SERVICING SUPERMARKET REFRIGERATION EQUIPMENT

By: Kenneth S. Franklin
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INTRODUCTION

The 1960s and early 1970s brought about a revolution in the merchandising of food products. With the growth and extension of suburban areas has come the concept of shopping center areas of distribution, with many stores close together providing convenient shopping facilities.

Not only has the self-service operation become a reality, but it has been refined so as to provide the greatest convenience to the shopper. This method of merchandising has spread to other fields beyond the food store, and has led to extensive changes in display equipment of all types.

Probably the greatest changes have been seen in the display equipment provided for refrigerated food products. Manufacturers have kept pace with these fast moving trends by providing the major equipment needed, as well as the multitude of complimentary equipment required to make use of the display refrigerator. Food processors have found literally hundreds of methods of packaging and pre-cooking food items for quick preparation in the home. Most of these products require refrigeration.

To the uninformed refrigeration service engineer, the modern display refrigerator is mystifying. It is the purpose of this section to remove the mystery. The RSES motto, "Service Through Knowledge," is well applied to the display case.

Early self-service display refrigerators presented many engineering problems. Most such early refrigerators or "cases" were cooled by means of gravity coils, plate coils, or combinations of each. The cases were often complete with built on ends, and were simply placed next to each other in the store. Often cumbersome and bulky, they nevertheless were very successful. This success led to great amounts of research and development toward providing better merchandising ability, adding beauty to the store, and simplifying installation and operation.

As the engineers learned to control air flow, there was a breakthrough to the forced air display case. These cased were more compact and yet held more product. The advent of forced air cases for low temperature operation brought the engineers to an important cross-road with respect to methods for defrosting the finned coils required of forced air. But hot gas and electric defrost systems were developed, and considerable experience gained. The greater majority of manufacturers found electric defrost systems were most acceptable due to their simplicity, ease of installation and lower cost. Today, most manufacturers provide the reliable electric defrost system for low temperature equipment, and many use it for cases operating in what is commonly known as the commercial temperature range.

A further important development was the evolving of "endless" construction, which allowed massive display in what appears as one large refrigerator.

The modern food store is usually arranged in departments. Refrigerated equipment occupies a major share of these departments and contributes greatly to the profit resulting from the well planned, well operated supermarket. Generally, these departments (and the equipment designed for them) are designated by the following names:

1. Meat Traditionally a "department".
2. Produce -Moved from the sidewalk to a position of importance within the store.
3. Dairy -Once just butter and milk-now a panorama of enticement for the shopper.

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4. Frozen Food and ice cream.
5. Specialty Department -Such as spot displays and frozen bakery Products.

GENERAL INSTALLATION CONSIDERATIONS

Store layout engineers as well as installation service engineers must give serious consideration to several factors in order to deliver to the owner an installation which will perform in a satisfactory manner, and provide the best operation of the food store. Of the list which follows, the first item probably is most important, yet least followed.

1. Read the manufacturer's instructions.
2. Do not install display cases tight to walls.
3. Avoid locating cases under large glass windows.
4. Avoid locations having direct sunlight.
5. Consider the possibility of drafts from doors, air conditioning outlets, etc.
6. Cases must be level--start lineup at highest point.
7. Follow manufacturer's recommendations for joining and trimming the cases.
8. Provide proper wiring.
9. Read the instructions again.

The refrigeration portions of the installation should follow good practices as to line sizes, workmanship, evacuation and start-up procedures. Particular attention must be paid to avoidance of excess pressure drop in lines, moisture and contamination.

OPERATION OF DISPLAY CASES

As we consider each department, it must be remembered that there will be specific differences in the equipment of the various manufacturers. The information presented, however, will generally apply. It is important, too, to realize that self-service equipment has no "product load", and machines are sized to handle heat leakage loads, primarily.

MEAT DEPARTMENT (SELF-SERVICE)

Product temperature desired ....(+2°C) 34°F

Average discharge air temperature expected..........(-5°C) 23°F

Average return air temperature expected....(2°- 2.5°C) 34- 35°F

Cut-in pressure (R-12)..............................(11.34 kPa) 25 psig

Cut-out pressure (R-12) (approx.)...................(4.54 kPa) 10 psig

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NOTE:

The cut-in pressure allows operation on a frost cycle. Do not allow frost on coils to melt during the off cycle.

Defrosting of meat cases is usually handled with a time-pressure defrost clock. This is usually set for two defrosts daily during hours when the store is closed. Set defrost termination pressures for cases with electric defrost at 42 to 46 psig (19 kPa - 20.8 kPa) (R-12), and for cases without electric defrost set the termination pressure at 38 psig (17.2 kPa) (R-12).

Expansion valves should be adjusted so as to flood the end of the coil, or halfway through the heat exchanger if one is provided.

AIR FLOW

- Meat cases are designed so as to provide approximately 2/3 of delivered air under the product and 1/3 of the air over the product. For this reason, cases must be loaded to get the correct air pattern. (Figure 6)

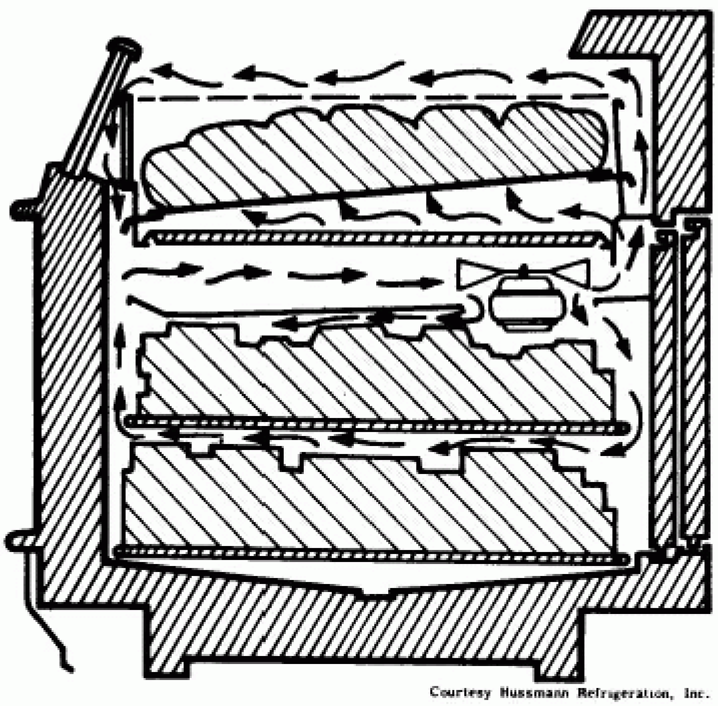

Figure 6

Air circulation in a typical self-service meat case.

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TEMPERATURE

When checking temperatures in the product zone, shield thermometers from light to avoid affects of radiant heat which will result in misleading temperature readings.

PRODUCE DEPARTMENT

Product temperature desired ....(8.5C) 40°F

Average discharge air temperature expected ...(4° - 6.5°C) 36 - 38°F

Cut-in pressure (R-12).................................(17.24 kPa) 38 psig

Cut-out pressure (R-12)...............................(8.16 kPa) 18 psig

Defrosting of produce cases is by off-cycle defrost. Expansion valves should be adjusted so as to flood to the end of the coil.

There are two general types of produce displays:

BULK DISPLAY

Produce must cover the discharge grilles so that the air wells up through the product. Leafy product must be sprayed from time to time during the day. Wet burlap night covers should be used when store is closed, to prevent excessive dehydration of the product.

PACKAGE DISPLAY

Leave the upper discharge air grille uncovered so that air flows over the product. Spraying and night covers are not required.

DAIRY DEPARTMENT

Product temperature desired...........(2.5° to 3.5°C) 36 to 38°F

Average discharge air expected.......(-1° to + 1°C) 30 to 34°F

Cut-in pressure (R-12)...............(17.24 kPa) 38 psig

Cut-out pressure (R-12).......(4.54 to 6.35 kPa) 10 to 14 psig

Defrosting of dairy cases is by off-cycle defrost. However, to assure defrosting under peak conditions where condensing unit operation may be continuous, a time-pressure defrost clock is used. The clock is set for two defrosts at periods when the store is closed, and the defrost termination pressure is set at 38 psig (R-12) (17.24 kPa).

Expansion valves should be adjusted to fully flood the coil.

AIR FLOW

There are many variations of air flow patterns. Basically, air should flow over and around the product. Much dairy product can be tightly packed on the display shelves. For this reason, it is important to leave one or two of the upper rows of discharge openings in each shelf position uncovered so that air may flow over the mass.

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NOTE:

Some manufacturers, and some operators require slightly lower product temperatures in the dairy department. This in turn requires operation on a frost cycle, with cut-in pressure at 25 psig (11.3 kPa) (R-12), so that the frost on the coil does not melt during normal off cycles.

FROZEN FOOD AND ICE CREAM DEPARTMENT (CONVENTIONAL SINGLE DISPLAY)

	F.F.	I.C.
Product temperature desired	0°F (-17.5°C)	-10°F (-23°C)
Average discharge air temp expected	-18°F (-26°C)	-22°F (-31°C)
Average return air temp expected	3°F (-11.5°C)	-10°F (-23.5°C)

Condensing unit low-pressure control settings when a thermostat controls case temperature are shown in Table 1. This table applies when the thermostat bulb is located in the return air.

Table 1

	Frozen Food			Ice Cream		
	R-12	R-22	R-502	R-12	R-22	R-502
Cut-Out	15" Hg	6" Hg	0# [0Kg]	15" Hg	6" Hg	0# [0Kg]
Cut-In	2" Hg	8# [3.6Kg]	13# [5.9Kg]	2" Hg	8# [3.6Kg]	13# [5.9Kg]

When a low-pressure control is used for temperature control, control settings are as shown in Table 2.

Table 2

	Frozen Food			Ice Cream		
	R-12	R-22	R-502	R-12	R-22	R-502
Cut-Out	6" Hg	5# [2.3Kg]	9# [4.1Kg]	10" Hg	2# [.9Kg]	5# [2.3Kg]
Cut-In	5# [2.3Kg]	17# [7.7Kg]	23# [10.4Kg]	2# [0.9Kg]	13# [5.9Kg]	18# [8.2Kg]

Control settings given are approximate. Individual installations may require slightly different settings.

ELECTRIC DEFROSTING

Defrost is usually once per day at 3:00 A.M.

Time initiated--Time terminated: 46 minutes

Time initiated--Pressure terminated:

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	R-12	R-22	R-502
Set return pressure	38 psig (17.2 Kg)	70 psig (31.8 Kg)	82 psig (17.2 Kg)
Set fail-safe	60 minutes		

Some equipment will require more than one defrost daily, in accordance with the manufacturers recommendations. Regardless of the number of defrosts used, it is important that each defrost be complete in itself. The addition of defrost periods of insufficient length in an attempt to overcome icing of the coil is the mark of the inexperienced service engineer. Each defrost must clean the coil of frost, and allow defrost water to drain from the case. Figures 6 -16 show typical defrost system wiring diagrams. RSES Troubleshooting diagrams are included.

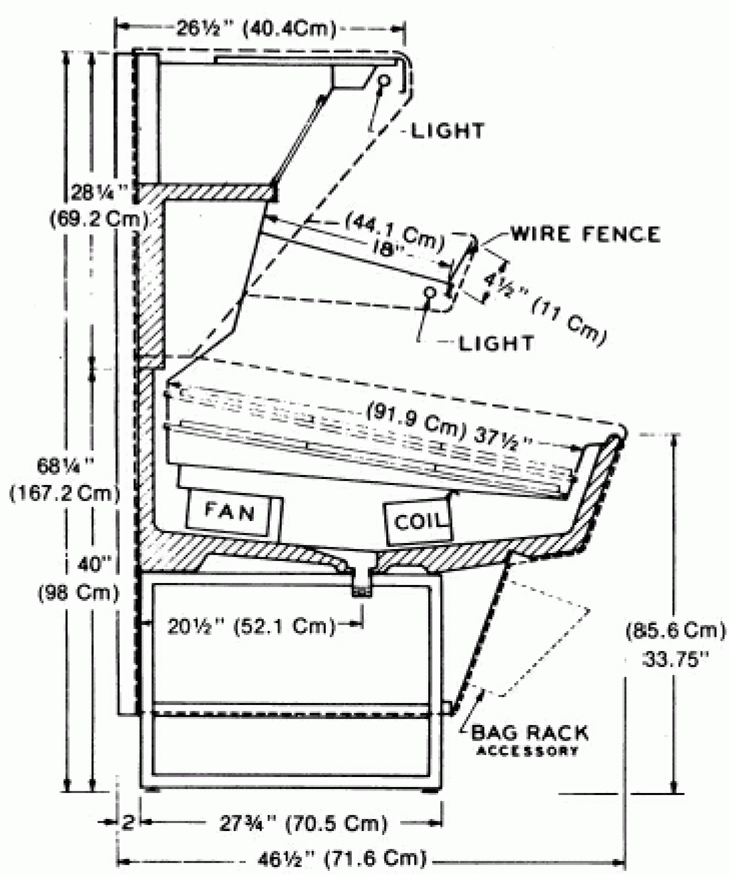

Figure 7

Cross section of two-shelf produce case

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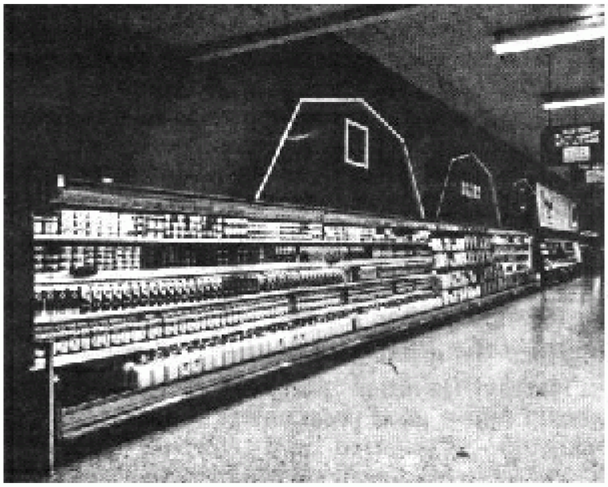

Figure 8

Typical open, self-service dairy case

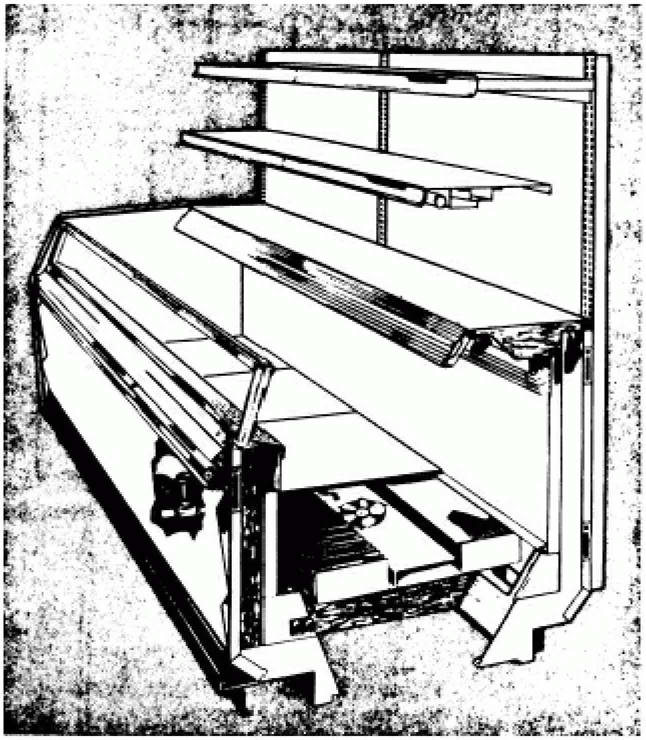

Figure 11

Cross-section drawing of ice cream case with non-refrigerated superstructure

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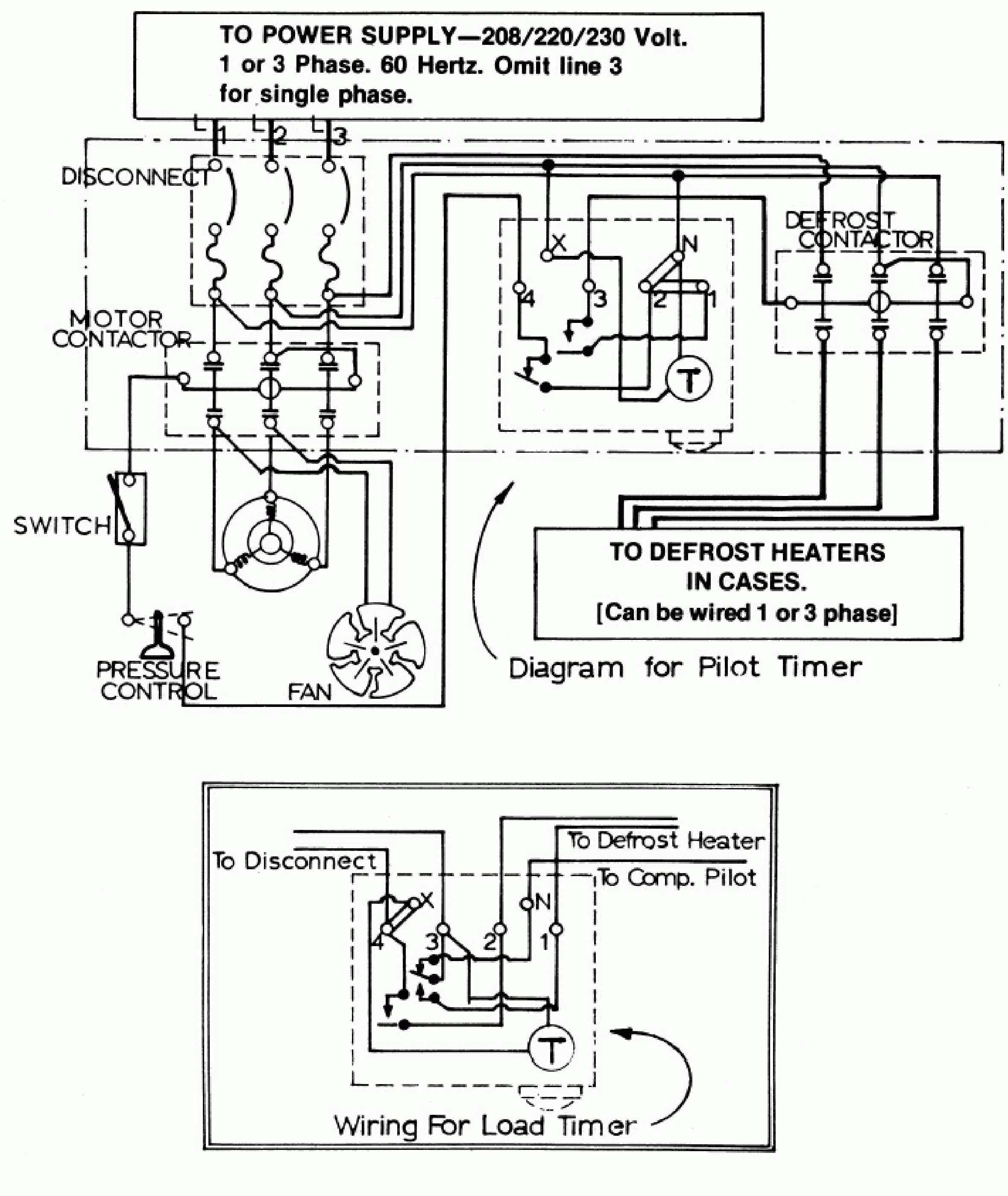

Figure 13

Typical wiring for frozen food cases with electric defrost. Inset shows wiring where case defrost heater load is less than timer contact ratings.

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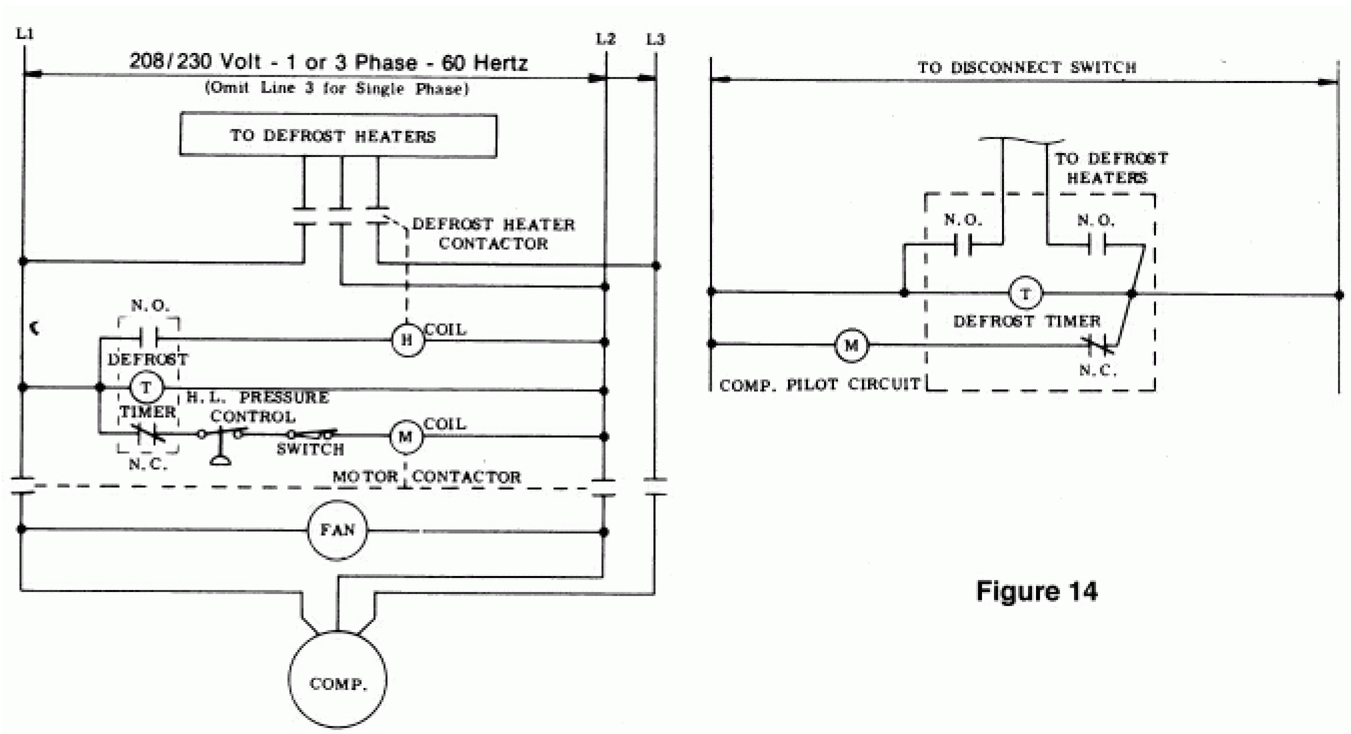

Figure 14

RSES Troubleshooting Diagram for Figure 13. Diagram on LEFT is normal circuit showing defrost timer contacts in pilot circuit. Diagram on RIGHT shows connections when timer contacts carry full heater current.

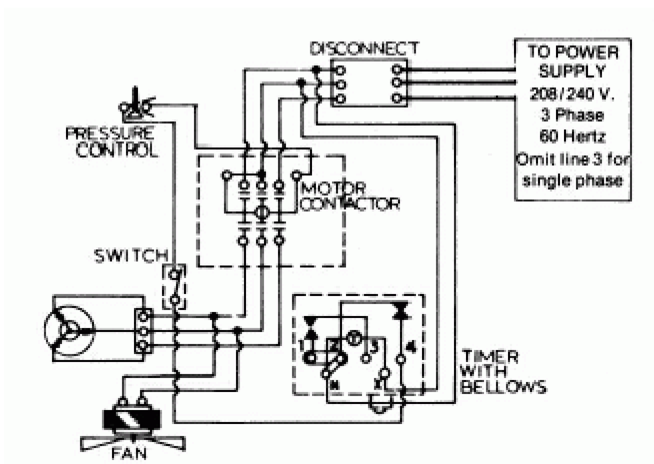

Figure 15

Typical wiring of cases without defrost heaters, using time clock for defrost.

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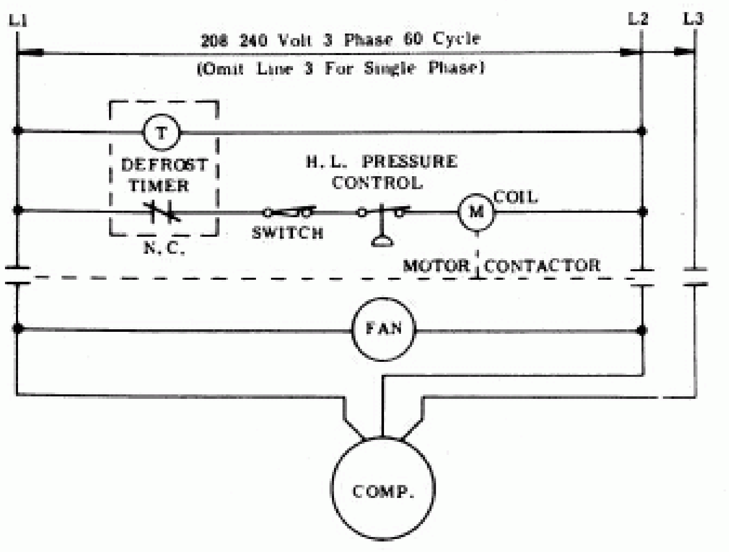

Figure 16

RSES Troubleshooting for circuit shown above.

Multi-deck frozen food cases have been developed in the past few years. Due to the many approaches used to operate this equipment, it is important to follow the instructions provided by the specific manufacturer.

SERVICING DISPLAY EQUIPMENT

Modern equipment requires modern service methods. The service engineer handling today's display cases needs the tools to properly perform intelligent diagnosis of operational problems. To work without proper equipment is to invite incorrect judgment, and often results in unhappy, dissatisfied customers. A competent service engineer will use and understand the following:

Compound Gage

High-Pressure Gage

Several Thermometers

Electrical Thermometers

Ohmmeter

Sling Psychrometer

Velometer

Volt-Ammeter

Suction Recorder

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High-Pressure Recorder

Temperature Recorder (Remote Bulb)

Diagnosis of operational problems requires considerable knowledge, curiosity, and ability to observe. Except for outright stopping of condensing units, this reasoning out of the problem at hand may call upon all of our facilities so that a proper conclusion is reached. For every problem there is an answer. Most service problems are simple-all can be solved. Remember basic refrigeration. Make use of a check list so as not to overlook any item.

CHECKLIST FOR DISPLAY CASE SERVICE DIAGNOSIS

Head Pressure

Suction Pressure

Line Voltage

Unit On

Unit Off

Amperage

Condensing Unit

Heaters

Defrost Period

Line Sizes

Expansion Valve Adjustment

Frost in Return Flue

Heater Ohms

Refrigerant Charge

Discharge Air Velocities

Anti-Sweat Heater Operation

Condition of Coil

Temperatures in Cases

Discharge Temperature

Case or Product Temperature

Return Air Temperature

Water Temperatures into and out of Condenser (Water Cooled Units)

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NOTE:

Above items are not necessarily in order, but serve as reminders for complete diagnosis.

LOW-TEMPERATURE PROBLEMS

Low-temperature equipment is often most misunderstood. The following discussion will assist you in your efforts toward solution of some of the more difficult situations.

PRODUCT MUST BE AT PROPER TEMPERATURE WHEN PLACED IN THE CASE.

Remember, the case is not designed to lower product temperature. Many a soft ice cream complaint has been traced to improper handling of the product prior to being placed in the display case.

PRODUCT MUST BE KEPT WITHIN THE LOAD LINES.

This is the most prevalent abuse found with self-service cases. High product temperature, aspiration of room air, heavy frosting of coils and increased operation costs are the penalty of over loading. Be ever on guard for over loading-even for short periods of time.

DRAFTS

Excessive air movement must be avoided with self-service equipment. Drafts cause a displacement of the case air, adding store heat and moisture to the case. This results in heavy coil frosting, high product temperatures, frost on product. Velocities over 20 fpm (9.4 l/s) are considered excessive, in the immediate vicinity of the case.

RADIANT HEAT

This will affect product temperatures even when the product is surrounded with air at proper temperature. The only remedy is the elimination of the cause, whether it be lights, heaters or sun heat through poor roof construction.

HIGH STORE HUMIDITY

Humidity takes its toll in increased operation costs, sweating of equipment, ice formation on product, frosting of coils, higher product temperature. An in-store relative humidity of 55% should be the limit for best results.

PROPER COIL TEMPERATURE

Recommended temperature must be maintained to achieve satisfactory operation. There are several things which affect this, some of which are:

EXPANSION VALVE ADJUSTMENT

Coils must be fully active. All expansion valves should be checked for proper adjustment even though they are "factory set". Modern case coils are properly sized under fully flooded conditions. Bear in mind that a properly operating coil in a low temperature case is delivering suction gas to the suction line at from -20°F to -35°F (-29°c to -37°c). This means the suction line will frost out of the case and this should be expected. Raising superheat settings to keep frost lines within the case means starved coils, unable to do the work for which they are intended. This all too common error is avoided by properly insulating suction lines for at least 30' (9M) from the case.

EXCESS PRESSURE DROP

Pressure drop robs compressor capacity. Limit pressure drop by properly sizing lines, using as few fittings as possible, using long radius elbows, etc. Pressure drop for suction lines should not exceed 1 psi (.45 kPa) for R-12 or 2 psi (.9 kPa) for R-22 (based on equivalent length).

IMPROPER AIR FLOW

Air flow must be maintained to have proper coil temperature. Fan motor speed, proper fan blades, blade alignment are some points to check here.

LOW HEAD PRESSURE

Insufficient head pressure can seriously affect the pressure drop across expansion valves with resultant loss in capacity. Flashing in liquid lines adds to this loss.

OIL LOGGING

Oil in the evaporator creates improper coil temperature. Often commonly thought to occur only with R-22, it can also be found in R-502 systems as well as improper piped R-12 systems.

POOR DRAINING

Drains which clog or lack pitch will result in ice formation on coils. This prevents proper air circulation and results in incorrect coil temperature.

IMPROPER DEFROST

Wrong control settings or low voltage can create iced coils. Regardless of the number of defrosts per day, each defrost must be complete.

IMPROPER CONTROL SETTINGS

Obviously, improper settings will result in incorrect coil temperatures.

CONDENSATION ON FIXTURES

Service Engineers are often faced with complaints of condensation of fixtures. Such conditions can be most aggravating to store owners, and puzzling to the refrigeration man.

Condensation due to failure of "anti-sweat" heaters is usually easy to determine due to acute symptoms. Areas which are in contact with cold case air often have anti-sweat heaters to keep metal temperatures above the dew point. When these heaters fail, the area sweats and is easily observed. Heater locations and connection points are shown in the service instructions for the fixture. (Figure 18)

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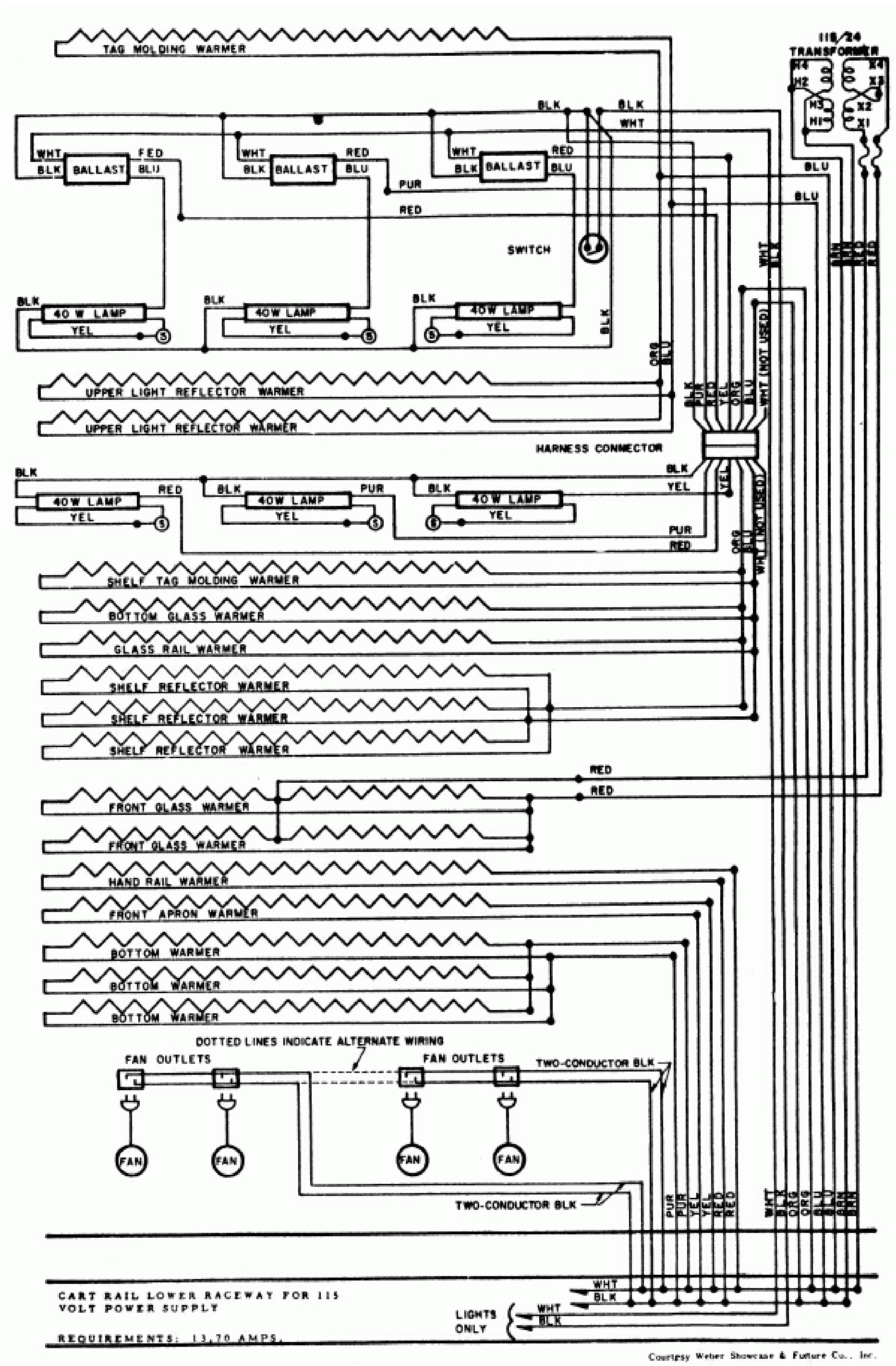

Figure 18

Typical 115V Wiring Diagram for a Frozen Food Case

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Drafts will often cause condensation at certain areas within the fixture due to the relatively warm, moist air from the store contacting cool metal parts.

Dead air spaces created by installing cases tightly to walls, or boxing in with wood or metal will cause condensation on backs and bottoms of fixtures. Such areas require ventilation to overcome the problem. Most manufacturers have fans available to provide this ventilation.

Many so-called air conditioned stores provide comfort cooling only, without removing latent heat. Store humidity rises, and at the same time store temperatures fall. The result is a condition of high wet bulb with low dry bulb and a perfect set-up for condensation.

Some store operators turn off air conditioning at night. The fixtures remove primarily sensible heat, hence by morning, store humidity is excessive. Often outside air is brought into the building without control, rain or shine. Combined with shut down of air conditioning at night, condensation is almost guaranteed. These last two conditions usually show up as a heavy condensation complaint in the morning, with easing off by afternoon. This, then, is an important "check point" in finding the cause of the complaint.

Occasionally, contractors will pour the floor slab for the store without providing a vapor seal under the slab. Ground moisture can easily pass through concrete, causing great damage, especially in any dead air space above.

New stores tend to be "wet" for some time, and this is another item to consider when searching for the answer to condensation.

Uninsulated suction lines running through toe spaces of fixtures can bring metal surfaces below the dew point, creating condensation complaints.

CONCLUSION

Few other areas of refrigeration have experienced such rapid changes as the food display equipment field has. Servicing the food store can be rewarding, and is always challenging. The future holds great promise for the service engineer who continues to learn about these products, gaining in skill.