Refrigeration Workshop Exercises

220/240 V - 50 Hz

FESTO

Refrigeration and HVAC

LabVolt Series

Student Manual

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Student Manual

Refrigeration Workshop Exercises

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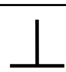
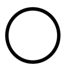
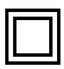
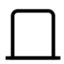
Safety and Common Symbols

The following safety and common symbols may be used in this manual and on the equipment:

Symbol	Description
⚠ DANGER	**DANGER** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
⚠ WARNING	**WARNING** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
⚠ CAUTION	**CAUTION** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
CAUTION	**CAUTION** used without the *Caution, risk of danger* sign ⚠, indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage.
	Caution, risk of electric shock
	Caution, hot surface
	Caution, risk of danger
	Caution, lifting hazard
	Caution, hand entanglement hazard
	Notice, non-ionizing radiation
	Direct current
	Alternating current
	Both direct and alternating current
3∿	Three-phase alternating current
	Earth (ground) terminal

Safety and Common Symbols

Symbol	Description
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (supply)
	Off (supply)
	Equipment protected throughout by double insulation or reinforced insulation
	In position of a bi-stable push control
	Out position of a bi-stable push control

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Preface

The most important application of a modern refrigeration system is the refrigerator used for the preservation of food.

Most foods spoil rapidly when kept at room temperature due to the rapid growth of bacteria. When food is kept at a temperature of about 4.4°C (40°F), bacteria grow quite slowly. Therefore, food kept at this temperature will last much longer.

Other refrigeration systems are used for air-conditioning, beverage cooling and freezing of food.

Refrigeration first became important commercially in the 18th century in Europe and North America. Blocks of ice from frozen lakes and ponds were stored in insulated store rooms for summer use.

Ice was first made artificially about 1820 as an experiment but did not become commercially practical until 1834.

It was not until 1918 that Kelvinator produced the first automatic refrigerator for the American market. Total sales for that year were 67 machines and 200 more in 1919 to 1920. Today, more than 10 million units are sold each year.

We invite readers of this manual to send us their tips, feedback, and suggestions for improving the book.

Please send these to did@de.festo.com.

The authors and Festo Didactic look forward to your comments.

About This Manual

In refrigeration and air-conditioning systems, various skills are required to perform operations such as installing, troubleshooting and replacing defective components.

The Universal Refrigeration Trainer, Model 3420, is a versatile trainer. Its standard industrial components are reusable. The insulated stainless steel chamber has a clear plastic door and its components are mechanically mounted on removable and reversible wooden panels. All wiring devices are of the industrial type. The heavy gauge steel support is mounted on four heavy-duty casters. This trainer is supplied in kit form.

The manual Refrigeration Workshop Exercises provides a student laboratory manual consisting of two units. The first unit covers security in the laboratory and common refrigeration symbols. The second unit contains four suggested exercises involving typical refrigeration systems. Each exercise has two parts: the assembly of the mechanical system, and the electrical wiring. Upon completion of this manual the student will be familiar with safety rules, able to identify symbols, and able to assemble several typical refrigeration and electrical circuits.

Safety considerations

Safety symbols that may be used in this manual and on the equipment are listed in the Safety Symbols table at the beginning of the manual.

Safety procedures related to the tasks that you will be asked to perform are indicated in each exercise.

Make sure that you are wearing appropriate protective equipment when performing the tasks. You should never perform a task if you have any reason to think that a manipulation could be dangerous for you or your teammates.

Systems of units

Units are expressed using the International System of Units (SI) followed by the units expressed in the U.S. customary system of units (between parentheses).

Equipment Required

Refrigeration Equipment

QTY	DESCRIPTION	NUMBER
7.6 m	Tubing CU375	29027
1	Solenoid Valve FI 6.4 mm (1/4") - FI 6.4 mm (1/4")	29053
1	Filter/Dryer	36789
1	Liquid Indicator 1 FE 6.4 mm (1/4") - FI 6.4 mm (1/4")	36785
1	High-Pressure Refrigerant Gauge	36025
1	Low-Pressure Refrigerant Gauge	36026
1	Liquid Indicator 2 FE 9.5 mm (3/8") - FE 9.5 mm (3/8")	36786
1	Thermostatic Expansion Valve FE 6.4 mm (1/4") - FE 6.4 mm (1/4")	29062
20	Nut FI 250	29063
12	Nut FI 375	29064
2	Nut FI 500	29065
2	Tee 9.5 mm (3/8") - 6.4 mm (1/4") - 9.5 mm (3/8")	29067
7.6 m	Tubing CU250, soft	29071
1	Strainer/Capillary tube	29074
2	Tee FE 6.4 mm (1/4") - FE 6.4 mm (1/4") - FE 6.4 mm (1/4")	29083
1	Suction Line Accumulator	29087-1
2	Adaptor NPTF 1/8" - FE 6.4 mm (1/4")	29095

Mechanical Equipment

QTY	DESCRIPTION	NUMBER
13	Hex Kep Nut 6-32	22114
2	PRH Screw 8-32-1/4"	22115
13	PRH Screw 6-32-3/8"	22171
46	PRH Tapping Screw 10-1/2	23001
4	PRH Tapping Screw 10-5/8	23272
6	Angle Bracket	29050
3	Liquid Indicator Bracket	36878
1	Filter/Dryer Bracket	36879
3	Copper Clamp 6.4 mm (1/4")	29075
3	Copper Clamp 9.5 mm (3/8")	29076
1	Solenoid Valve Bracket	29070
1	Pressure Controller Bracket	29109

Equipment Required

Electrical Equipment

QTY	DESCRIPTION	NUMBER
10 m	Wire (TFF 16 black)	22668
12	Twist connector #31	23299
5 m	Wire Bx 14/3	24222
26	Connector 500, straight	24223
2	Porcelain Receptacle	25088
5	Box	25091
15 m	Wire Bx 14/2	25132
10	Twist connector #33	25133
10	Twist connector #35	25859
2	Incandescent Lamp 220 V – 100 W	29038
1	Control Box	29043-5
3	SPST Wall Switch (250 V)	29046
1	Thermostat −30°C/40°	29047-5
1	SPDT Wall Switch (250 V)	29049
1	Dual Pressure Controller	29051
1	Solenoid Valve Coil 240 V	29054-5
35	Anti-Shorts Bx 14/2	29073
5	Switch Steel Plate	29078
1	Octo. Box Cover	29079
1	Line Cord Assembly	29094-5
1 m	Flexible Conduit ½"	29243
1	Angle Connector BX	29245
1	DPST Wall Switch (250 V)	23175

Notes

F = Flare
I = Internal
E = External
PRH = Phillips Round head
SRH = Slotted Round head

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Unit 1

Preparation

UNIT OBJECTIVE

When you have completed this unit, you will be familiar with the safety rules and the symbols used in refrigeration. You will also have prepared the refrigeration trainer for the suggested exercises.

DISCUSSION OF FUNDAMENTALS

A thorough safety program is essential for anyone working in potentially hazardous situations. If the students follow the safety instructions completely, there will be no serious hazards or dangers in the laboratory.

Know the locations of the First Aid kits in your shop or lab. Insist that each injury receives immediate attention, regardless of how minor it seems to be. Notify your instructor of every accident. He will know what to do.

Symbols are used extensively in refrigeration diagrams to identify devices, fixtures and components. Being thoroughly familiar with these symbols and their use is essential for a refrigeration worker.

Exercise 1-1

Safety and Symbols

EXERCISE OBJECTIVE

Upon completion of this exercise you will be familiar with the safety rules and the symbols used in refrigeration.

DISCUSSION OUTLINE

The Discussion of this exercise covers the following points:

- Shop Safety
- Electric shocks
- Equipment related injuries
- Safety applied to refrigeration
- Refrigeration symbols and abbreviations
- Summary

DISCUSSION

Shop Safety

A thorough safety program is essential for anyone working with refrigeration or electrical equipment. Electricity can be dangerous and even fatal to those who do not understand and practice the simple rules of safety. Many people receive fatal shocks every year from the ordinary electricity found in the home. Even well-trained technicians who, either through overconfidence or carelessness, violate the basic rules or personal safety risk electrocution. The basic rule of personal safety is always:

THINK FIRST!

This rule applies to all industrial work as well as refrigeration workers. Develop good habits of workmanship. Learn to use tools correctly and safely. Always think through your procedures, your methods, and the applications of tools, instruments and machines before acting. Never permit yourself to be distracted from your work and never distract another worker engaged in hazardous work. There are generally three kinds of accidents that appear all too frequently: electric shock, burns, and equipment related injuries. Your knowing and studying about them and observing simple rules will make you a safe person to work with.

Electric shocks

Are they fatal? The physiological effects of electric current can generally be predicted with the chart of Figure 1-1.

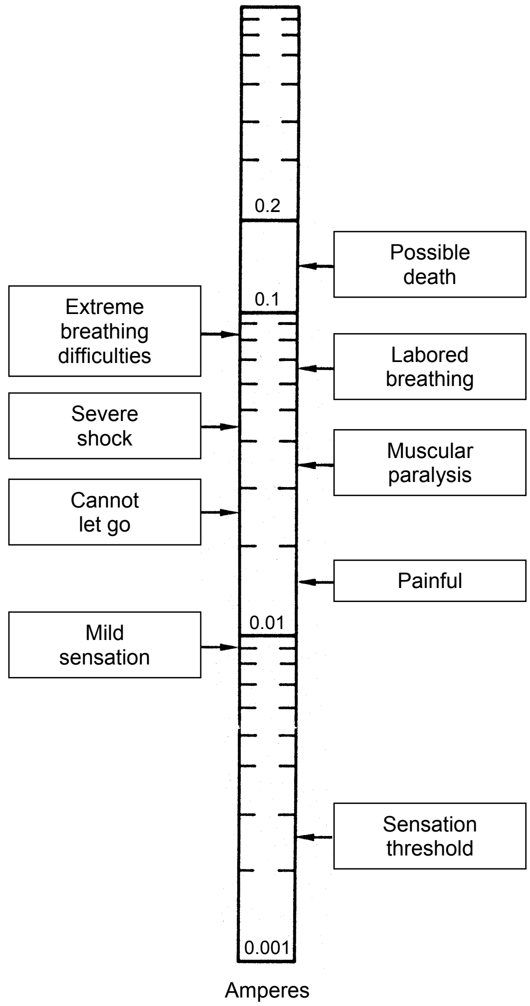

Figure 1-1. Physiological effects of electric current.

Notice that it is the current that does the damage. Currents above 100 mA, or only one tenth of an ampere, can be fatal. A worker who has contacted a current above 200 mA may survive if given immediate attention. Current below 100 mA, can be serious and painful. A safe rule: DO NOT PLACE YOURSELF IN A POSITION TO GET ANY KIND OF A SHOCK.

Equipment related injuries

These safety rules apply to all students who work with tools and machinery. Four rules for safe practice and to avoid equipment related injuries are:

1. Metal corners and sharp objects on a chassis and panels can cut and scratch. File them smooth.

2. Improper selection of the tool for the job can result in equipment damage and personal injury. Always use the right tool.

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3. Use proper eye protection when grinding, chipping or working with refrigerants that might splatter.

4. If you do not know, ASK YOUR INSTRUCTOR!

Safety applied to refrigeration

Before working on refrigeration systems and with refrigeration equipment, several safety rules should be observed:

1. Goggles and gloves should be worn at all times, especially during charging and evacuating.

2. Silver brazing materials sometimes contain cadmium, which when heated, produces poisonous fumes. Only silver brazing materials that do not contain cadmium should be used.

3. Wrenches should always fit snugly on refrigeration line fittings. A poorly fitting wrench could slip causing injury to the technician and damage to the fitting.

4. If a leak is suspected, sufficient ventilation must be provided before depressurizing the unit.

5. When pressure testing for leaks, a low or medium pressure of compressed air or nitrogen should be used. Never use oxygen.

Before charging, the refrigerant R number should be checked to avoid mixing refrigerants. The system should always be charged with liquid refrigerant into the high side and refrigerant vapor into the low side. The compressor cannot compress liquid. This could cause the compressor to burst.

Liquid refrigerant in contact with your skin may freeze and cause "frost bite". The skin should be washed with water and treated for frost bite.

All service valves and cylinder valves should always be "cracked" before opening. This ensures quick control of the flow of gas if a problem arises.

Refrigerant cylinders should always be stored in a cool dry place and should only be used for storing the refrigerant named on the label.

Never attempt to recharge a disposable service cylinder. It may explode.

Moisture, if allowed to enter a system, is likely to cause considerable damage. Everything connected with refrigerating mechanisms should be kept thoroughly dry.

Most accidents are the result of carelessness. If the safety rules are observed and applied, any job can be performed safely.

Refrigeration symbols and abbreviations

Symbols are used extensively in all areas of refrigeration work. They are used to identify all devices, piping fixtures and components on a refrigeration diagram. The diagram can be a pictorial view, double line, or a schematic, single line. The diagram is usually drawn isometrically. This isometric shape enables the maximum amount of information to be placed on a single sketch or drawing.

Figure 1-2 shows some piping symbols used on refrigeration diagrams.

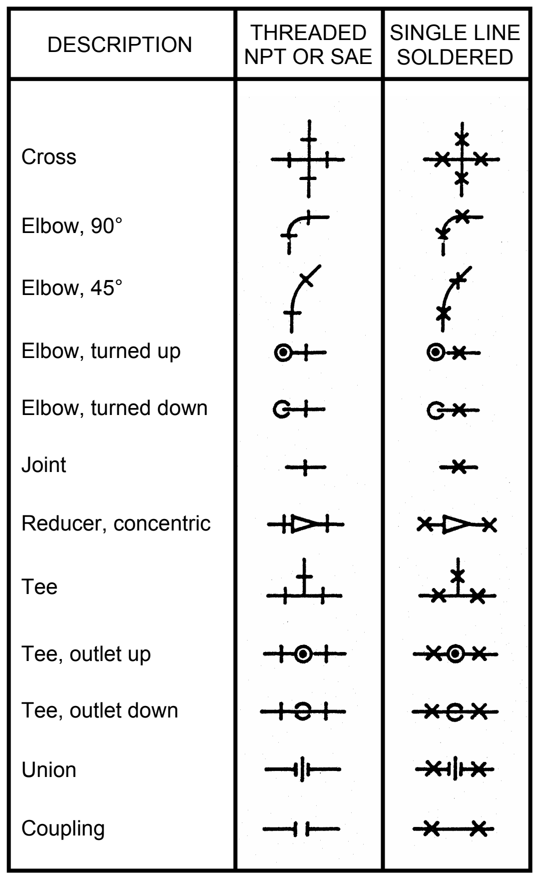

Figure 1-2. Pipe symbols.

Figure 1-3 shows a legend of various connections and schematic representations.

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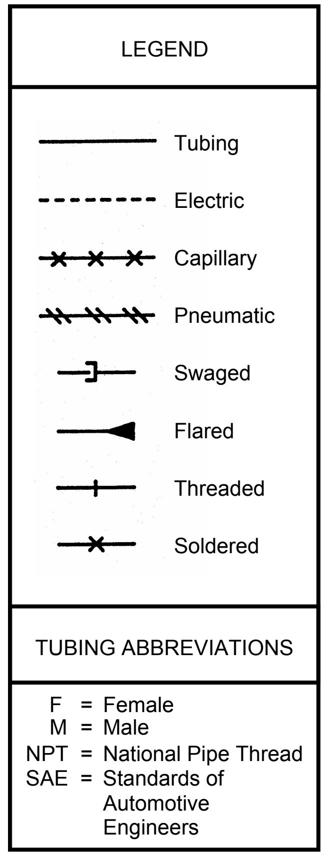

Figure 1-3. Legend and tubing abbreviations.

The symbols that represent various devices in refrigeration systems are shown in Figure 1-4 and Figure 1-5. These symbols are used for both single line and double line diagrams.

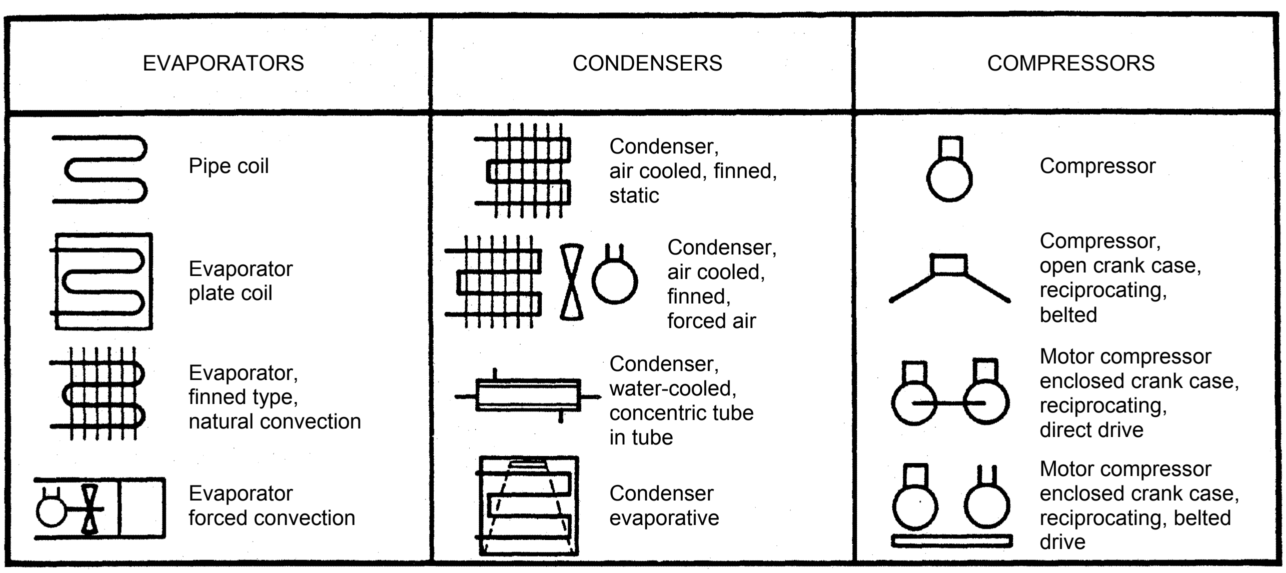

Figure 1-4. Symbols of devices (Part 1).

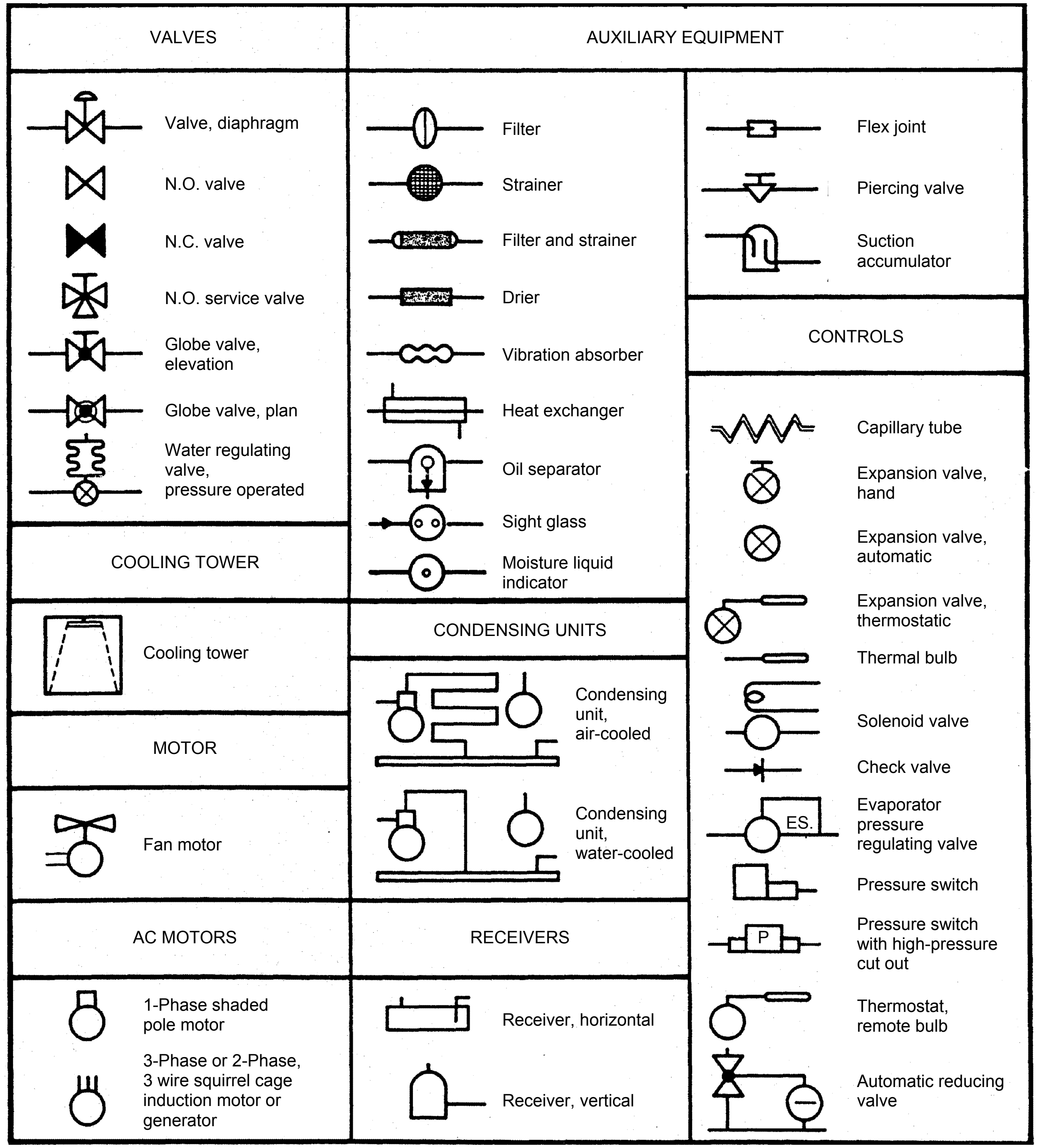

Figure 1-5. Symbols of devices (Part 2).

When working with refrigeration systems, the technician should have knowledge of various electrical symbols. Since the cause of most system failures is electrical, symbols must be known to follow through wiring diagrams. The various electrical symbols commonly used in wiring diagrams are shown in Figure 1-6.

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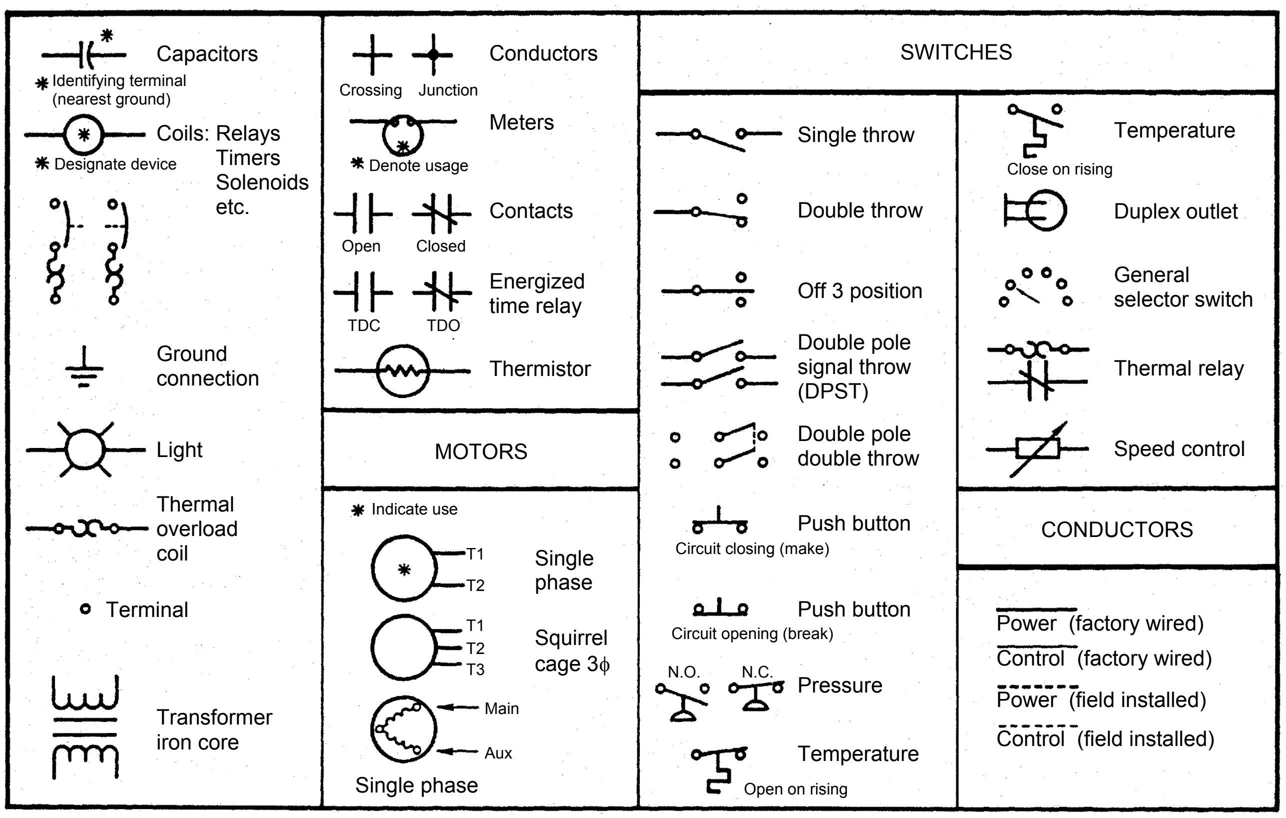

Figure 1-6. Electrical symbols.

In connection with refrigeration symbols, standard abbreviations are used to identify various devices. Table 1-1 is a partial list of abbreviations used in this manner.

Table 1-1. Abbreviations used to designate devices

DEVICE	ABBREVIATION
Automatic Expansion valve	AEV
Back-Pressure Regulator	BP
Liquid Indicator	LI
Manual Valve	V
Meter	M
Pressure Controller	PIC
Pressure Indicator	PI
Service Valve	S
Solenoid Valve	SV
Temperature Sensor	TS
Thermostatic Controller	TIC
Thermostatic Expansion Valve	TEV
Temperature Indicator	TI
Wet Bulb Temperature	WBT

Summary

Always stop and think before acting.

Do not place yourself in a position to get any kind of electrical shock.

Avoid burns.

Use tools and machinery properly.

Carefully follow the safety rules applied to refrigeration systems.

Symbols are used in refrigeration work to identify all devices and piping fixtures within a system in a diagram.

Electrical symbols are also used in refrigeration work to identify electrical devices on wiring diagrams.

Abbreviations are used in connection with symbols to designate various devices.

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Assembling the Universal Refrigeration Trainer

EXERCISE OBJECTIVE

When you have completed this exercise, the trainer will be ready to accept the different components called for by the suggested layout for each exercise.

This exercise is optional and may not be required if this assembly has already been made.

PROCEDURE

1. For your protection, a special line cord assembly has been wired at the factory. Identify this component and mount it at the extreme left of your board, as shown in Figure 1-7.

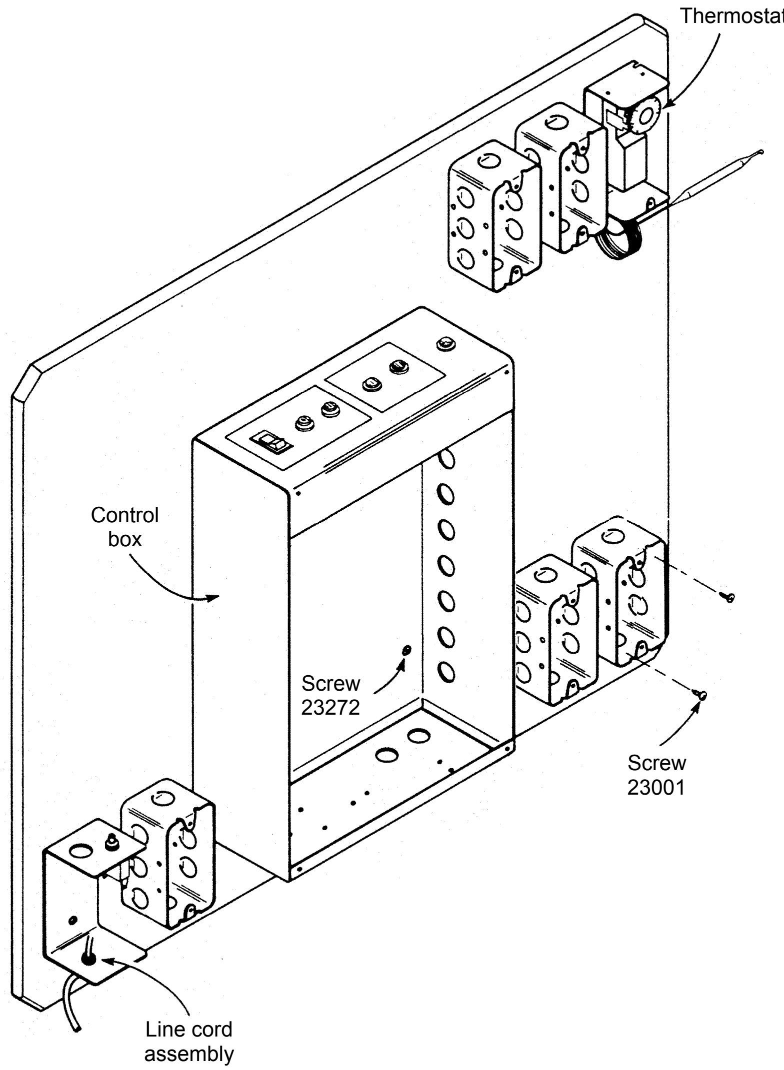

Figure 1-7. Suggested layout for electrical boxes.

2. Identify each of the electrical components shown on the layout of Figure 1-7 and position them as suggested. Make sure that each box is evenly spaced so that the next wiring operation can be made easily. Fasten each box to the wooden panel using the appropriate hardware.

Not all of the electrical boxes shown in Figure 1-7 are used in each exercise. When wiring the trainer, you can remove unused boxes if you wish.

3. Figure 1-8 shows the placement of the electrical components in the evaporator chamber. Mount these components but do not wire them yet.

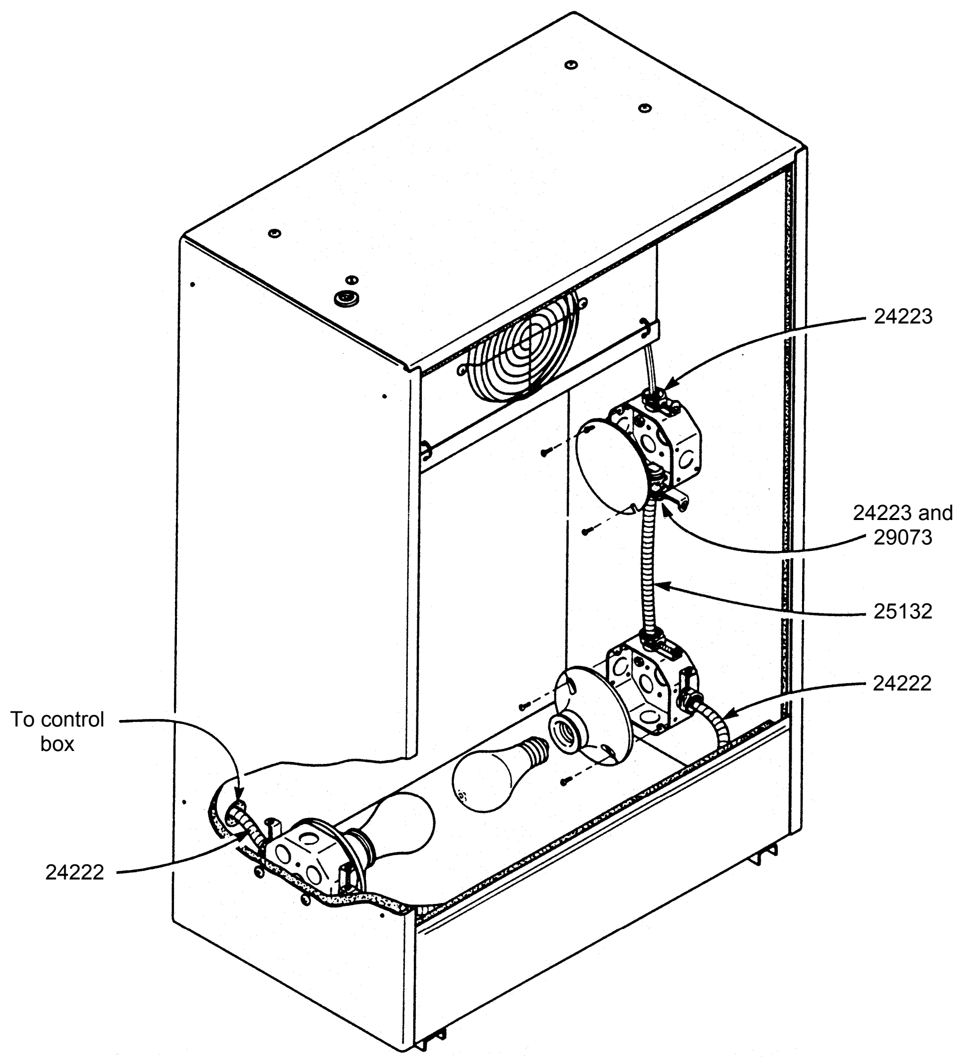

Figure 1-8. Heat load and evaporator.

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Four Typical Refrigeration Systems

UNIT OBJECTIVE

When you have completed this unit, you will have assembled several typical refrigeration and electrical circuits.

DISCUSSION OUTLINE

The Discussion of Fundamentals covers the following points:

- The basic refrigeration system
- The Refrigeration Cycle
- Symbols used in electrical schematic diagrams

DISCUSSION OF FUNDAMENTALS

This unit contains four exercises involving typical refrigeration systems. Each exercise has two parts, the first one concerns the refrigeration circuit and the second one that concerns the electrical wiring. Depending on your specialization, your instructor may ask you to do both parts of each exercise, or only one.

The basic refrigeration system

The main function of a refrigeration system is to remove heat from a place where it is undesired and transfer it to another place. This can be accomplished by using four basic devices:

- compressor
- condenser
- evaporator
- pressure reducing (metering) device

A basic refrigeration system is shown in Figure 2-1.

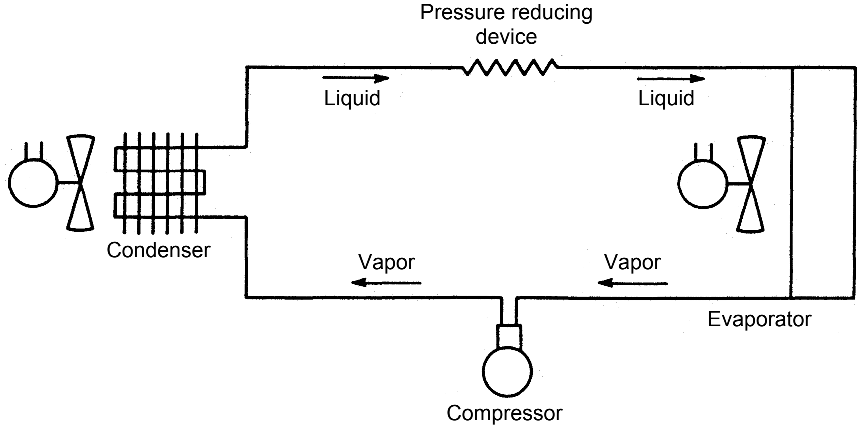

Figure 2-1. Basic refrigeration system.

The Refrigeration Cycle

The compressor is the heart of the refrigeration system. It acts as a circulating pump, drawing the refrigerant vapor from the evaporator and compressing it into the condenser.

In the evaporator, liquid refrigerant absorbs heat from the air passing over the surface of the coil. When heat is absorbed the liquid changes to a vapor. The heated vapor is drawn into the compressor where it is subjected to an increase in pressure. The temperature of the vapor therefore increases.

The refrigerant vapor is now under a high pressure and at a high temperature. The vapor then passes through the condenser where sensible and latent heat is removed and the vapor changes back into a liquid. The liquid refrigerant, however, is still under pressure.

The liquid then flows through the pressure reducing (metering) device that reduces the pressure. The decrease in pressure lowers the temperature of the liquid even more.

The cold, low pressure liquid then flows through the evaporator, allowing the refrigerant to boil and vaporize, absorbing heat from the refrigerated space. The cycle then repeats as the heated vapor is drawn into the compressor.

Symbols used in electrical schematic diagrams

The following symbols are used in this manual:

CI	capacitor
CB	circuit breaker
CR	current relay
F1	condenser fan
F2	evaporator fan
L	heat load
OL	overload relay
P1	power on lamp
P2	compressor indicator lamp
P3	condenser pilot lamp
P4	evaporator pilot lamp
P5	load indicator lamp
P6	defrost indicator lamp
PC1	high-pressure controller
PC2	low-pressure controller
S1	main switch
S2	compressor switch
S3	condenser fan switch
S4	evaporator fan switch
S5	heat load switch
S6	defrost switch
SV	solenoid valve
TIC	thermostat

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Refrigeration System with a Capillary Tube and a Thermostat

PART A: REFRIGERATION CIRCUIT

OBJECTIVE

When you have completed this part, a refrigeration circuit using a capillary tube as a metering device will be ready to accept the refrigerant.

DISCUSSION

Figure 2-2 shows a typical refrigeration system with a capillary tube. In the evaporator, liquid refrigerant absorbs heat from the air passing over the surface of the coil. When heat is absorbed, the liquid changes to a vapor. The heated vapor is drawn into the compressor where it is subjected to an increase in pressure. The temperature of the vapor therefore increases.

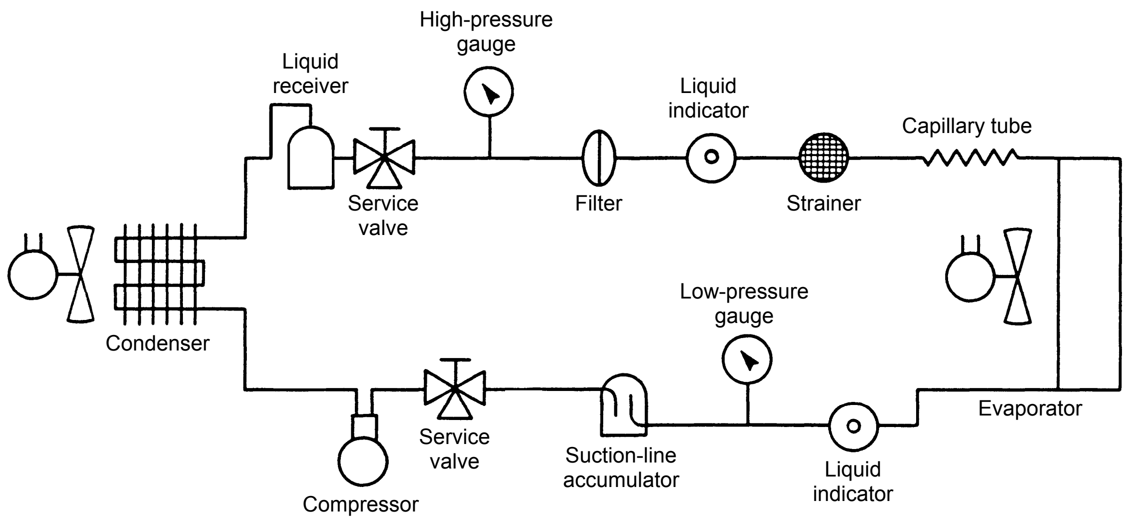

Figure 2-2. Typical refrigeration system using a capillary tube as a metering device.

The compressor is the heart of the refrigeration system. It is a circulating pump, drawing the refrigerant vapor (at low pressure) from the evaporator through a suction-line accumulator and compressing it into the condenser.

The refrigerant vapor in the condenser is under high pressure and at a high temperature. The vapor passes through the condenser where sensible and latent heat is removed bringing the vapor into a liquid state. The liquid refrigerant is still under high pressure.

The liquid then flows through the capillary tube that immediately reduces the pressure. The decrease in pressure lowers the temperature. The cold, low pressure liquid then flows through the evaporator, allowing the refrigerant to boil and vaporize, absorbing heat from the refrigerated space. The cycle then repeats as the heated vapor is drawn to the compressor.

PROCEDURE

1. Identify the different components in the refrigeration schematic of Figure 2-2, and position them so that the circuit can be completed.

   For this purpose, it is suggested to take off the panel and place it flat on your workbench.

   To help position the different components, use the suggested layout of Figure 2-3.

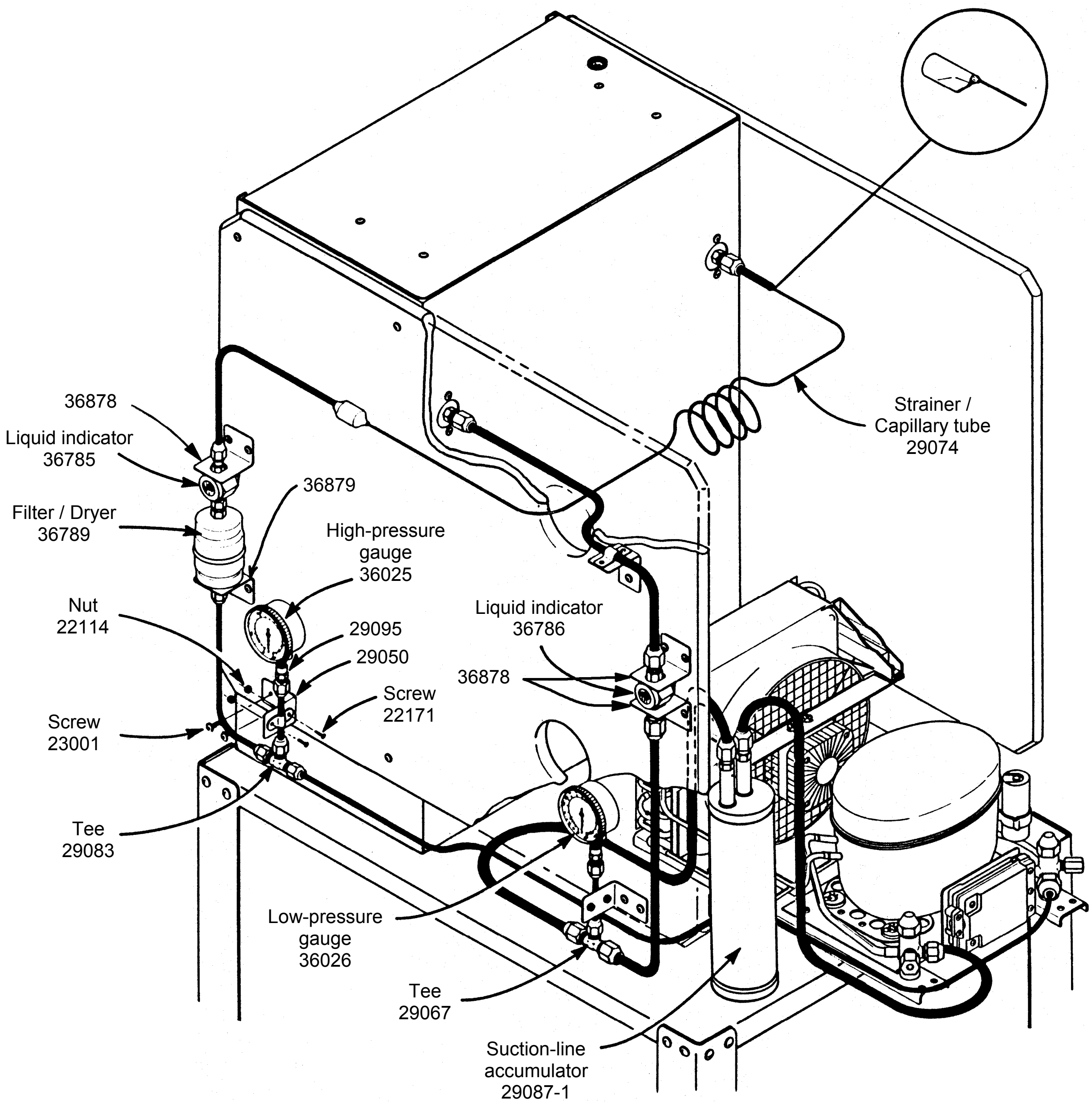

Figure 2-3. Suggested layout.

2. Once the components are positioned, assemble the refrigeration circuit by cutting, flaring and bending the different pipes.

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3. Once the circuit is assembled, fasten the circuit to the wooden board using the supplied brackets.

4. Tighten all joints and check for leaks. Charge the system.

PART B: WIRING THE TRAINER

OBJECTIVE

When you have completed this part, you will be able to explain the electrical circuits associated with the trainer set up using a capillary tube as a metering device.

DISCUSSION

The power is fed to the circuit through the line cord and protective breaker assembly.

The switch S1, shown in Figure 2-4, is used as the main switch. When turned on, all other components are energized through their appropriate circuits.

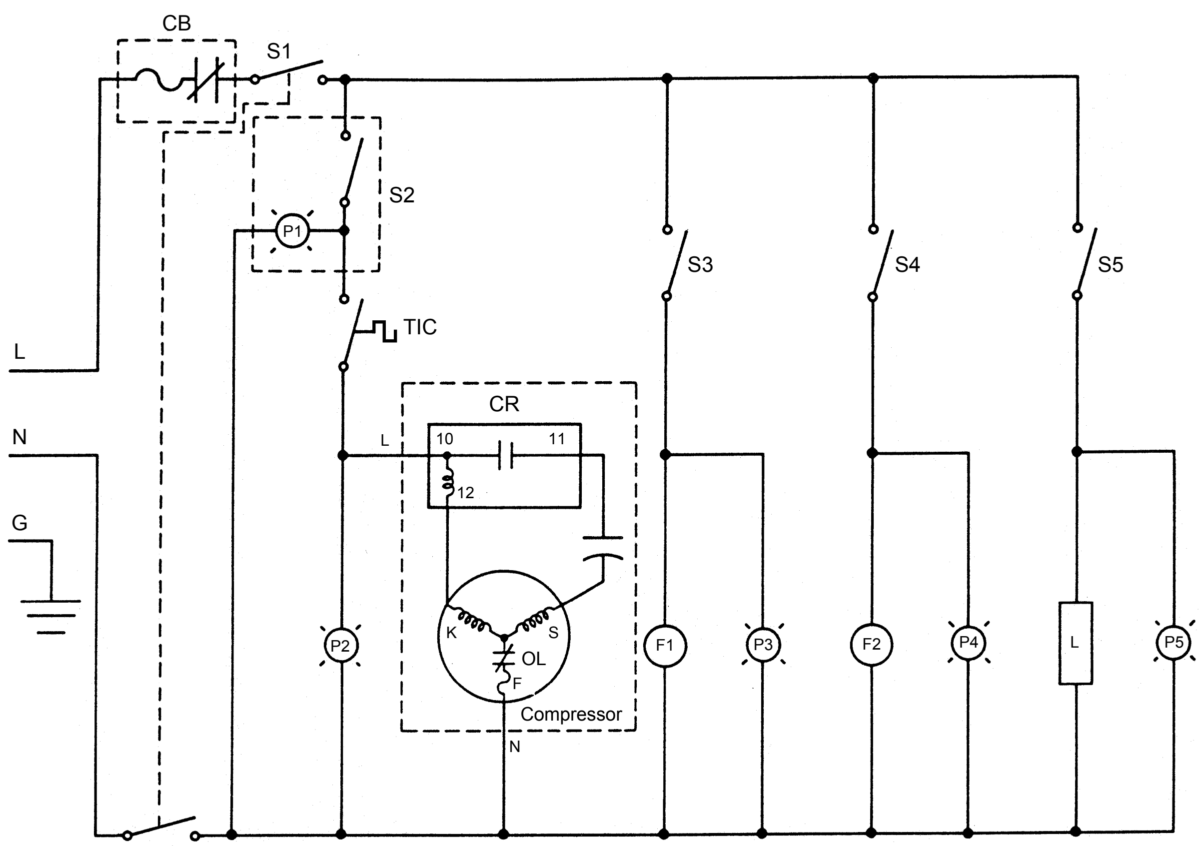

Figure 2-4. Electrical schematic diagram of a capillary tube system.

The switch S2 will energize the thermostat circuit and the built in indicator light will turn on. When the temperature increases above the set point of the thermostat, it will close its contacts energizing the compressor motor through its current relay CR and its thermal protection OL. The indicator lamp P2 will turn on. The current relay and thermal protection relay are built into the compressor.

On starting, the compressor will draw a high current (approximately 4-5 times the running current). This high current inrush will actuate the armature of the current relay, will close its contacts, and allow the capacitor and the start winding of the compressor to be energized.

Once the compressor motor is running, the current will drop to the nominal value and the current relay will open its contacts, de-energizing the starting winding. The compressor will run until the thermostat opens its contacts, calling for an automatic stop, or until the switch S2 is opened manually. Note that the overload relay could also stop the compressor should it be in an overload or an overheated condition.

The switch S3, when closed manually, will energize the condenser fan and will turn on the indicator lamp P3.

The switch S4, when closed manually, will energize the evaporator fan and will turn on the indicator lamp P4.

The switch S5, when closed manually, will energize the heat load into the refrigerated chamber simulating the presence of a warm object to be cooled. It will also turn on the indicator lamp P5.

PROCEDURE

1. Identify the different electrical components in the schematic diagram of Figure 2-4, and locate them in the boxes already mounted. A suggested layout for the switches is shown in Figure 2-5. The heat load and evaporator wiring is shown inFigure 1-8.

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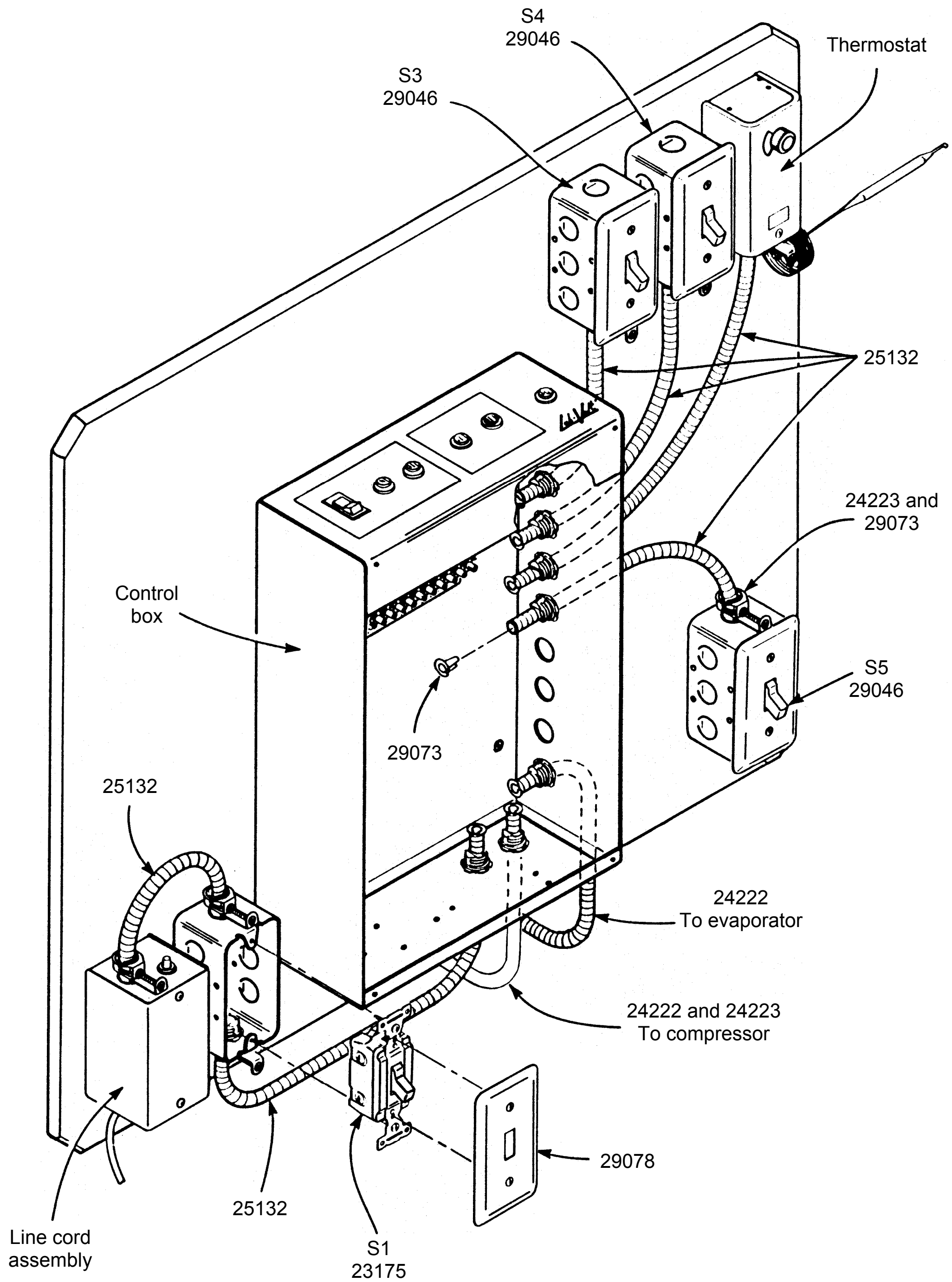

Figure 2-5. Suggested layout for switches.

Refer to Figure 2-6 for the location of the indicator lamps. They were wired at the factory to simplify the final wiring.

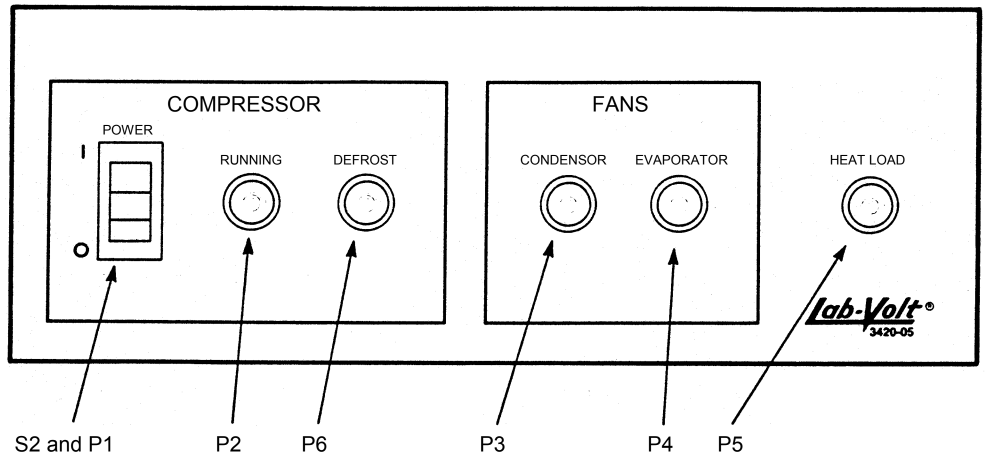

Figure 2-6. Control panel face plate showing the compressor switch and indicator lamps.

2. Determine the minimum number of wires that are necessary to connect each component using a minimum of conductors into each cable joining the different components and the control panel.

   The connections between the different wires into the control panel can be secured using connectors and can be done through the terminal board of the indicator panel shown in Figure 2-7.

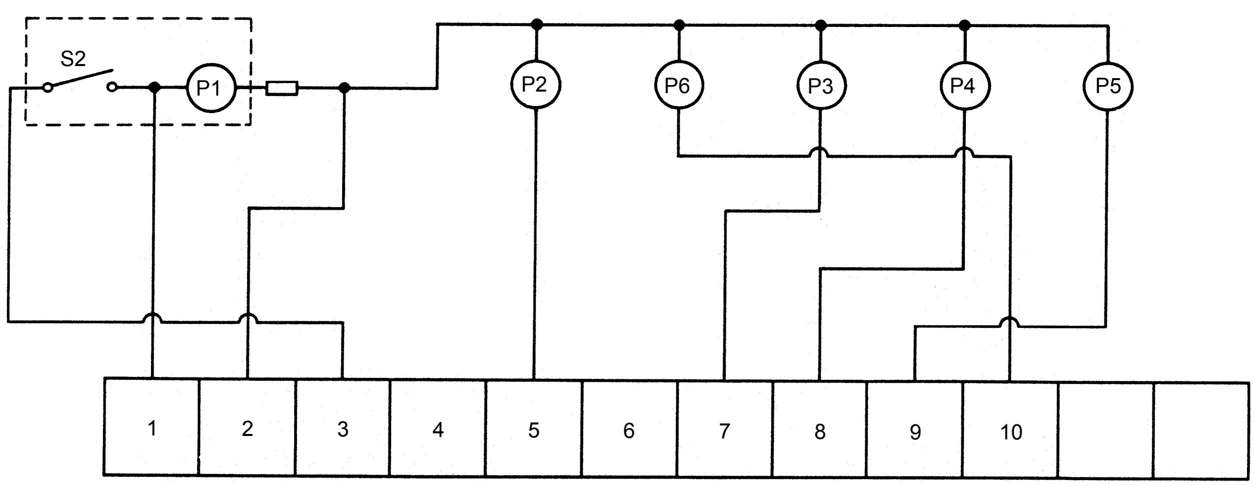

Figure 2-7. Control panel terminal block wiring diagram.

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Refrigeration System with a Thermostatic Expansion Valve

Part A: Refrigeration Circuit

Objective

When you have completed this part, a refrigeration circuit using a thermostatic expansion valve (T.E.V.) will be ready to operate.

Discussion

On larger refrigeration and air-conditioning systems where the heat load variation is large, the thermostatic expansion valve is most often used. It can operate efficiently over a much larger heat load range than the capillary tube control. Cooling systems which fall into this category are large walk-in coolers, beverage coolers, office air-conditioning units, and many other commercial cooling systems. The cooling unit must be able to remove heat from the refrigerated space as fast as or faster than heat can enter.

The thermostatic expansion valve controls the flow rate of liquid refrigerant entering the evaporator in response to the superheat of the refrigerant gas leaving it. An increase in the heat load on the evaporator increases the temperature of the refrigerant gas leaving the evaporator. The bulb of the thermostatic expansion valve senses this increase and the expansion valve widens its valve opening to reestablish the desired operating point. A decrease in the heat load causes the opposite effect such that the operating point is maintained. In this manner, the expansion valve will compensate for a variable heat load as it is applied to the system.

When using a thermostatic expansion valve, a liquid receiver is often required at the outlet of the condenser to store excess refrigerant within the system and insure a constant supply of liquid refrigerant to the expansion valve. It also eliminates the need of a precise charge on the system. Thus, the requirement for both the expansion valve and liquid receiver makes this type of refrigerant control more expensive than capillary tube control.

PROCEDURE

1. Identify the different components in the refrigeration schematic of Figure 2-8 and position them so that the circuit can be completed.

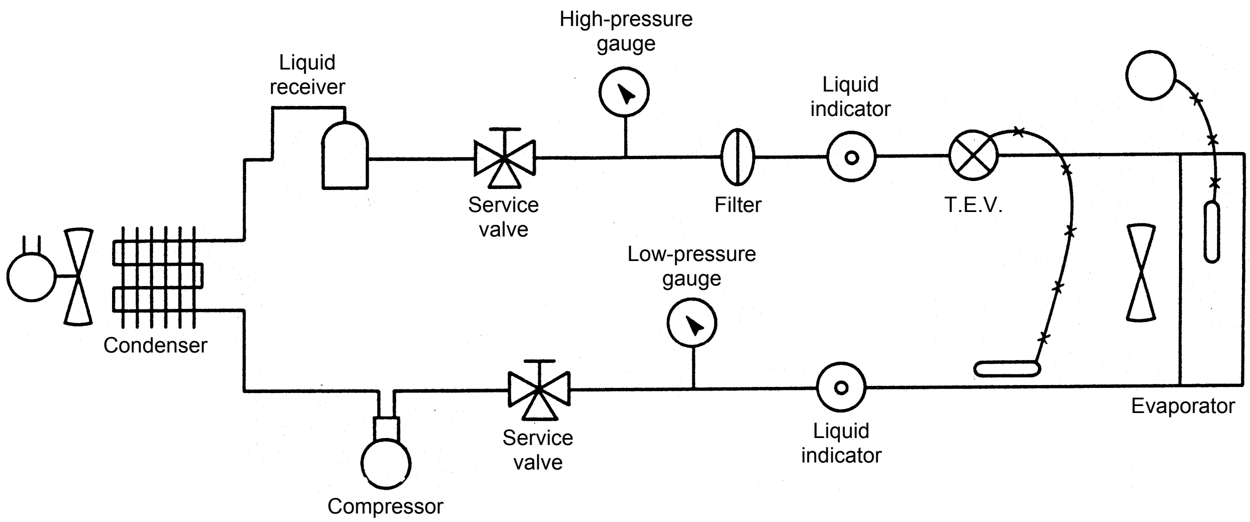

Figure 2-8. Typical refrigeration system using a T.E.V.

For this purpose, it is suggested to take off the panel and place it flat on your workbench. After the components are positioned on the board, mount it back in place.

To help position the different components, use the suggested layout of Figure 2-9.

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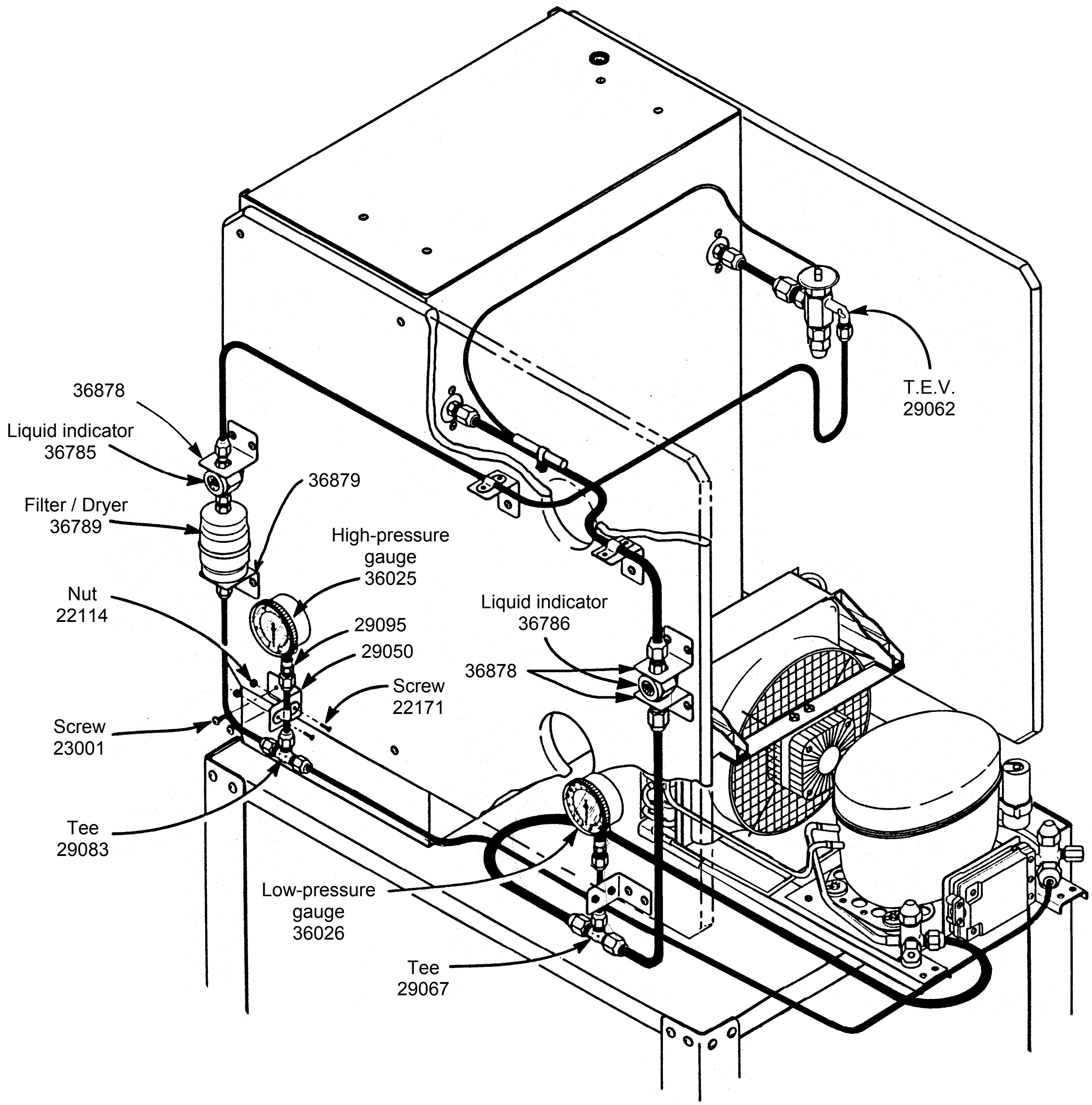

Figure 2-9. Suggested layout.

2. Once the components are positioned, assemble the refrigeration circuit by cutting, flaring and bending the different pipes.

3. Once the circuit completed, fasten the circuit to the wooden panel using the supplied brackets.

4. Tighten all the joints and check for leaks. Charge the system.

PART B: WIRING THE TRAINER

OBJECTIVE

When you have completed this part, you will be able to explain the electrical circuits associated with the trainer set up using a thermostatic expansion valve as a metering device.

PROCEDURE

1. In this exercise, you will use the same control circuit as in the previous exercise. Wire the circuit as show in Figure 2-10 and Figure 2-11.

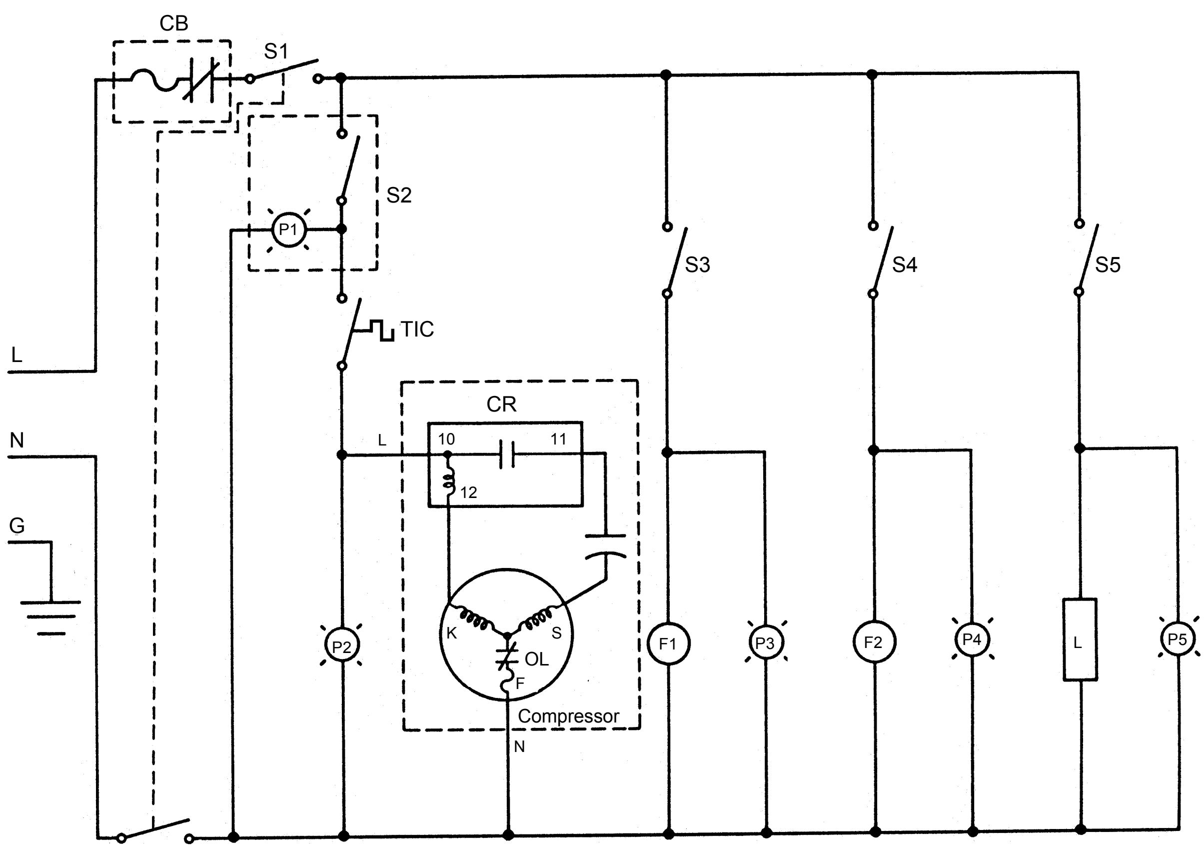

Figure 2-10. Electrical schematic diagram.

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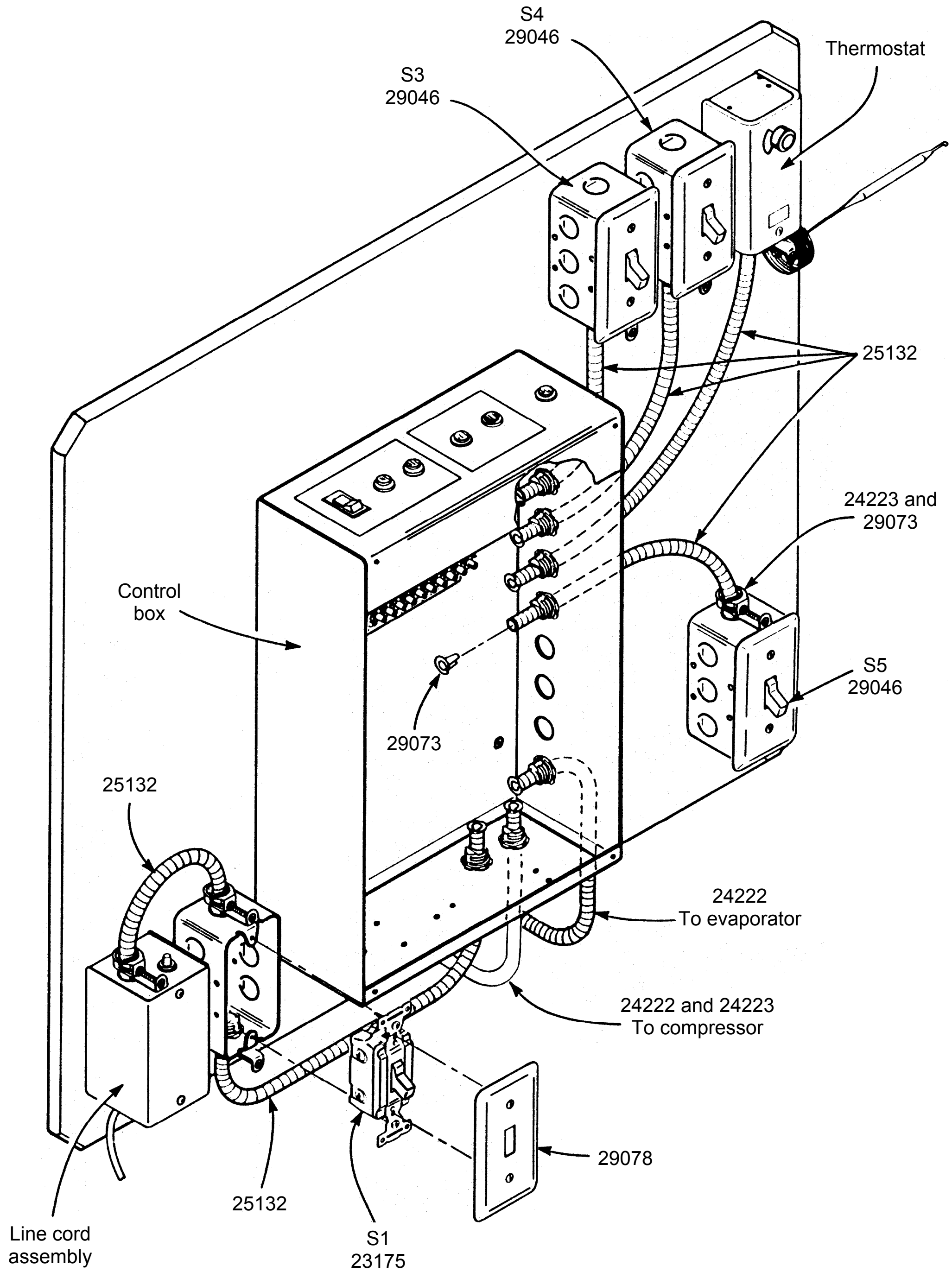

Figure 2-11. Suggested layout for switches.

Refrigeration System with a Dual Pressure Controller

PART A: REFRIGERATION CIRCUIT

OBJECTIVE

When you have completed this part, a refrigeration circuit with a dual pressure controller will be ready to operate.

PROCEDURE

1. Refer to the refrigeration circuit of the previous exercise and modify it so that a pressure controller can be added. Use the schematic of Figure 2-12.

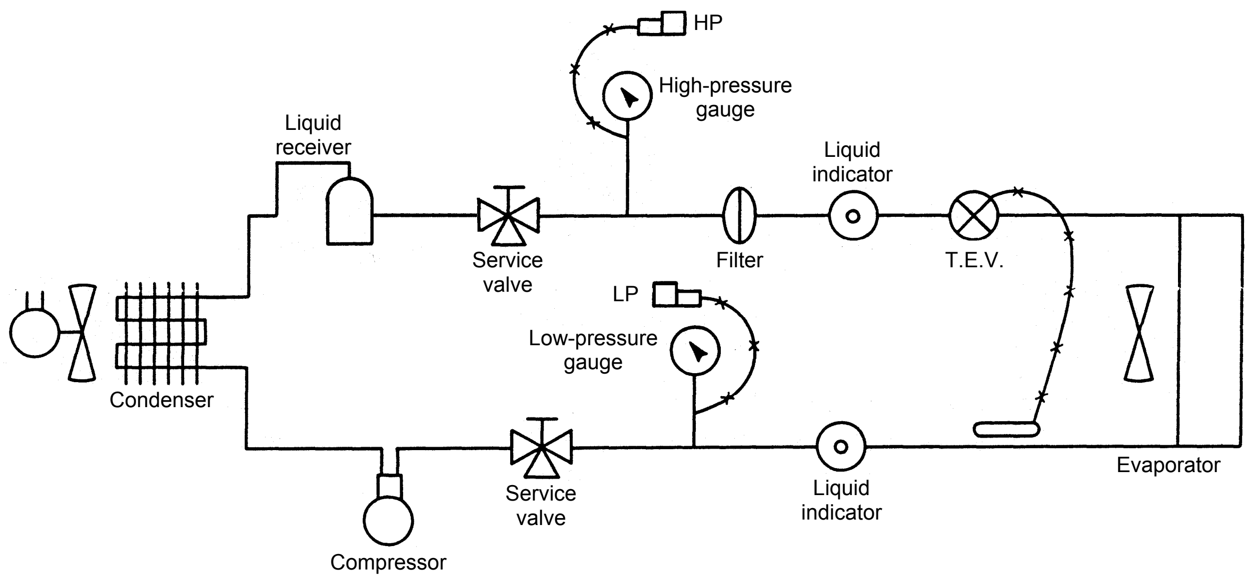

Figure 2-12. Refrigeration system with a dual (high/low) pressure controller.

2. Position the components to accommodate the double pressure controller. Complete the circuit, check for leaks and charge the system.

PART B: WIRING THE TRAINER

OBJECTIVE

When you have completed this part you will be able to explain how to connect a pressure controller.

PROCEDURE

1. Modify the control circuit of the previous exercise to include the contacts of the pressure controller. Refer to Figure 2-13, Figure 2-14, and Figure 2-15. Rewire the control circuit to include the change. The heat load and evaporator wiring is shown in Figure 1-8.

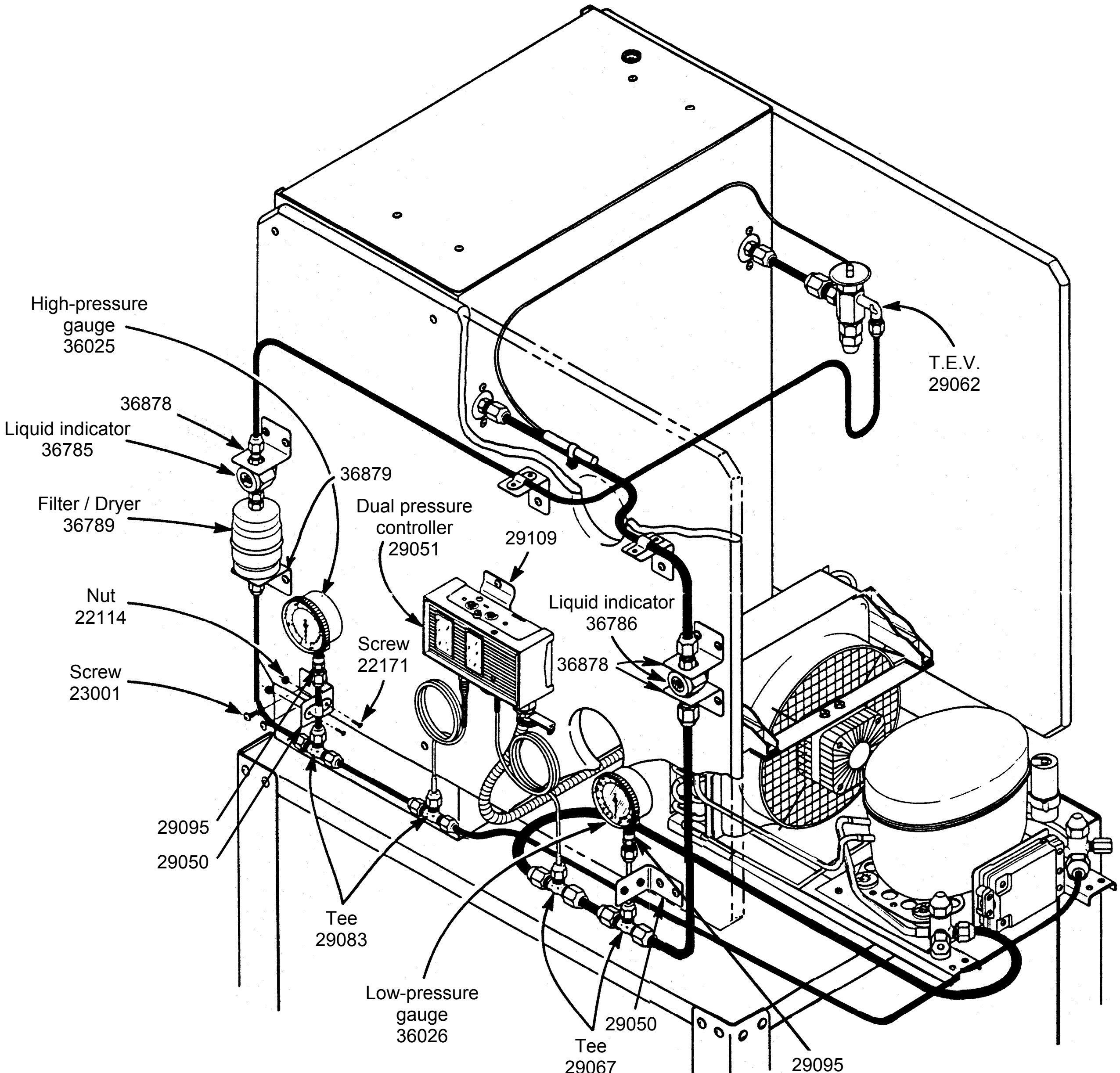

Figure 2-13. Suggested layout.

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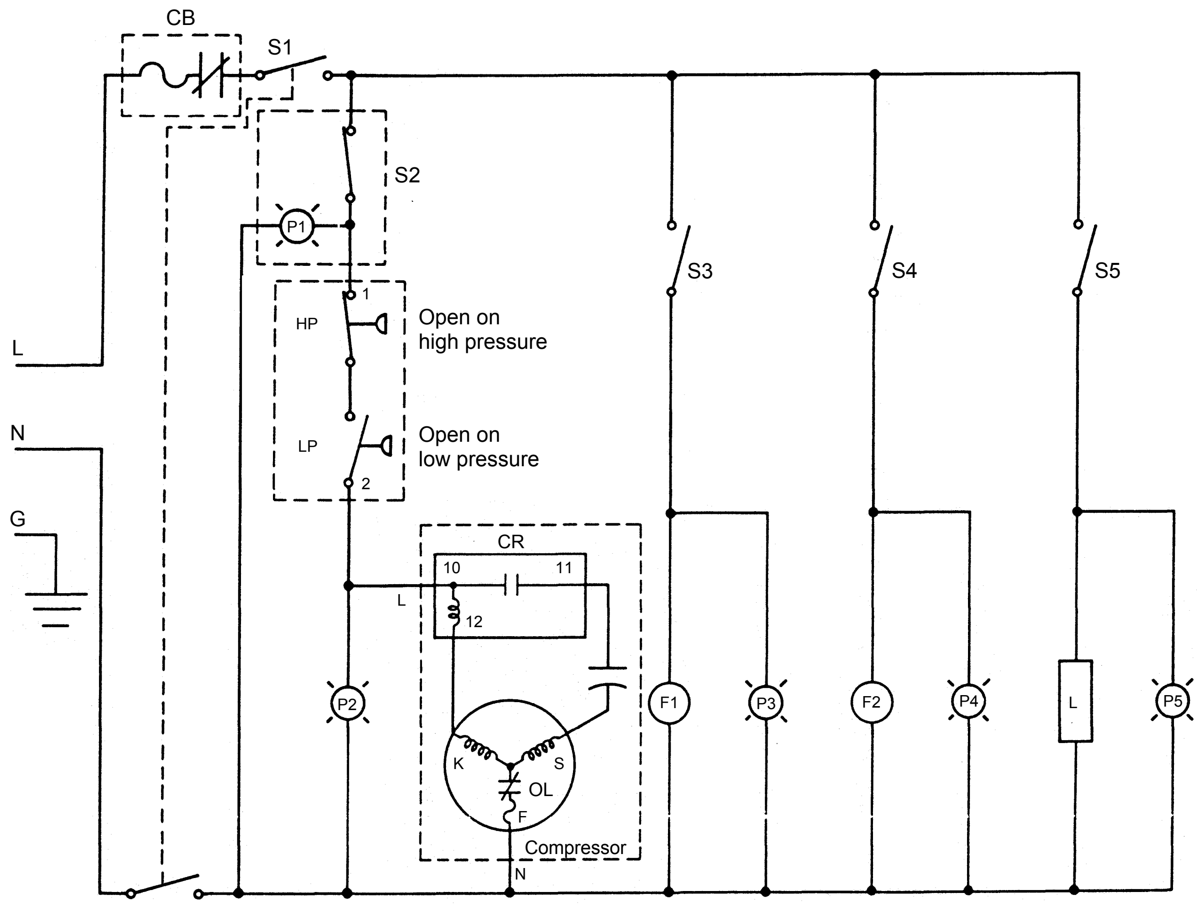

Figure 2-14. Electrical schematic diagram.

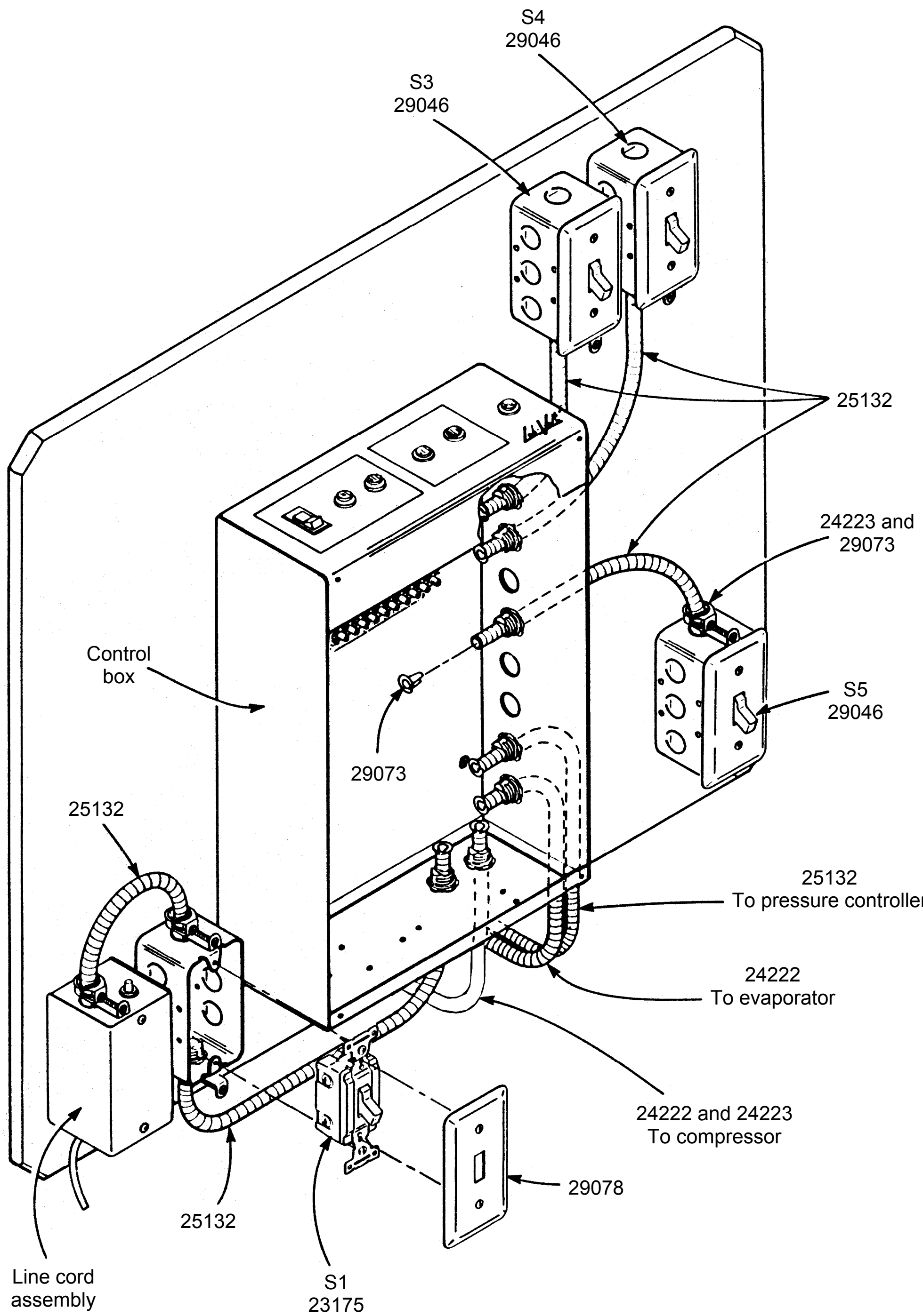

Figure 2-15. Suggested layout for switches.

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Refrigeration System with a Dual Pressure Controller and a Thermostat

PART A: REFRIGERATION CIRCUIT

OBJECTIVE

When you have completed this part, a refrigeration circuit using a solenoid valve will be ready to operate.

PROCEDURE

1. Modify the refrigeration circuit of the previous exercise to include a solenoid valve. Use the schematic of Figure 2-16.

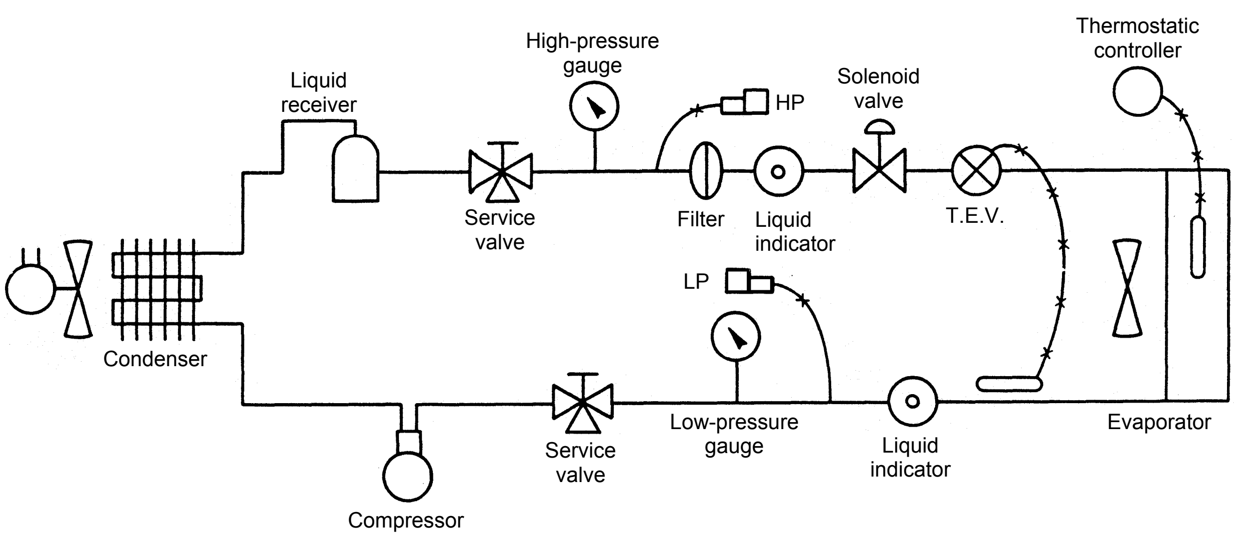

Figure 2-16. Refrigeration system with a dual pressure controller and a thermostat.

2. Position the components to accommodate the solenoid valve. Complete the circuit, check for leaks and charge the system.

PART B: WIRING THE TRAINER

OBJECTIVE

When you have completed this part you will be able to explain the use of a solenoid valve.

Procedure

1. Modify the control circuit of the previous exercise to include the thermostatic controller. Refer to Figure 2-17, Figure 2-18, and Figure 2-19. Rewire the control circuit to include the change. The heat load and evaporator wiring is shown in Figure 1-8.

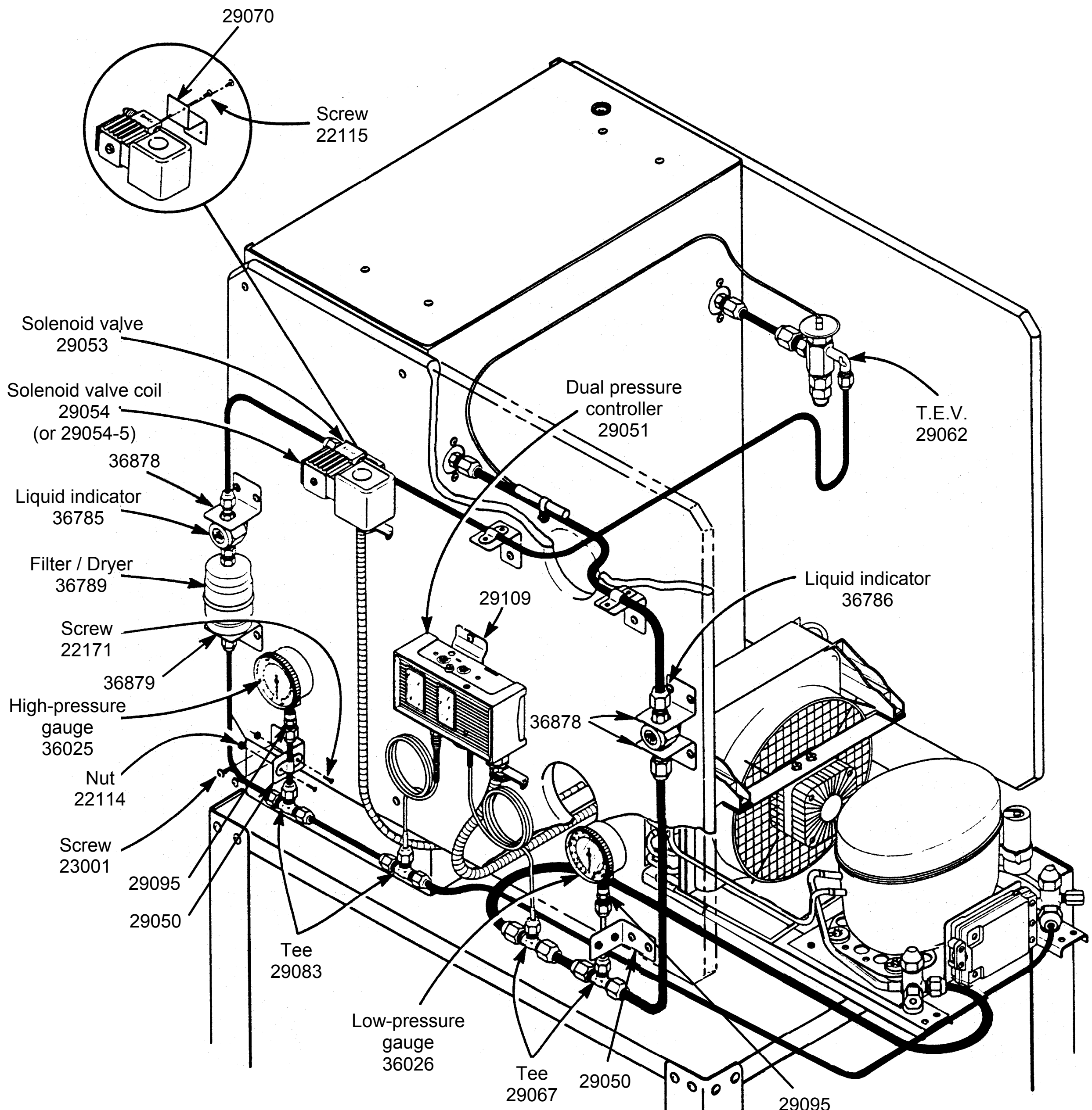

Figure 2-17. Suggested layout.

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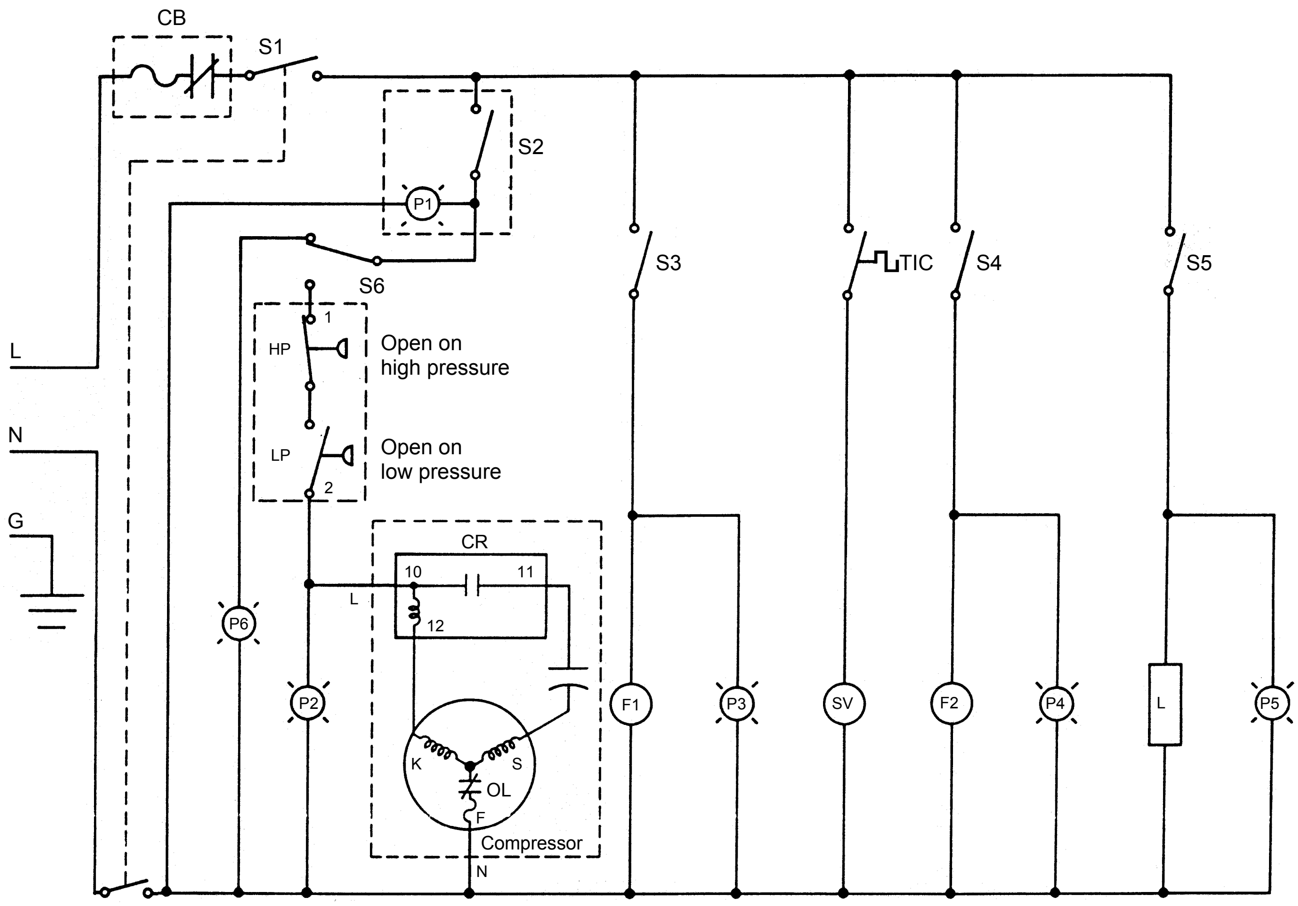

Figure 2-18. Electrical schematic diagram.

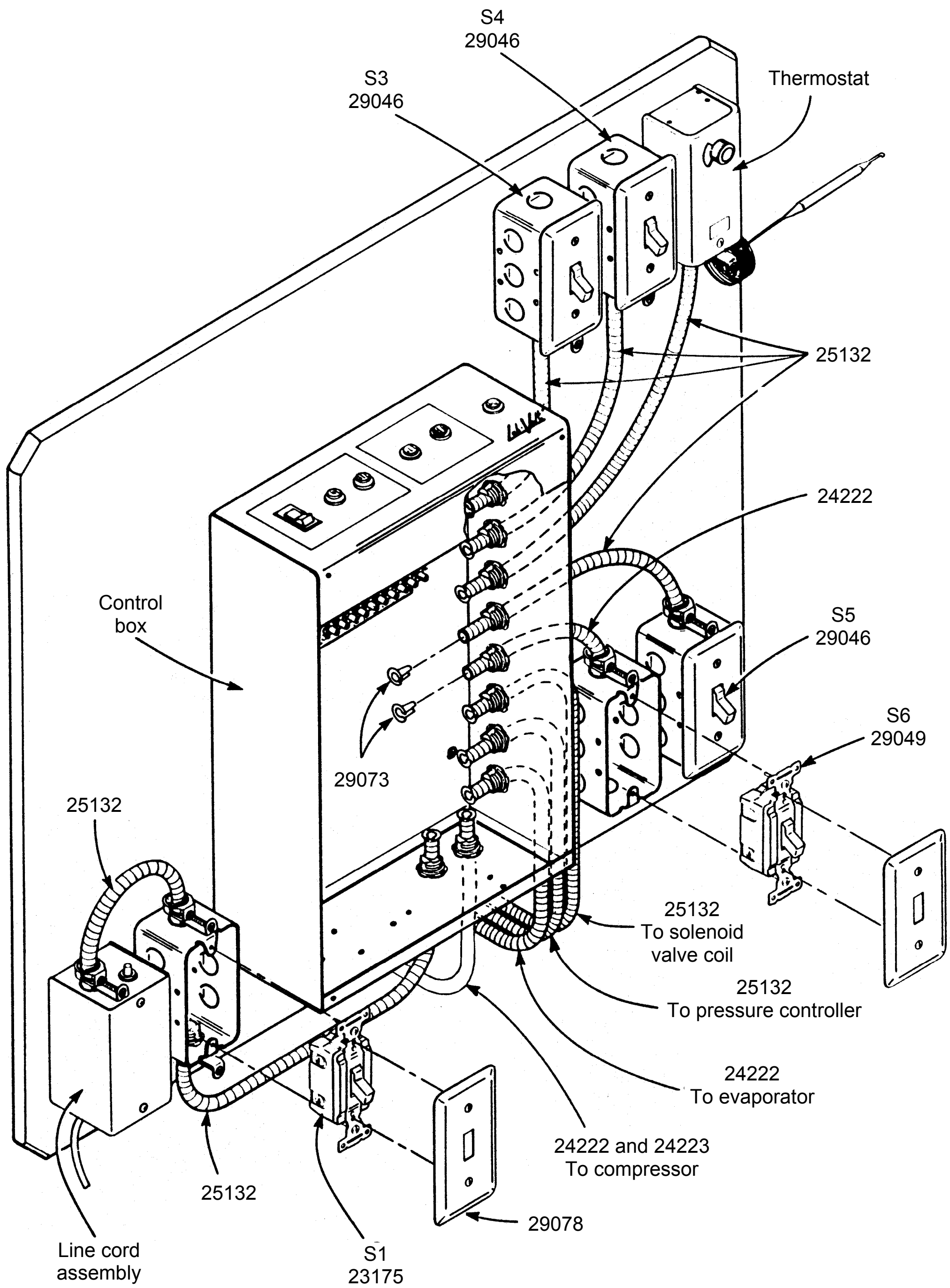

Figure 2-19. Suggested layout for switches.

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Supplementary Information

The service valve

The service valve, shown in Figure A-1, is a three-way valve. It shuts off the refrigerant flow in the system when the valve stem is seated (maximum turns clockwise). It shuts off the charging, discharging or gauge opening when the valve stem is turned all the way out (maximum turns counterclockwise). When the valve stem is turned part way (cracked position), both of the openings allow refrigerant to flow.

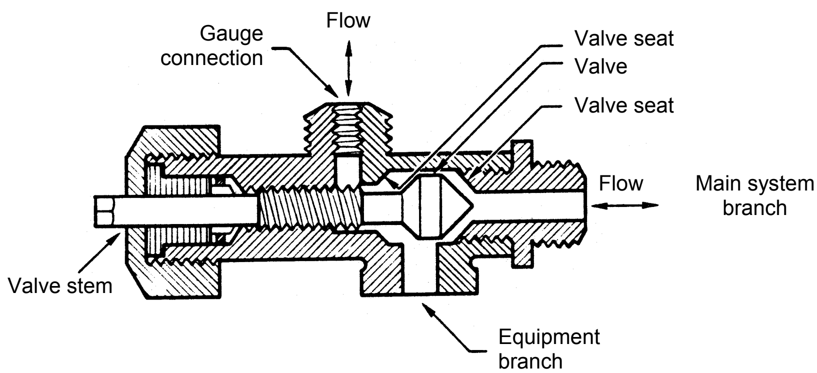

Figure A-1. Refrigeration service valve shown in cracked position.