multi-evaporator systems

REFRIGERANT SIGHT GLASSES

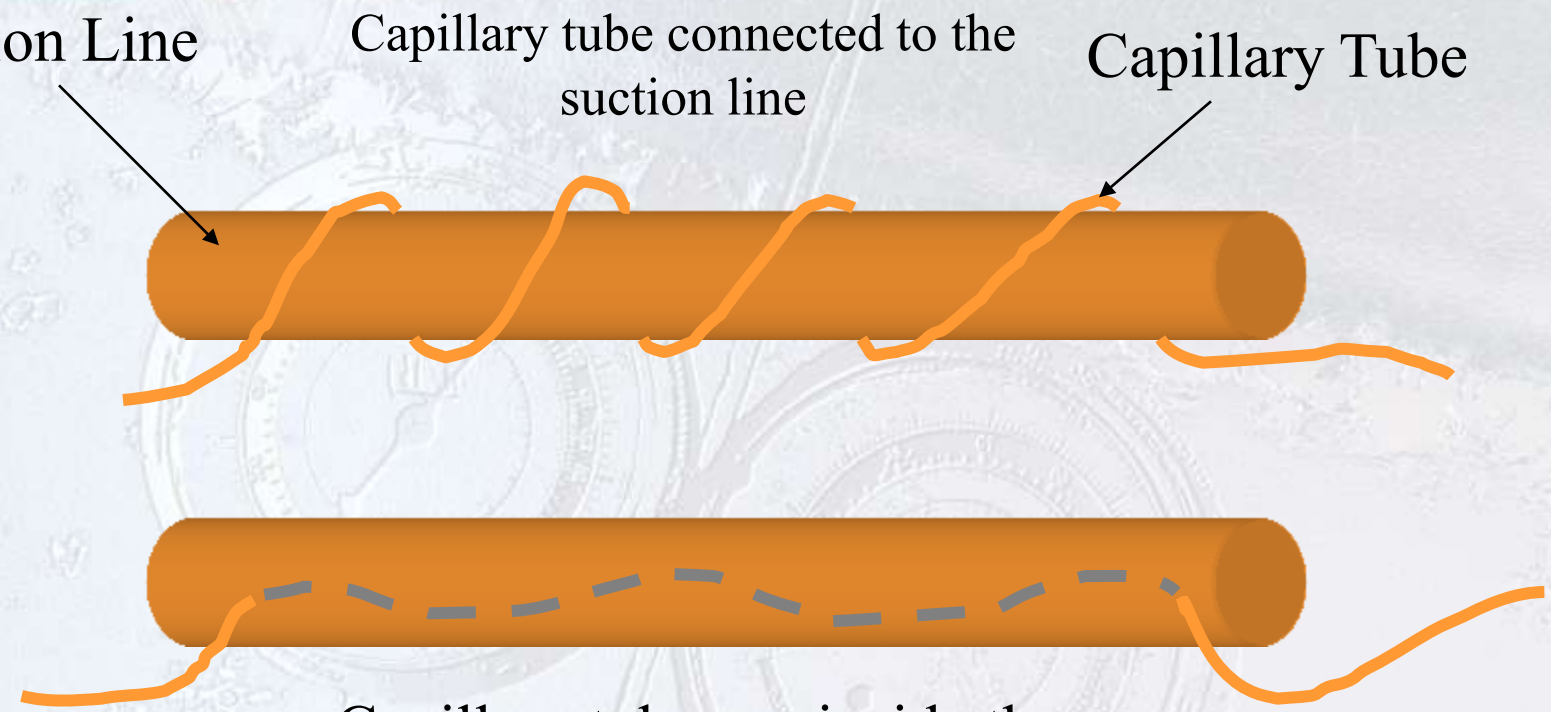
- Installed in the liquid line
- Enables the technician to determine if a solid column of liquid is reaching the expansion device
- Can also be supplied with a moisture indicator
- Usually installed after the filter drier

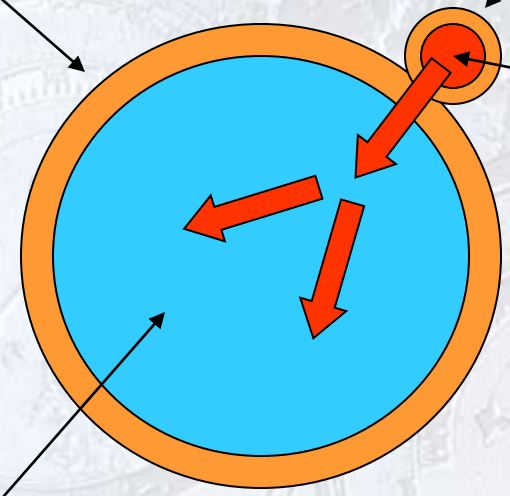
LIQUID REFRIGERANT DISTRIBUTORS

- Used on multi-circuit evaporators
- Located at the outlet of the expansion device
- Designed to allow equal refrigerant flow to all evaporator circuits
- Some distributors are made with side inlets used for hot gas defrost

HEAT EXCHANGERS

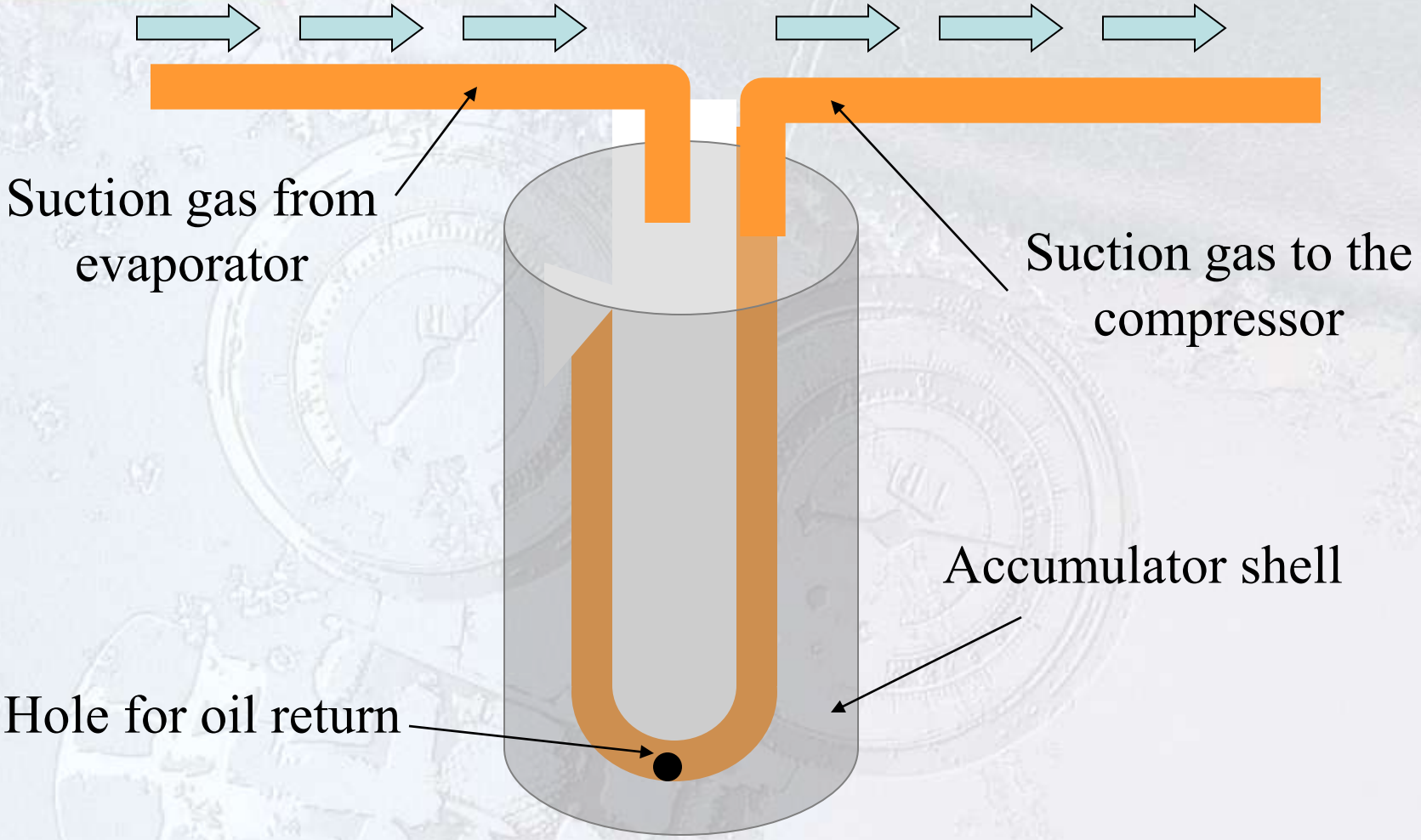
- In the suction line leaving the evaporator
- Suction and liquid lines are connected to allow heat to transfer between them
- Increases the amount of subcooling in the liquid entering the expansion device
- Prevents liquid from moving through the suction line into the compressor

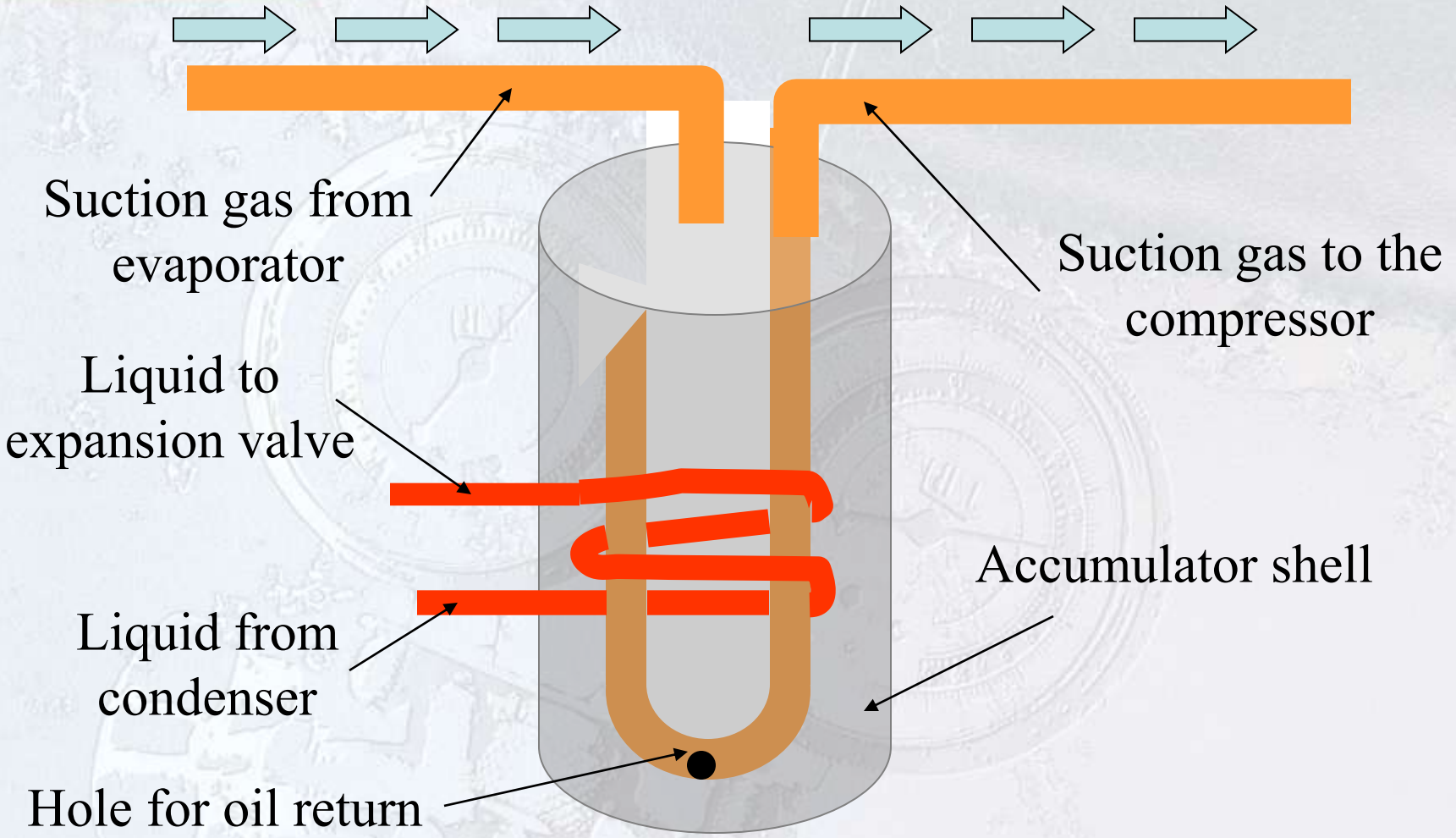




SUCTION LINE ACCUMULATORS

- Located in the suction line, close to the compressor
- Prevents liquid refrigerant from entering the compressor
- Gives liquid a place to boil off before entering compressor
- Sometimes, the liquid line is routed through the accumulator to help boil away any liquid and also increase liquid subcooling





CAUSES OF LIQUID FLOODBACK

- Improper TXV setting
- Oversized TXV
- Loose TXV thermal bulb
- System overcharge
- Reduced airflow through evaporator coil
- Low system load
- Defrost problems

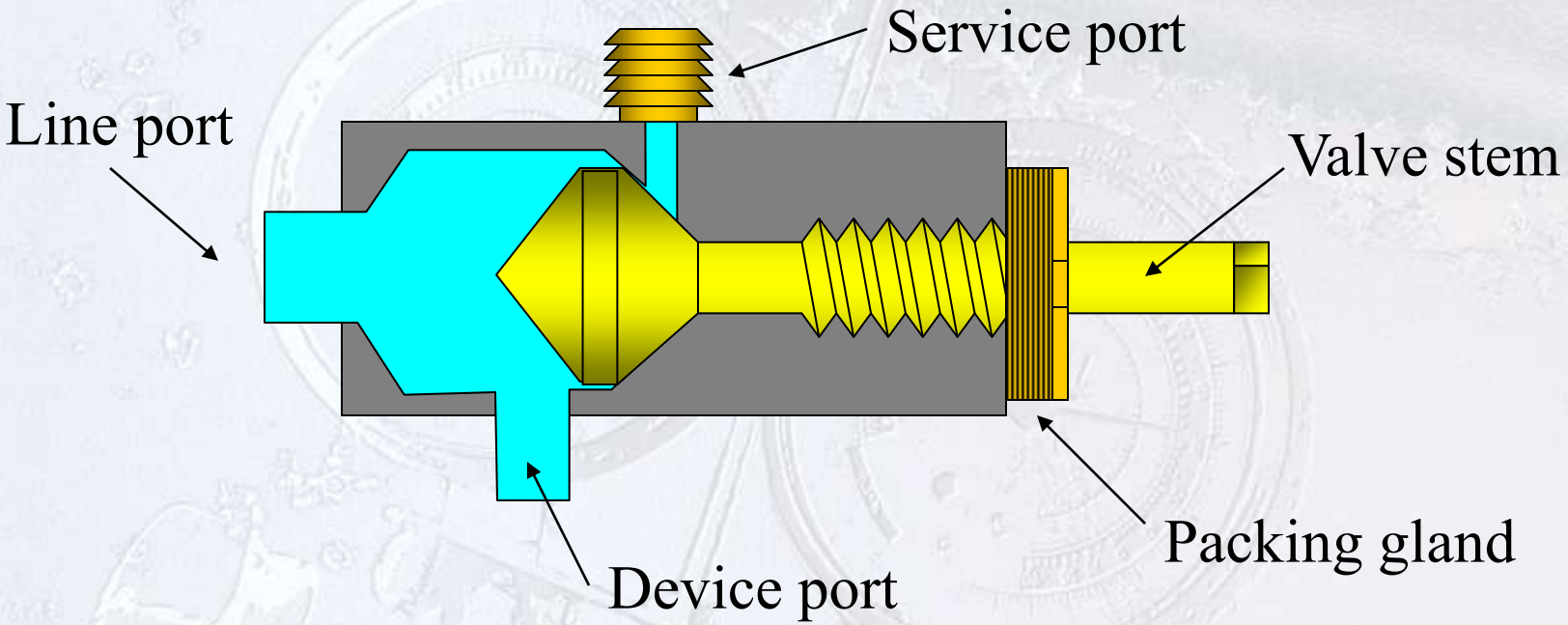
SUCTION-LINE FILTER DRIERS

- Located in the suction line
- Good compressor protection
- Must be installed when system has become contaminated
- Usually have two pressure ports to read the pressure drop across the device

SUCTION SERVICE VALVES

- Normally attached to the compressor
- Valve positions
  - Back seated – Normal operating position
  - Front seated – used for pump down and service
- Mid seated – Used for system evacuation
- Cracked off the back seat – Used for taking pressure readings, charging refrigerant into the system, or removing refrigerant from the system

SERVICE VALVES

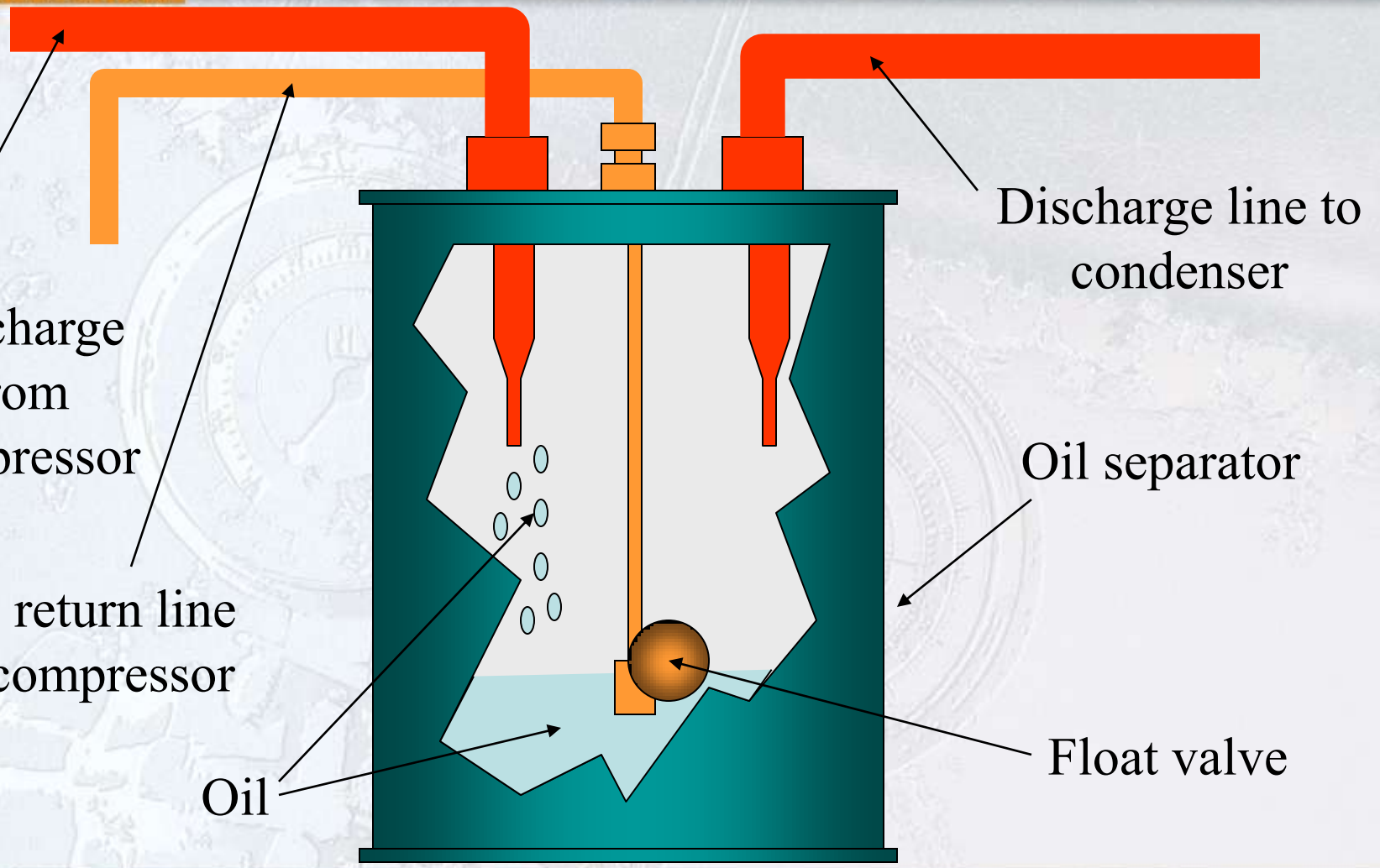


DISCHARGE SERVICE VALVES

- Located in the discharge line
- Normally attached to the compressor
- Used as a gage port and to valve off the compressor for service
- Same positions as the suction service valve
- This valve should not be front seated when the compressor is running except during closed-loop capacity tests

OIL SEPARATORS

- Installed in the discharge line
- Separates oil from the refrigerant and returns the oil to the compressor
- Oil drops fall to the bottom of the separator
- Oil level raises a float and opens a valve
- Difference between high- and low-side pressures push oil back to the compressor
- Device needs to be kept warm



PRESSURE ACCESS PORTS

- Installed to take pressure readings at various points in the system
- Line piercing valves can be installed while the system is running
- Can be saddle type or solder type
- Can either have a Schrader pin or a small valve

CRANKCASE HEAT

- Prevents refrigerant from migrating to the oil in the off cycle
- Prevents oil from foaming and being pumped out of the compressor
- External type heaters
- Insertion type
- Crankcase heat is needed during the off cycle and is sometimes controlled by a set of normally closed contacts that open when the compressor is energized

UNIT SUMMARY - 1

- Additional components enhance system operation
- The EPR is used on multiple evaporator systems to maintain different pressures in each evaporator
- EPR valves are located in all evaporators except the lowest pressure evaporator
- The CPR provides a limit to the pressure that can enter the compressor
- Relief valves release refrigerant from a system when a high-pressure condition exists
- Low ambient controls are used on refrigeration systems that operate year round

UNIT SUMMARY - 2

- Common low ambient controls include fan cycling, shutters, dampers and condenser flooding
- Solenoid valves are used to start and stop the flow of refrigerant (Snap-acting valve)
- Liquid line solenoids are used as part of the automatic pump down cycle
- Pressure witches open and close in response to sensed pressures
- Pressure switches can be operational or safety devices

UNIT SUMMARY - 3

- The oil pressure safety control ensures that compressors operate with sufficient oil pressure
- Defrosting medium temperature refrigeration systems can be accomplished with planned, random or off-cycle defrost
- Defrosting low temperature refrigeration systems is accomplished with hot discharge gas (internal) or electric strip heaters (external)

UNIT SUMMARY - 4

- Receivers are refrigerant storage tanks located at the outlet of the condenser
- Receivers are equipped with service valves that can be beackseated, cracked off the backseat, midseated or frontseated
- Filter driers remove dirt, moisture, and acid from the refrigeration system
- Check valves ensure that refrigerant flows through the circuit in only one direction
- Refrigerant distributor allow equal amounts of refrigerant flow to all evaporator circuits

UNIT SUMMARY - 5

- Suction line/liquid line heat exchangers increase subcooling and help ensure that 100% vapor enters the compressor
- Accumulators help liquid refrigerant boil before it enters the compressor
- Oil separators help remove oil from the hot vapor that is discharged from the compressor
- Crankcase heat helps boil refrigerant from the oil in the compressor crankcase