Raker

Appliance Repair Professionals, Inc.

Refrigerators and Freezers

Manual 7

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Refrigerators & Freezers

Introduction

Einstein is featured on the lesson cover for a very good reason. To a novice, repairing refrigeration systems seems utterly impossible. From their point of view, you need to be an Einstein to understand and fix one.

Refrigerators offer no easy clues as to what is wrong, most of the time they die quietly. Seldom are the moving parts visible.

This is great news for us! It keeps out the meddlers and Mr. Fix-it types. We get more work at higher prices.

Refrigeration repair requires very careful attention to subtle clues. It is more essential than ever to listen to the customer. It is also important to delicately approach refrigeration systems. Key information can be lost and diagnostic time wasted if the wrong approach is used. A refrigeration system is a fragile and easily disturbed.

In this lesson we will learn how a freon system works, how to diagnose it , and how to repair its components.

A Bottom Freezer from the 60's

Fig071_01
A New SubZero Side-By-Side

In some ways, refrigerators are easier to repair than other appliances. For instance, they all utilize the exact same operating theory. They all operate on freon gas. Also, a great many parts are interchangeable between brands and models. We don't have to concern ourselves with many different designs like we do on washing machines. There are some differences, but they are not dramatic. Brands are so similar that it is possible to be working on a refrigerator and not even know what brand you are fixing!

In order to properly repair refrigerators, it is necessary to thoroughly understand how the freon system works. This, of course, is the heart of the cooling system.

Uncle Harry's
Story Time

In the early stages of my appliance repair career, I was somewhat intimidated by refrigeration systems. Back in the 70's, they seemed mysterious to me. For years, I refused service calls on them and concentrated on laundry equipment. (Oh, the money I must have turned away.)

Service techs were always talking about "back pressure", "charging", "evacuating systems" , "restrictions", "dryers". I really didn't know what they were talking about.

As luck would have it, about 1979, I bought an old company, Reliable Service Co. Inc. It was a major expansion, doubling the size of my company from three to six trucks. Along with the new company came three service men, and a lot of refrigeration work.

It wasn't too long before I realized that the servicemen that came with the company were largely incompetent. Very quickly, I was forced to learn refrigeration. Refrigerators were popping up that none of my techs could properly repair.

As it turned out, the dreaded refrigeration wasn't so bad after all. Today, I enjoy refrigeration calls. They are good moneymakers; they're clean, and the work is relatively simple.

It's like learning to swim, you have to jump into the water. Eventually, I became better than any of the men. That was because I understood the freon theory better.

The Freon System

First, the word "system" refers to the piping that carries the freon around to various sections of the refrigerator. It is silver-soldered shut and often referred to as the “sealed system.” To understand the sealed system, it is necessary to understand freon gas.

Freon has a number of peculiar properties that make it ideal for a refrigeration system. **It is an odorless, colorless, non-corrosive, non-flammable, cheap (it used to be), non-poisonous gas**. It’s most important property is that it turns into a liquid at fairly low pressures. At normal room temperatures, 70°F, freon turns from a gas into a liquid at about 70 lb. per square inch. If you buy a can of freon at the store, it is full of a liquid. The pressure in the tank, is around 70 psi.

Propane is a similar gas. When you buy it for your grill, it also a liquid under pressure, You can feel the liquid sloshing around in the tank. Like freon if you exhaust it to the air, it turns into a gas.

Have you ever noticed that a propane tank gets frosty when propane is rapidly exhausted from the tank? Freon operates much the same way. The laws of physics dictate that when a liquid evaporates into a gas, it absorbs energy.

Evaporation is a Cooling Process

This is the key to all freon systems. Simple enough! We will trace the freon path through a complete refrigeration cycle, beginning at the evaporator.

The Evaporator

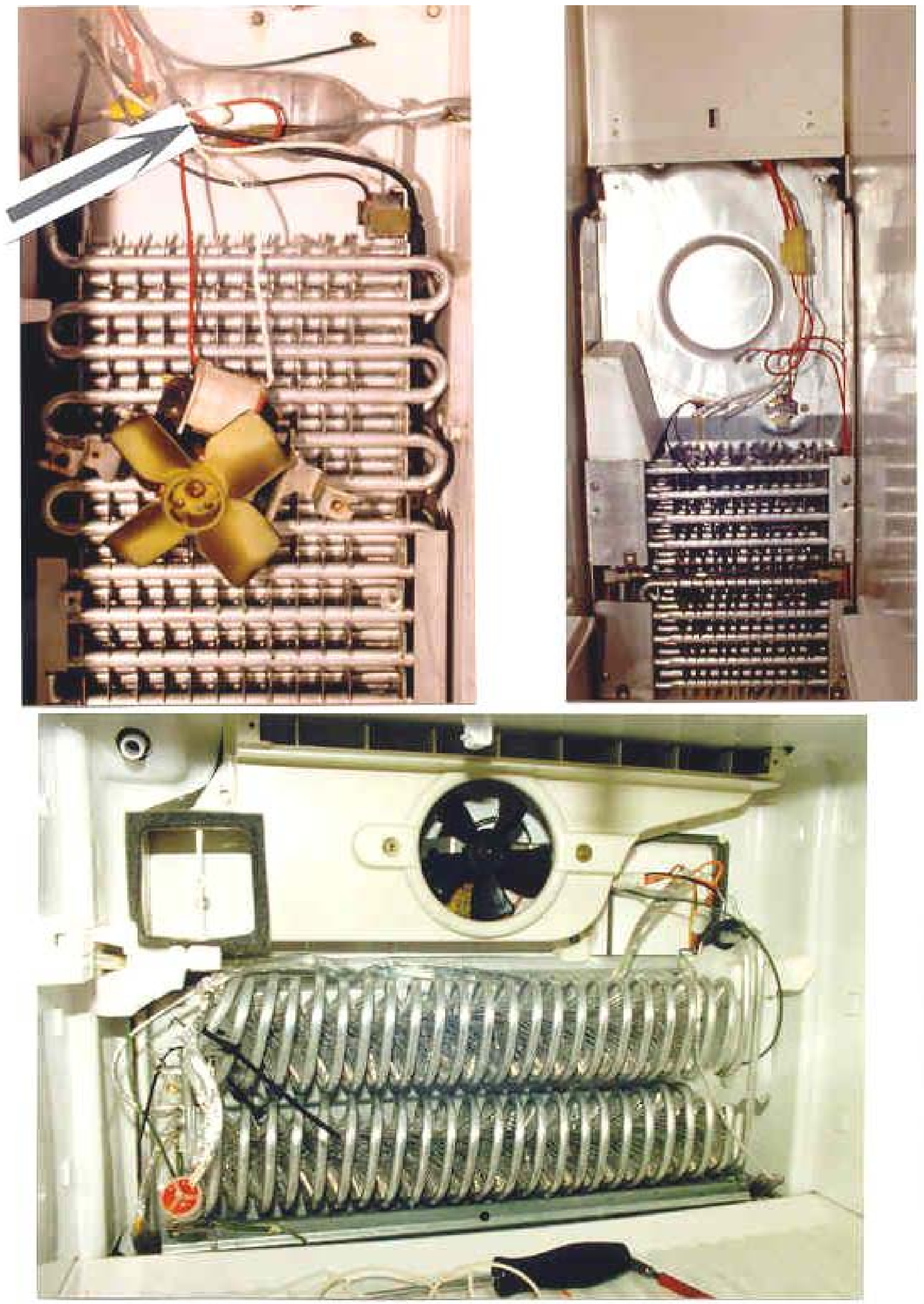
As liquid freon enters the freezer section of all refrigerators, it boils from a liquid into a gas and absorbs heat from the surrounding chamber. The boiling takes place within the **evaporator.** The evaporator is a long aluminum coil of tubing that looks very similar to a car radiator.

If you shut off the fans and listen, you can actually hear freon boiling as it enters the swelled section, known as the expansion bulb, of the evaporator. You can hear it trickling and bubbling and boiling as it works its way through the evaporator. If you had X-ray eyes and could see inside the evaporator, you would see droplets of freon boiling into a gas. The freon is gradually pumped by the compressor from the inlet to the outlet of the evaporator.

The boiling temperature of the freon is 15 °F below zero. As it boils, it freezes the evaporator. A finger will stick against a cold evaporator

.

Fig071_02



The Capillary Tube

To attain correct temperatures, the amount of freon that enters the evaporator must be carefully controlled. On large commercial refrigeration systems the flow controller is called an "expansion valve." On domestic refrigeration systems a capillary tube controls the flow. A capillary tube is also known as a "metering device."

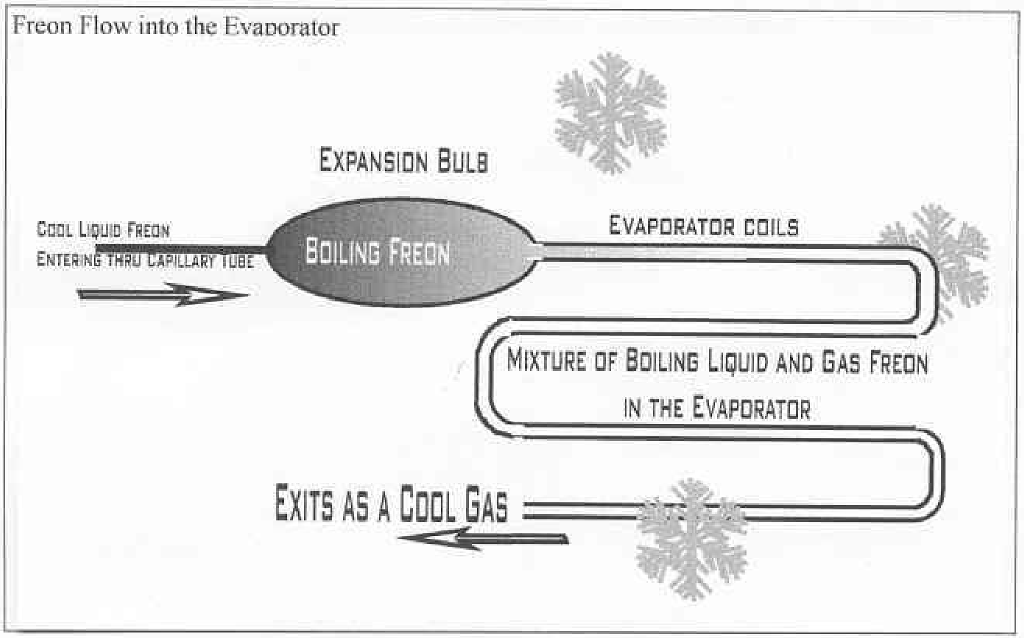
It is a long thin copper tube. Freon backs up at high pressure behind the capillary waiting to squirt out the hole at the end. The coiled, tiny ten-foot tube restricts the flow of freon like the pinhole in the end of a water pistol. Freon squirts out the end of the capillary tube and into the evaporator expansion bulb.

Fig071_03

Freon enters the evaporator as a liquid, evaporates and leaves as a low-pressure gas.

Freon evaporation will drop the temperature to 15°F below zero on the surface of the evaporator!

Fig071_04



Freon Flow into the Evaporator

Chilled freon gas exits the freezer compartment and travels back to the compressor.

Consider the following refrigeration design problem. As freon leaves the freezer section it is a chilled gas and it must flow back to the compressor. In the summer time, condensate will form on the cool return line. The condensate is much like that which forms on cold water pipes in the summer. Potentially this wet return line can cause rust and dripping down the back of the refrigerator. And sometimes it does!

This problem is prevented in two ways. The first solution we will cover now, the second later. Looking on the back of a refrigerator, there is only one insulated freon line. It is the line from the evaporator back to the compressor. It is covered with black foam rubber to minimize condensate problems**.**

Uncle Harry's
Trick of the Trade # 92

Identify the freon return line by looking for the black insulation. To identify the lines connected to the compressor feel the two lines that enter and exit. The inlet line will be cool and the exit or discharge line will be hot.

Fig071_05

Cool freon gas returning from the evaporator enters the compressor at a low pressure of 1-2 pounds per square inch (psi). The compressor pumps the freon up to about 150-180 lb. psi. It operates very much like an air compressor. Instead of air, a refrigeration compressor compresses gaseous freon.

The laws of physics again intervene:

If a gas is compressed in a confined space, its temperature will rise.

Consequently, the compressor and the gas being compressed and discharged get hot. Incidentally, this heat is the energy that was absorbed by the boiling freon from the food compartments. Almost magically, freon flow has transferred heat from inside of the box to the outside! Now the problem is how to get rid of the heat.

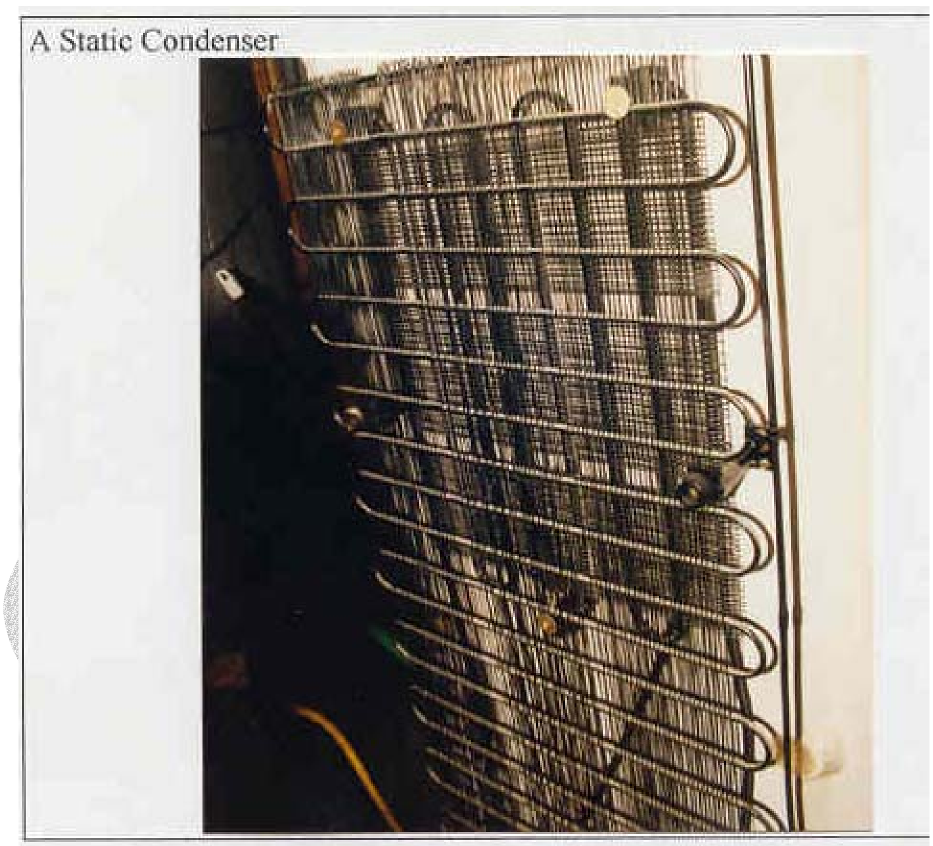
Fig071_06
Typical Compressor Jammed Under A Refrigerator

The Condenser

The hot pressurized gas from the compressor enters another long series of steel tubes that are very similar to the evaporator..

This second series of tubes is called the condenser. It is positioned either underneath or up the back of the refrigerator. They are always painted black and zigzag back and forth just like the evaporator. The condenser is used to radiate the heat out of the hot freon.

Fig071_07



Freon as a high-pressure gas enters the condenser. As the gas makes its way through the condenser, it gradually chills down and condenses into a liquid. . This is the exact reverse of what happened inside the evaporator within the freezer.

Picture the condenser as operating exactly like cooling coils on a moonshine still. Freon is equivalent to the moonshine trickling out of the still's copper coils.

Condensers are made in two different ways, static and fan cooled. A static condenser uses room air currents to cool the freon as it flows through the coils. If the coils are folded into a small space not enough air will flow to sufficiently cool the freon. A condenser-cooling fan is necessary. Static condensers are used on smaller and older refrigerators.

Newer and more expensive refrigerators are larger and generate more heat. They all require a condenser-cooling fan. Also, installing the condenser below the food compartment, allows the refrigerator it to be jammed against the wall or installed in a tight cabinet- (Zero clearance.) Instead of the hot air flowing up the back wall, it now flows out the front . Cats love this warm spot.

Fig071_08

A Compact Condenser and a Bad Cooling Fan

Jamming the condenser into tight quarters in a boon for the service business. The fan constantly sucks in lint and animal hair clogging the condenser.

The combination of the compressor and the condenser is often known as the “condensing unit”. Together they condense freon from a gas into a warm liquid. A similar pair of components sits outside your house. It is called an “air conditioning condenser” and performs the same function.

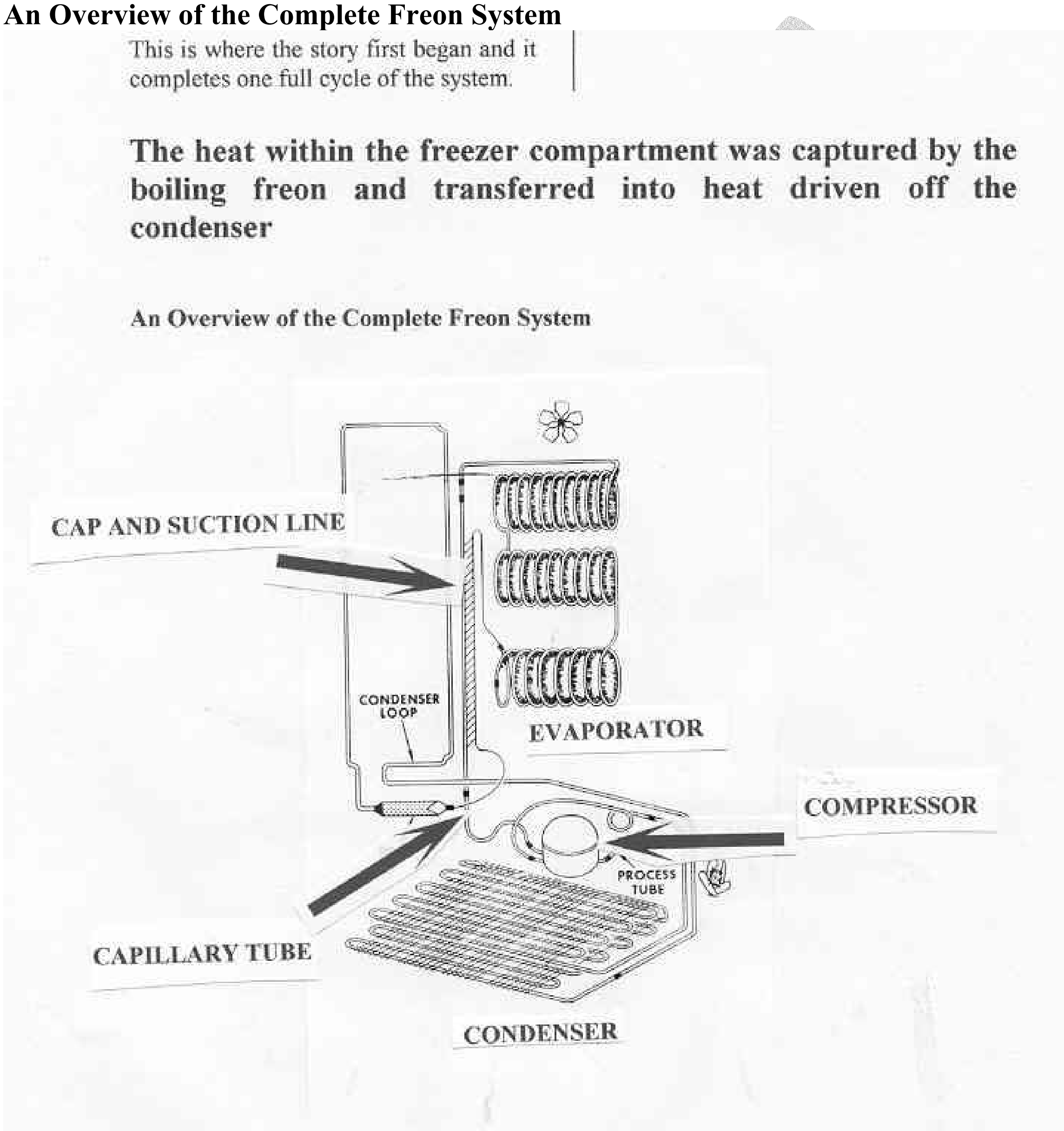
The evaporator for your air conditioner sits in the furnace chamber.

At the outlet of the condenser, the now liquid freon has cooled down to room temperature. After freon leaves the condenser, it goes through a filter or dryer to clean out any impurities. Dirt may come from the compressor oil or any corrosion inside the system. The outlet of the dryer is the input to the capillary tube.

This is where our story first began and we have completed one full cycle of the freon system.

Heat within the freezer compartment was captured by the boiling freon and transferred into heat driven off the condenser and into the surrounding room.

Fig071_09
An Overview of the Complete Freon System



Freon System Refinements

Some bright engineer, realized that if the capillary tube is soldered to the return line from the evaporator, two positive things could be accomplished at the same time.

1. The slightly warm freon making its way through the capillary tube to the evaporator would get even cooler if it were snuggled up against the cool freon coming back from the evaporator.

2. The warm capillary tube helps to warm up the return line slightly resulting in less chance of condensate.

As mentioned previously that there are two methods of preventing condensate from forming on the return line from the evaporator. Soldering the capillary tube to the return line is the second method.

The soldered section of tubing is called the "cap and suction" line. If the solder fails condensate will form on the cap and suction line.

> *Uncle Harry's*
> Trick of the Trade # 93
> A separated cap and suction line can be repaired with plastic cable ties.

This freon sealed system is a very highly engineered and sophisticated. It is pre-set at the factory to run like a digital watch and is not really designed to be tampered with. The system is hard-soldered shut and with rare exception has no access valve. The amount of freon in the system is very carefully weighed to fractions of an ounce. The system is balanced out, so that freon coming back from the evaporator is at exactly the right pressure as it enters the compressor.

Understanding System Problems

Freon systems fail in three ways:

1. A leak and a loss of freon.

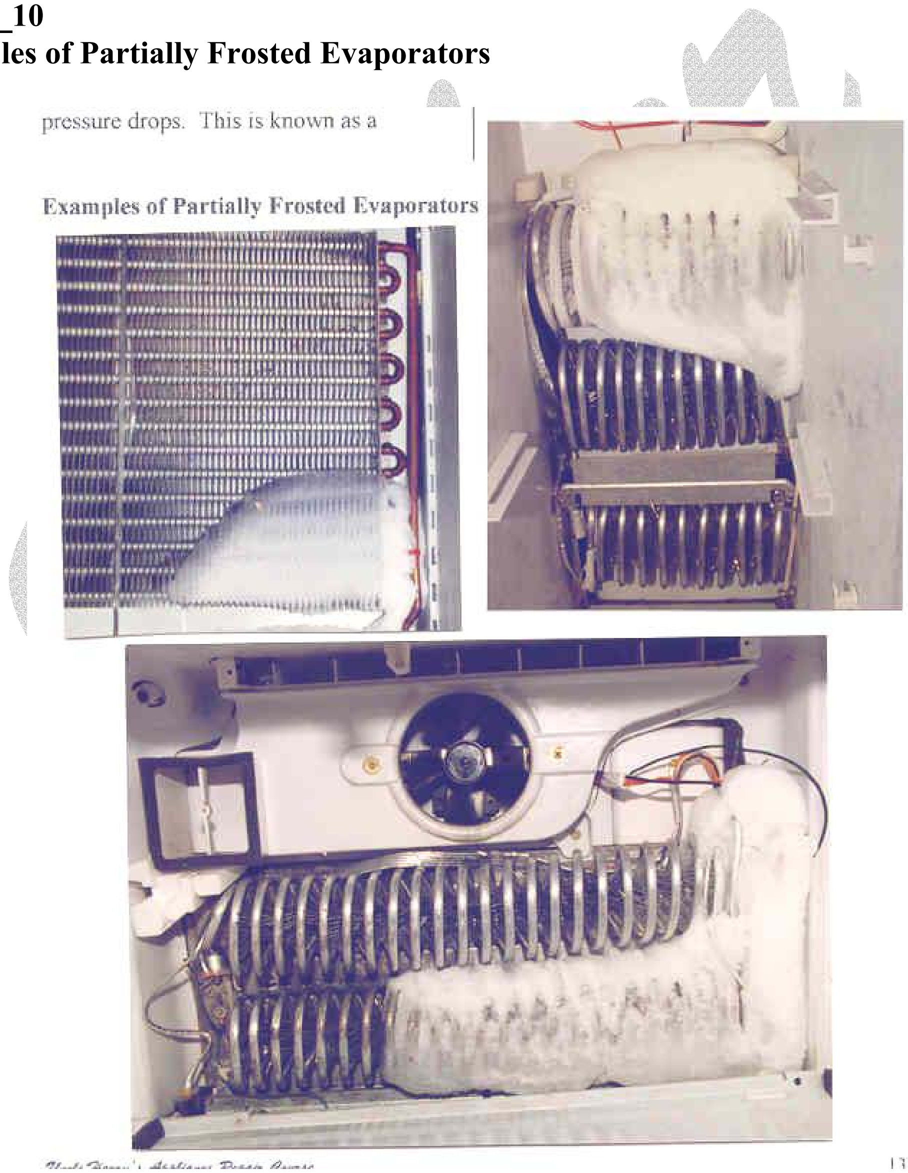
2. A restriction or clogging in the lines.

3. Compressor failure.

1. Leaks and Pressures within the Freon system

The freon pressure returning to the compressor is known as "back pressure." As mentioned before the amount of freon is adjusted to stabilize at a backpressure of 1-2 psi. If some freon leaks out the system, the backpressure drops. This is known as a "short system". As the compressor keeps trying to suck freon from the lines, it drops the backpressure into a vacuum. Eventually there is not enough freon to adequately fill and cool the evaporator. Instead of being evenly frosted, all of the freon will boil away near the expansion bulb.

Fig071_10
Examples of Partially Frosted Evaporators



Leaks can occur in both the evaporator and the condenser. Condensers, sometimes, have a loop that sits in the drain pan underneath the refrigerator. The heat from the hot freon helps to evaporate the defrost water. In some cases the loop carries compressor oil instead of freon. For our purposes, it doesn’t matter.

Naturally, these loops rust in the water, perforate, and allow the freon to leak out. SubZero refrigerators are known for rusted through condenser loops. Water can then get into the system. Water creates havoc in a freon system. It causes rust inside the steel condenser lines and ice crystals to form at the end of the capillary tube. A system contaminated with water is basically trashed.

Evaporators are made of aluminum and the capillary and return lines are copper. Welding two dissimilar metals together is extremely difficult. It can only be done with special welding equipment. Even though the factories do their best, the junction between the two metals remains a weak spot. Evaporator leaks usually form at the joints where the capillary tube or the return line are welded to the aluminum evaporator.

Human interference is another major cause of leaks. Sometimes freon lines are damaged during a move. More often they are punctured. In the trade this is often called “the ice pick trick”. Small manual defrost units are the main problem. Customers get impatient with the defrost process and use an ice pick to chip away accumulated ice. They puncture the exposed evaporator coils.

Uncle Harry's
Trick of the Trade # 94

In spite of anything you might hear to the contrary, **there is no reliable method for repairing a punctured evaporator.** Once an evaporator is punctured it must be replaced.

Fig071_11

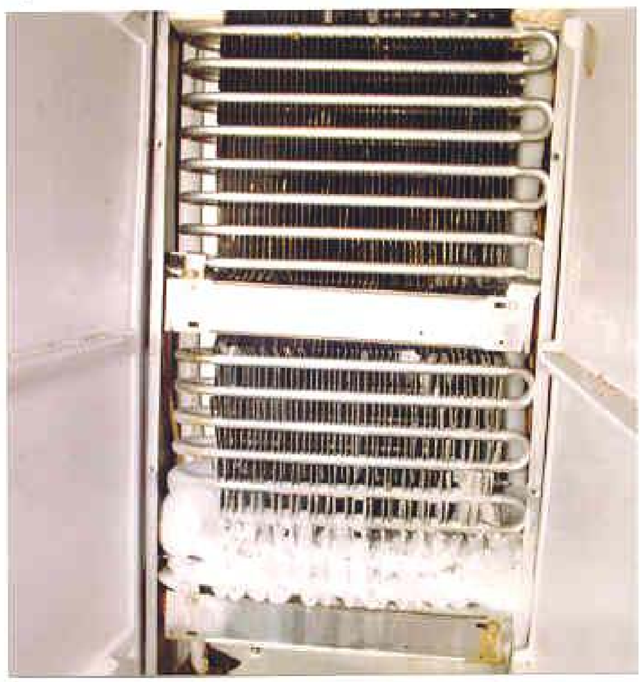
A Manual Defrost Freezer Badly in Need of Defrosting

2. Restrictions

Anything that blocks the flow of freon is called a "restriction." Restriction problems are more common than leaks. They result in a similar frost pattern. When the system is restricted insufficient freon gets to the evaporator and poor cooling results.

Fig071_12

A Restricted System



Restrictions usually occur at the inlet or outlet of the capillary tube.

Any tiny fragments will be sufficient to clog the inlet. The in line dryers are helpful, but not perfect.

Any moisture in the system will freeze with the freon as it evaporates at the outlet of the capillary tube. Tiny ice crystals are sufficient to plug up the small tube. In fact the dryer's job is to absorb water along with dirt.

An overheated or burned out compressor will create contamination.

By checking temperatures, it is possible to separate a restriction from a leak. An empty or dry system will not have any freon to pump. Therefore, the condenser will not be hot. The compressor will be only warm to the touch; no gas is being compressed to generate heat.

In contrast, the condensing unit of a restricted system will be very hot. The poor compressor will be pumping freon into a totally blocked condenser. The gas pressure will reach the compressor limits of 200-300 psi. The compressor and some or all of the condenser will be too hot to touch.

> *Uncle Harry's*
> Trick of the Trade # 95
>
> Develop a habit of feeling all the freon lines as you work. Diagnosis becomes easier when you know the proper temperatures of each one.

GE, in recent years, has had a tremendous number of problems with its new style compressor and condenser. The redesigned units were first sold in the middle 80's and are easily identified by brown door gaskets. Apparently, restrictions are frequently occurring in the condensing system. There have been a great number of failures during and beyond the customary 5-year warranty period.

GE has reacted by extending the warranty to 10 years on a pro-rata basis. Customers can get a condenser replacement in the 6th, 7th or 8th year for about $200.00. With the extended warranty, the repair cost averages about half the normal price. GE mechanics have gotten so good, that they can do a system replacement in less than two hours. This is about half the normal time. They must get a lot of practice.

3. Compressor Failures

Compressors fail in four ways:

1. Overheating, binding and locking up.

2. The internal valves fail and little or no freon is pumped. They become "inefficient".

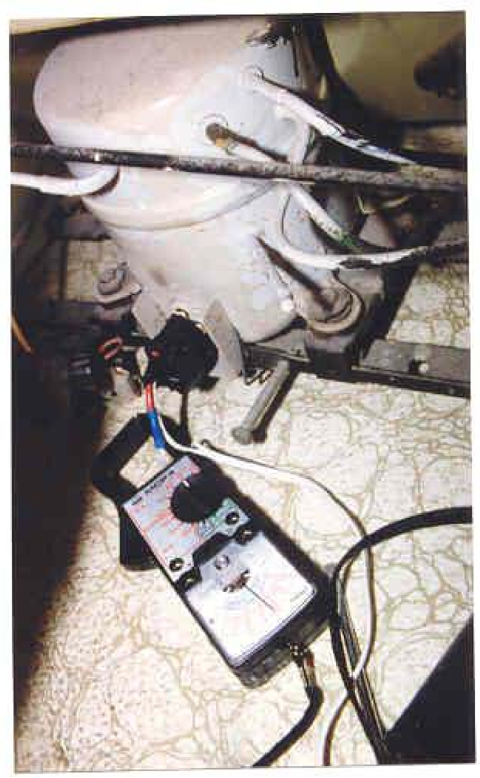
3. The motor windings short or burn out.

4. They begin making strange noises.

5. External starting and safety devices fail.

Fig071_13

Monitoring the Current Draw on a Typical Compressor



1. Overheated Compressors

By far the most common compressor failure is overheating. All compressors have a high limit thermostat mounted on the side. The thermostat operates exactly like a dryer limit. It opens when the set temperature is exceeded. It also opens if the compressor draws too much current.

The safety emits an audible click and breaks the compressor circuit. Fortunately, overheating is seldom fatal. The cause is often elsewhere and can be corrected. Once the compressor cools down, it usually resumes normal operation.

The common cause of overheating is a clogged condenser. Frequent cleaning by the homeowner is needed.

The second most common cause is a blocked or bad condenser fan motor.

Tight compressors

A tight compressor is much like a seized gasoline engine. A bearing or a piston has galled to the shaft or the piston wall. The unit becomes too hard to turn and overheats or simply locks. Some failing compressors continue to work under normal conditions, but fail on hot days.

Knowledgeable mechanics often call these "high wattage compressors." High wattage refers to the current draw of the compressor. A dragging compressor will draw more current ,as it tries to perform its necessary duties. The excess current will generate more heat and eventually cause the overload to operate. It is possible to spot a high wattage compressor with an Amprobe by comparing the rated current to that observed.

Usually, careful observation will provide the same information. Most of the time compressors are not just half bad, they are completely shot.

The life of some dragging compressors can be extended with a "hard start kit." A hard start kit replaces the starting relay and limit mounted on the compressor. It includes a strong capacitor designed to give the compressor a jolt, during the first few seconds of startup.

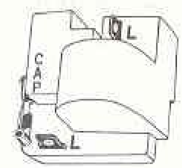
Hard start kits are successful in only about one-third to one-half the cases. When they work it is almost like a miracle. Instantaneously, a locked compressor comes back to life. Keep in mind that that they are not a cure all. They only buy time in most cases. Some basic problem is still lurking.

RELAYS — OVERLOADS

PUSH-ON COMBINATION RELAY/OVERLOAD

The PRO Relay offers excellent locked motor protection, plus the durability of a solid state relay. A start capacitor can be installed easily, if required.

- Fast push-on installation
- Eliminates start winding overheating
- Can be used with a start capacitor



PUSH-ON RELAY/OVERLOAD

PART NO.	HORSEPOWER	VOLTAGE
PRO-81	1/12 thru 1/5	115
PRO-41	1/4 and 1/3	115

RO SERIES
RELAY & OVERLOAD COMBINATION

SUPCO PART NO.	REFERENCE GEM NO.	MARS NO.	H.P.	VOLTAGE
RO-61	IC-15	21305	1/12 thru 1/5	115
RO-41	IC-13	21310	1/4 and 1/3	115
RO-82	—	—	1/12, 1/10 and 1/8	220
RO-62	IC-25	21315	1/6 and 1/5	220
RO-42	IC-23	21320	1/4 and 1/3	220

RO

SYT SERIES
RELAY & OVERLOAD COMBINATION

SUPCO PART NO.	REFERENCE GEM NO.	MARS NO.	H.P.	COMP. AMPS
SYT8-9	GYS7-8-9	21002	1/7, 1/8 AND 1/9	2.2
SYT6	GYS5-6	21004	1/6	2.92
SYT5	GYS5-6	21004	1/5	3.50
SYT4	GYS4	21005	1/4	4.37
SYT3	GYS3	21006	1/3	5.83

SYT

RCO SERIES
RELAY, OVERLOAD & START CAPACITOR

SUPCO PART NO.	GEM	ROBERT SHAW	H.P.	VOLTAGE
RC0410	HS410	600-410	1/4, 1/3	115
RC0810	HS810	600-810	1/12 thru 1/5	115

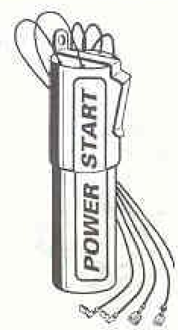
RCO

POWER STARTS

DESIGNED SPECIFICALLY FOR COMPRESSORS
THAT HAVE RUN CAPACITORS

These units are designed specifically for the newer PSC Type refrigerators and freezers being sold by most manufacturers today. They provide that additional boost that overcomes most hard start problems.

PART NO.	H.P.	VOLTAGE
SPS 4	1/12 thru 1/2	120
SPS 42	1/12 thru 1/2	220



2-6

2. An Inefficient Compressor

If a valve fails within the compressor, freon will not be pumped and no cooling will take place. Its external temperature can identify an inefficient compressor. The compressor dome will only be slightly warm, instead of hot to the touch. Also the discharge line will be at room temperature.

The compressor is not hot because no work is being done.

A dry system, one without freon, will act the same way.

Uncle Harry's
Trick of the Trade # 96

Detecting a dry or weak compressor

While the refrigerator is running unplug it, and immediately plug it back in. A good refrigerator will immediately click off the overload safety. It will take ten to fifteen minutes to restart. A good compressor is unable to start up against the normal operating head pressure of 150 psi. Time must allowed for the discharge freon pressure to die down.

A bad compressor or a dry system will develop no head pressure. It will restart immediately.

3. A Burned Out Compressor

A burned out compressor has bad internal wiring. Either the windings are shorted together or open circuited. Either case is easy to diagnose.

There are two methods.

One is to remove the connector from the side of the compressor and test the resistance with an ohmmeter. It is necessary to test between each pair of terminals. It is also necessary to test for a short between the windings and the outside dome. Unfortunately, the resistance reading for a good winding is very low and hard to accurately measure. A short to the dome is easy to find.

Second method:

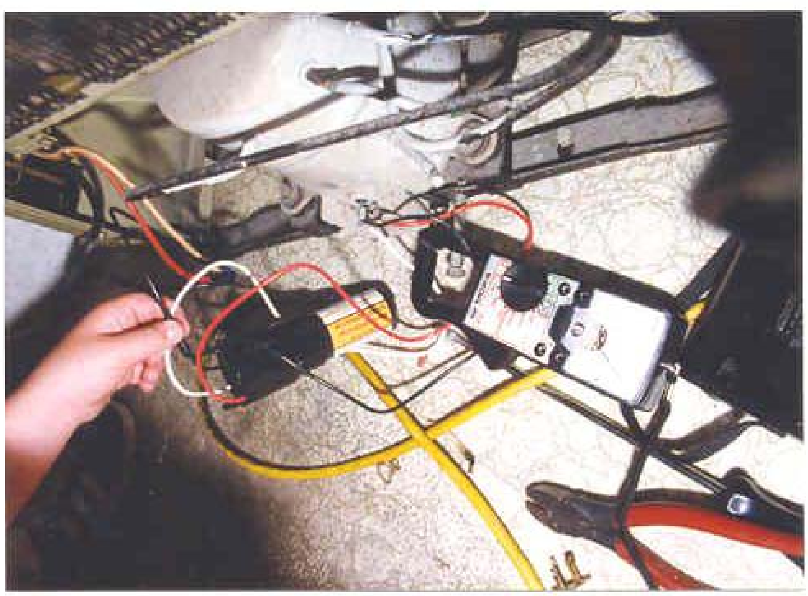
Uncle Harry's

Trick of the Trade # 97

The fastest and surest way to diagnose a bad compressor is to hook up a "hard start kit" and plug it into the trouble light. If the compressor runs, look elsewhere for the problem. If it doesn't, you know for sure, the problem is internal.

Fig071_15

Hard Start Kit Being Installed



4. Strange Noises

The pump within the sealed dome sits on springs. It quietly bounces as it pumps. The springs, and the external rubber grommets holding the dome in place, are designed to minimize noise.

As the refrigerator ages, the mounting grommets get hard, and transmit vibration to the cabinet. Customers sometimes complain of noisy compressors. Either a simple explanation, or replacing the rubber mounts is needed.

If one of the internal springs breaks, the motor tilts within the dome and may actually hit the side when it shuts off. This banging makes a very distinct rapping sound. Nothing can be done, short of replacing the compressor. Before too long, the sharp rapping will break something inside the dome.

Uncle Harry's
Story Time

I had an old refrigeration mechanic for a short time, prior to his retirement. A customer called in during his employment and described the broken spring noise. Old Joe said,

"Oh, tell her, she's got "stopper"."

All the young mechanics looked at him. Before long, one took the bait.

"OK, Joe, what's a "stopper."

First he explained where the noise came from. Then, he smiled and said, "Well, boys, one of these days, it's going to stop."

Replacing a failed compressor

Replacing a bad compressor varies from hard to impossible. The best situation occurs if the compressor quietly dies, and creates no contamination during its demise. Unfortunately, failures are usually a lot more dramatic. The more heat and burning involved, the more difficult the replacement job. When a compressor burns out, massive destruction occurs inside the sealed dome.

During the failure process, freon has been continually pumped through the burning motor, spreading debris throughout the system. Needless to say, the dirt will pile up at the entrance to capillary tube and clog up. It only takes one tiny speck of dirt to restrict the system

Compressor replacement is an art form. In addition to accepted standards, each mechanic develops his own style. All sorts of tricks of the trade have been devised to replace burned-out compressors. The difficulty centers around cleaning out the freon system. In case of a burnout, the best solution is replacement all of the system components, not just the compressor. It is recommended to replace both the evaporator and condenser too.

If they are not replaced, good technique requires that the condenser and evaporator be unsoldered from the system and blown out with high-pressure gas. Hopefully, this will blow out any accumulated debris. The gas is forced in from the exhaust end of the evaporator. It goes through the capillary backwards and cleans it.

Often a clean rag is wrapped at the outlet to detect any traces of dirt. In the past, freon was the handy ideal cleaning gas. With the new EPA restrictions, this is no longer allowed. Instead, a can of nitrogen is used. Once the rag shows no signs of dirt, the mechanic prays that there's no left over debris lodged in the system. It is then soldered back together.

Uncle Harry's
Story Time

Years ago, a customer convinced us to replace a burned out compressor. The refrigerator was really too old for the repair, but they wanted it. The compressor was tightly fitted, and overall a difficult replacement.

I felt confident in accepting the job, even though it was a tough burnout. I had the best refrigeration mechanic, in Baltimore, working for me. My mechanic had been doing system work for over 30 years.

After about a week, we got a callback on the job. The system was restricted. We cleaned and evacuated it a second time. Of course, we were even more careful than on the first time.

After about a week, we got another callback. It was restricted again.

Eventually, we were there twelve times. Even a second expert mechanic was brought in to try his skills.

We pulled the refrigerator out so many times, that the customer claimed that we had ruined her kitchen floor. Believe it or not, we wound up turning in the floor claim to our insurance company. They paid to replace it.

We finally gave up on the refrigerator and refunded most of the money.

Every mechanic in the company was affected by that job. It proved, beyond a doubt, just how miserable a contaminated system can be.

Before reassembly, a new filter dryer is always installed between the condenser and the capillary. Hopefully it will catch any lingering dirt. A new compressor is installed and the system is silver-soldered back together. There is a third tube on all compressors. It is called a "process tube." This process tube is used by the factory or field technician to gain access to the system.

Once a system has been cleaned and reassembled two further operations must take place:

1. The air, along with any moisture, must be sucked out.

2. The proper amount of freon must be added back.

Air and moisture are evacuated with a vacuum pump. A vacuum pump is a special compressor designed, specifically, to suck the system down into a vacuum. Old-time mechanics used old compressors for a vacuum pump. This is no longer possible under the new EPA laws. The pump is connected with special fittings to the process tube. Most good mechanics, let the pump run for a considerable time.

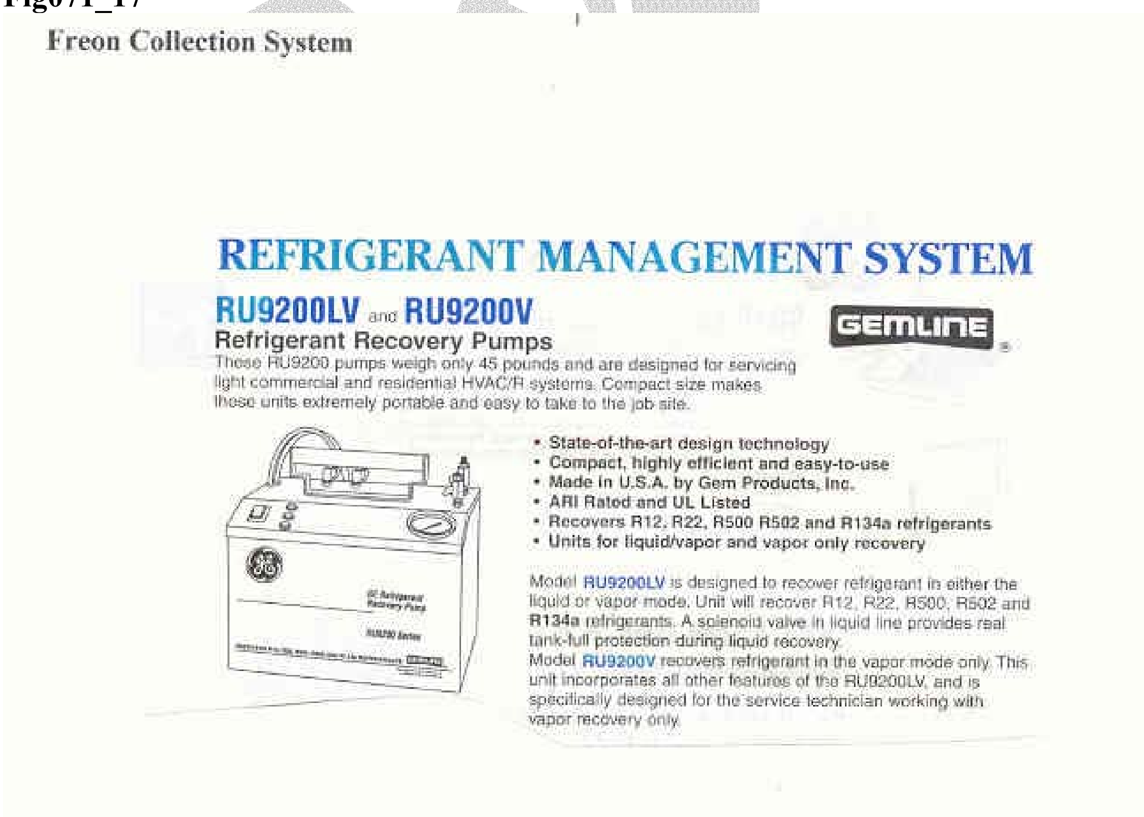
A minimum is thirty minutes, some let it run overnight.

The longer the pump runs, the more likely it will be that all the moisture will evaporate and be sucked out. Long pumping will not remove dirt, only moisture. Once the system is as clean and as dry as possible, freon is added.

This procedure is known as "charging." Typical refrigerators require 6-8 ounces of freon, less than a cupful. Again, special equipment is needed to accurately measure the freon.

In recent years, the EPA has added another layer of complexity. It is now necessary to recover and properly dispose of any excess freon. A system cannot be simply cut open and exhausted to the air. The old freon must be collected in the process.

Fig071_17



The fines for improper freon procedures are up to $25,000.00. A bounty is offered by the EPA for any leads, which result in convictions. They really mean business.

Uncle Harry's
Story Time

North of me, in the next county, a mechanic was recently caught exhausting freon. He was doing an after hour repair on an air-conditioner. Unknown to the mechanic, the customer (a true sweetheart) took a picture of him and turned him in for a reward. The mechanic was eventually fined $5,000.00. His comment was,

"It's going to take any awful lot of moonlight jobs to pay for that job!"

After the system is properly charged, it is turned on and run until it stabilizes. A set of refrigeration gauges is connected. Gradually, the "back pressure" can be checked. It should be 1-2 psi.. Once the pressures check out, the process tube is pinched shut with special "process tube pliers". The system is then soldered shut.

Some mechanics install and leave a Shraeder "tap valve" soldered onto the system. A Shraeder "tap valve" allows future testing of freon pressures and charging if needed. It also leaves a potential leak source.

Uncle Harry's
Trick of the Trade # 98

Superior mechanics leave no chance for leaks; they solder the system completely shut. If you decide to do system work, invest in tools to do it right. Use process tube adapters and pinching pliers.

The previous compressor replacement procedure is only a sketchy overview and is not intended to be complete. Actual system work requires much more study, Federal schooling and licensing.

Reviewing, it is obvious that compressor replacement and system work is complex, time consuming and requires a considerable investment in equipment. Consequently, the fees that must be charged, exceed $400.00. When an evaporator or condenser is also replaced, five or six hundred is not unusual.

If a refrigerator is over 10 years old, the decision is clear-cut. It is not wise for a customer to spend that much money. Up to five years, the compressor is covered by the factory warranty. Customers that complain to the factory during 6th year often get extended factory coverage.

The only manufacturer having significant trouble, in the 5-10 year range, is GE. As mentioned, they have extended the warranty coverage.

After considering the various factors, the number of potential customers dwindles down. Desirable systems jobs, the clean ones are in a distinct minority.

But the worst has yet to come.

Even after all the possible precautions are taken, most of the time problems arise anyway. The percentage of callbacks on systems work is extremely high. System replacement jobs, that last more than a year, are the rare exception.

Uncle Harry's
Story Time

Recalling again, my experience when I bought the Reliable Service Co. Inc., for several years, we continued doing system work. It wasn't too long, before I felt it was a financial black hole. The profits were generally less than normal repair work, and the callbacks were much greater.

I instructed my men to only accept the cleanest and most desirable jobs. The system work still was not as profitable as regular work. Eventually, after careful analysis, I stopped it altogether. We simply referred any system calls to friends in the business. Of course, we still collected a service charge for diagnosing the problem.

I remember, clearly, that my men thought I was crazy. They only saw the big checks coming in and thought I was throwing away very desirable, big money service work.

Of course, they didn't understand that it was the accounting that made the work undesirable.

Even today, fifteen years later, I watch technicians that continue to repair systems.

Everyone that I know doing it, still has continual problems.

Another example.

Just recently, I got a large hospital account. The head of maintenance told me about my predecessor. They were charging $500-600.00 to replace evaporators, condensers, and compressors on special built-in kitchen units. (It was very difficult to replace the whole unit.) In spite of all the precautions, the sealed system work still did not hold up for long. Callbacks caused them to lose the account.

Uncle Harry's
Trick of the Trade # 99

Stay away from system work.

Pay attention to your Uncle Harry!

Does it make sense to get involved in all the expense of equipment, licensing time and learning time to accomplish a specialty task? At the present time, a 25 LB can of freon costs $700.00 and it jumps every month. The EPA simply is making it impossible to economically repair systems.

Novices, homeowners, and new students seem to think the refrigeration problems are always freon problems.

<u>It simply isn't so</u>.

A classic service call:

"I want you to come look at my "Refrigidaire." I think it needs some "frezone.""

Refrigerator Temperatures

Understanding normal operating temperatures is important for quick diagnosis. Now that the sealed system is better understood, the temperature of each section will be reviewed.

Compressor Temperatures

When everything is operating as designed on a forced-air condenser, the compressor temperature, will be uncomfortable to your hand. It's not hot enough to burn, closer to 120 °F. The small outlet line of the compressor is hotter yet. It's carrying the compressed hot freon to the condenser.

Condenser Temperatures

The inlet to the condenser is of course the same line two feet away, so it is still pretty hot; but as the freon loses heat and condenses into a liquid, it slowly cools down. It gradually reaches close to room temperature, when it exits the condensing unit. Most of the condenser is warm to the touch.

Capillary and Suction Line Temperatures

As mentioned before, as the freon comes out of the condenser, it goes through a dryer and into a capillary tube, The capillary tube is soldered up against the line returning from the freezer. The combined capillary and return line will be a little cooler than room temperature. Once the suction line separates from the capillary tube, it will still be slightly cool to the touch.

The Freezer Section

Next is the freezer section where the freon is evaporating. The temperature on the evaporator itself will be about 10-15 °F <u>below</u> zero. The air temperature in a stabilized freezer that has cycled off will be about 12-18 °F.

On opening a side-by-side freezer, that is at 10 °F or below, on a humid summer day, fog will roll out like dry ice sitting on a stage set. In order for ice cream to be hard, but still scoopable, the temperature needs to be in teens. Ice cream is still soft between 20-28 °F.

Usually, customers first notice a problem with ice cream or frozen orange juice. Watch out for some new low fat ice creams, they need even lower temperatures to freeze hard.

Automatic icemakers also are an indicator of temperature. The internal cycle thermostat of most icemakers is set at 16 °F. When freezer temperatures are rising, a stalled icemaker is the first indicator.

Logically, if the icemaker continues to operate, the freezer temperature is below 16 °F.

The Fresh Food Section

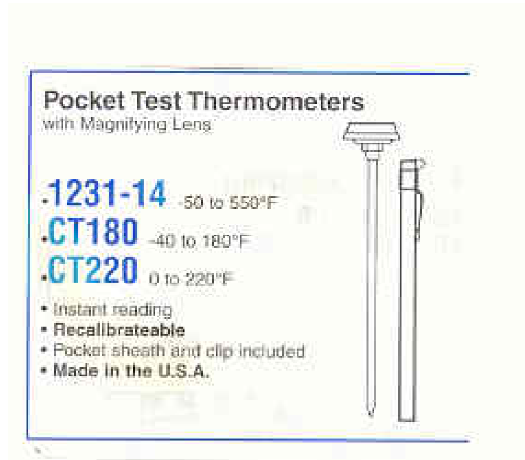
Continuing on, with the controls in the freezer and fresh food section set in the mid-range, the fresh food section will stabilize between 36-38 °F. and the freezer will stay below 20 °F.

> *Uncle Harry's*
> Trick of the Trade # 100
>
> It's very important upon arrival at a refrigeration call, to first test the temperatures of the freezer and fresh food section.

Testing Temperatures

As soon as you start opening the doors and looking around, you are losing valuable information. Customers often introduce you to a sick refrigerator by opening the doors. Be gentle, close the doors and immediately take the operating temperatures. It is critical to take accurate temperatures before doing anything else. If the doors are left open for over a minute, the information is lost.

Fig071_17



The quickest way to get accurate temperatures is to test the food itself. First, confirm that one of the liquids in the fresh food compartment has been there overnight. Wash off the tip of your thermometer and insert it into the liquid. Try to pick an item that was sitting near the center of a shelf. Stay away from the door and the crispers.

Reclose the door and wait a few minutes until the thermometer stabilizes. Read the temperature. Just laying the thermometer on a shelf in the air should be avoided. Likewise in the freezer, jam the tip of your thermometer between several packages of frozen food. Let it sit for several minutes, until it stabilizes.

While you are waiting, talk with the customer about the failure. Once the temperatures are established, proceed with further diagnosis.

An empty refrigerator can give incorrect temperature indications. The plastic and air remaining never appear as cold as food. The air temperature in a freezer can be below zero and the shelves may still not seem cold to the touch. It is essential to depend on a thermometer.

Air Flow and Control Settings

Understanding air flow and proper control settings are equally as important as the freon system. Nearly all of today's refrigerators have only one evaporator. It is in the back or the bottom of the freezer compartment. On side-by-sides, it's always up the back, and on top freezers, it's either on the floor of the freezer section, or on the back wall. On the bottom freezer models, it is on the back wall. Cold from this one evaporator must be circulated and controlled throughout the refrigerator.

Fig071_18

An evaporator fan motor sucks air over the evaporator and blows it through the various pieces of ductwork in the freezer and fresh food section. The bulk of it stays in the freezer, but about 25% is allowed to flow over into the fresh food section.

This division of airflow is controlled by a damper that is set by the customer. The damper control is usually called the "freezer temperature control."

When the damper is set in a mid-range the temperatures stabilize at 15-20°F in the freezer and 36-38 °F in the fresh food side. The split of the air, keeps a difference of about 20°F between the two compartments.

If the damper is set wide open, too much freezer air will come into the fresh food side. The freezer will climb into the middle and upper twenties, and spot freezing often occurs in the fresh food side.

Spot Freezing

Spot freezing occurs for several reasons.

1. The most common is improperly set controls.

2. The second is in infrequent use. When a refrigerator is seldom used, cold air settles to the bottom. Since the doors are rarely opened, the compressor and fans seldom come on to circulate the air. Vegetables in the crispers will freeze. Incidentally, crispers are located in the bottom because, it is the coldest area.

3. Too much food blocking the airflow. Cold spots form, if no air circulates.

Controls Set at the Maximum

If the damper is shut down to the point of being almost closed, the freezer temperature will get colder and colder. The reason for this is simple. The cold control that shuts off the compressor is in the fresh food side. With the damper closed off, very little cold air comes over to the fresh food section to satisfy the cold control. The compressor runs and runs trying to satisfy the cold control.

Many refrigerators fail to operate properly if the controls are set to the extremes. The freezer often drops below zero, and the fresh food compartment rises into the 40's. The system is simply out of balance.

At the first sign of trouble, customers always set the controls to the maximum!

In reacting this way, they have done absolutely nothing to solve the root problem. Instead, they often introduce a more problems.

Uncle Harry's
Trick of the Trade # 101

Before going on any refrigeration calls always ask the customer to set both controls back to the middle setting. It will eliminate one source of confusion.

Example of a very common service call. A customer will complain,

"My refrigerator is too warm. The freezer seems fine."

It is a common service call to arrive and find the freezer damper completely shut off. The refrigerator may be as warm as 45 °F. If the freezer is too cold, there is nothing wrong with the refrigeration system. The problem is simply one of balancing. There is a problem with the damper or the airflow.

Uncle Harry's
Story Time

I had a customer call a few years ago with the temperatures too cold in the freezer and not cold enough in the fresh food section. It was a side-by -side refrigerator. Her husband was an intelligent engineer. He had already run various tests on the damper and had determined, that it was functioning as designed. He was right. He even removed the damper from the opening between the fresh food section and the freezer and left it off for a day. Nothing seemed to solve the problem. The freezer stayed below zero and the fresh food side stayed in the upper 40's.

Stumped, the customer called a service company, not mine. An old competitor of mine came out and attempted to fix the problem. He took the freezer section all apart. Finally, he put in a defrost clock, re-assembled the refrigerator, and claimed it fixed.

In a short time, the problem reappeared. Unhappy with the first technician, the customer asked around and got my name. I interrogated her fully and determined that her husband definitely knew what he was talking about. It also was evident, that my friendly competitor had been unable to find the problem.

I told the customer, that there was an airflow problem. I had to empty out the freezer and remove the back wall, in order to see if I could solve the mystery. Upon inspection, I found a number of minor problems, but nothing that really explained the gross imbalance between the freezer and the refrigerator. I checked the fan rotation and the ductwork. I checked whether the fan blades had been put on backwards. I checked all of the rare things that I knew of, and still stood there stumped.

I re-assembled the freezer, closed the doors, and stood back and said to myself,

"I'm missing something stupid here, this has got to be something easy."

With the freezer door shut and the fresh food door open, only a trickle of air would come out of the 2 x 4" hole that was supposed to supply cold air to the fresh food side. No matter what I did, the air would not blow out of that hole as it should.

Standing there in frustrated desperation, I thought about the airflow system and realized what I was missing. There had to be a way for the air to get from the fresh food side back into the freezer. Of course, the air had to have a return path to make a complete loop. I had not checked the return air duct.

I knelt down and pulled out both crisper drawers of the refrigerator. Tucked neatly behind one drawer, I found a box *of Thomas's English muffins snuggled up perfectly against the return air hole. It completely blocked the air returning from the fresh food side back into the freezer. The problem was solved.*

Simple logic tells you that you can't continually exhaust air from a closed freezer into the refrigerator, without returning warm air back to the bottom of the evaporator. Everyone had missed the cause. No one was thinking through each step of the airflow.

I charged the woman $90.00 for the repair. It took an hour and a half to find that simple problem. She wasn't very happy. Nobody likes to look stupid, and pay a fee in addition.

> *Uncle Harry's*
> Trick of the Trade # 102
>
> Arriving to find an unplugged refrigerator or freezer is a useless service call. Always advise customers to either, leave the unit running, or at least turn it on 24 hours before your arrival.

All refrigeration diagnosis requires that temperatures be stabilized. Sometimes, problems with defrost systems, don't appear for several days. This is particularly true in the wintertime, when the humidity is low. Frost forms more slowly on the evaporator.

Some compressors, old Frigidaires for example, take several hours before there are any noticeable temperature changes. Trying to diagnose one from a warm start is a complete waste of time.

By turning on a refrigerator in advance there is little chance of any damage being done. It merely helps with the diagnosis. The damage is usually done well before you get the call.

Further Balance Problems

Other problems can disturb the delicate balance between the fresh food and freezer sections. Believe it or not, the freon system is very fragile. It doesn't take much to get it out of balance, and to lose proper temperature control.

Examples

1. A bad light switch

The heat generated by a freezer or refrigerator light that stays on, when the door is closed, will wreak havoc with the temperature control.

2. A bad door gasket

Any gap over one quarter inch and over 6” long will also cause trouble.

3. A partially opened door

A child, or even a parent, leaving the door ajar, after stuffing it full of groceries will cause rapid frost-up. It can even cause the compressor to overheat.

It is sometimes difficult to separate a true mechanical failure from one introduced by a customer. If a customer leaves the door ajar for two or three hours, it can cause a clog of frost in the evaporator. Sometimes the defrost system is not strong enough to melt out the frost jam and the problem gradually gets worse and worse.

4. A spill

A customer can spill water from an ice tray in a freezer. As the water trickles down it can form a frozen bridge of ice across the evaporator. Again this will cause a clog in the airflow and frost up.

5. Too Much Inspection

Sometimes, customers gets worried about a refrigerator. They continually check by opening the doors. This make matters much worse. It's the same as checking an oven by repeatedly opening the door. Every time the door is opened, the temperatures rise.

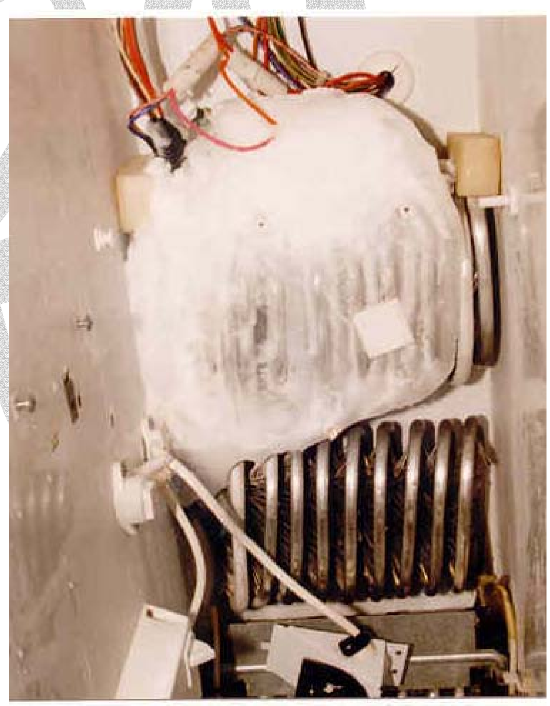
Questions to ask the customer, when solutions are not obvious:

1. When did the problem start?

2. Have they had any parties or strangers in the house?

3. Have there been any power outages?

Fig071_19
A Ice Bridge From A Leaking Icemaker



Understanding Frost-Free Systems

Now that you have a much better overall understanding of the cooling operation, we can get to the fun and money-making part.

Thank your lucky stars that frost-free refrigeration came along in the 50's. Along with frost-free came a landslide of continual moneymaking service calls. Nearly all of the current service work involves components of the frost-free system, rather than those of the freon system.

A frost-free system works in the following way:

The evaporator is a constantly cold surface sitting in humid air from the household. In six or eight hours, the evaporator will be covered with a layer of crystalline frost. The frost interferes with the transfer of cold between the cool aluminum coils and the warm, humid air.

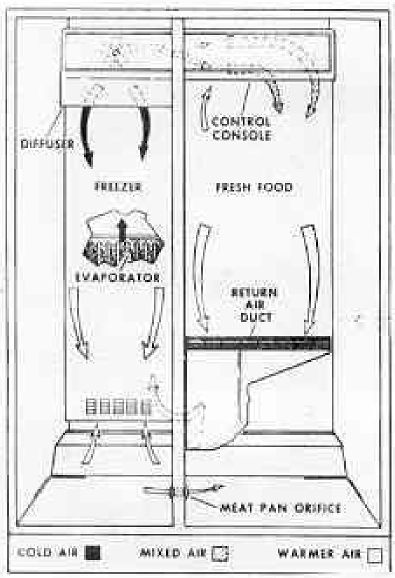
After 24 hours, enough frost builds up to restrict the airflow. After two or three days, the user will begin to notice temperature problems.

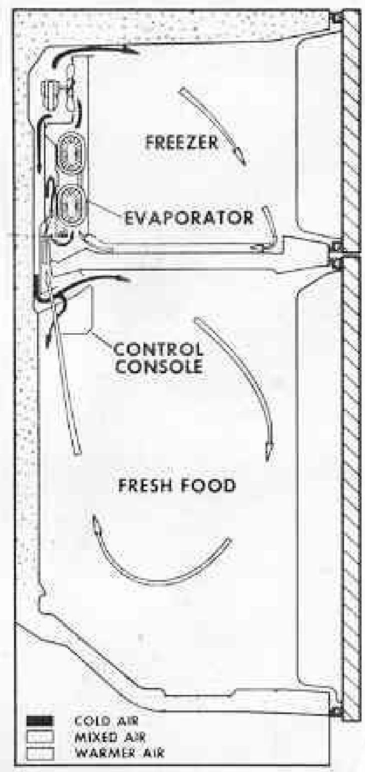
Some customers, with failed defrost systems, will actually go to the trouble of defrosting their refrigerator every three days. Although such a method is effective, it is a <u>bit</u> troublesome.

Obviously, a system is needed to melt the frost. On all frost-free systems, the cooling comes from one evaporator. A fan circulates air over the evaporator. A portion of that cold air is diverted from the freezer section, over into the fresh food section. Through use of a control damper, a balance of temperature is achieved between the refrigerator and the freezer.

Fig071_20
Airflow

household. In six or eight hours, the evaporator will be covered with a layer of crystalline frost. The frost interferes with the transfer of cold between the cool aluminum coils and the warm, humid air.





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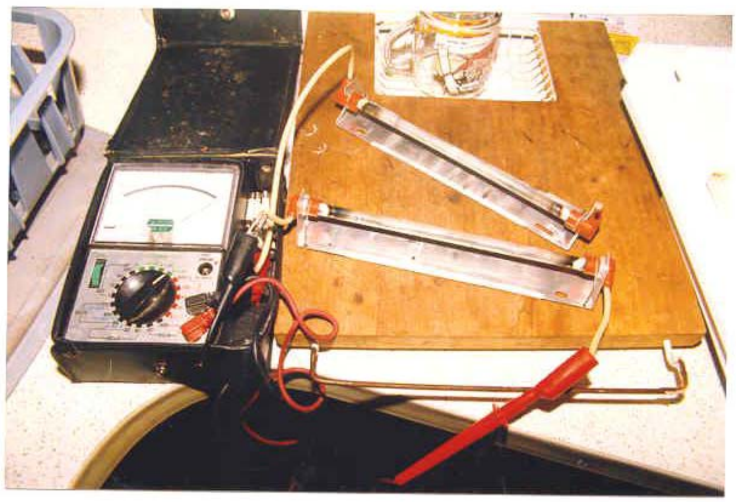
Hot-Gas Defrost

In the early years of the frost-free design, a valve was installed within the freon system. During the defrost cycle, hot gas from the compressor output, bypassed the condenser, and was diverted directly to the evaporator. These systems were called "hot gas defrost systems". Very few of these systems are still in operation.

Electric Heat Defrost and the Defrost Cycle

Today, the defrost heating is done with electric heat. An electric heater is built into the evaporator.

Fig071_21
Typical Evaporator Heaters



Evaporator heaters are made two ways:

1. Radiant heaters.

A radiant heater is a nichrome element (like a dryer element) built into a tempered glass tube. One, two, and even three are used. They operate much like a radiant bathroom floodlight.

2. Calrod Heaters

A calrod heater looks exactly like a bake or broil oven element. They are designed at a lower wattage, just enough to melt the frost.

Defrost heaters are controlled by the defrost clock. The clock turns off the compressor and turns on the heating system every 8 hours, for about 20 min. System defrost times vary from six to twelve hours.

> *Uncle Harry's*
> Trick of the Trade # 102
>
> A generic 8-hour clock will work on nearly every application.

During the defrost cycle the defrost heater stays on until one of two things happen:

1. The clock cycle runs out and restarts the compressor.

2. A safety defrost limit switch wired in series turns it off. The defrost limit is mounted on the evaporator. Defrost limit thermostats are set between 45°F and 90°F.

The melted frost trickles off of the evaporator collects in a little drain pan below.

Attached to the evaporator pan is a small tube that directs the water through the insulation to a second, larger pan sitting on the very bottom of the refrigerator. The larger pan is a plastic tray that can be removed and cleaned by the homeowner.

Some drain systems have small heaters built-in to keep the water liquid as it travels out of the cold area.

All of the components added to achieve a frost-free operation are complicated and prone to failure. They are:

1. The defrost clock

2. Defrost heaters.

3. The defrost limit

4. The drain system.

The Difference between Snow and Ice

A novice may think, "What a frivolous title for a section on diagnosing refrigerators." Far from it. The layman uses the words snow and ice interchangeably, ignoring the difference between them. Observing the difference is like a guidepost in refrigeration diagnosis.

Uncle Harry's

Story Time

Many times, I've instructed apprentice servicemen on the difference between snow and ice. Refrigeration is a subtle business. If technicians ignore the clues, they will never be successful. I have fired many trainees, because they repeatedly failed to properly observe conditions on service calls.

As far as refrigeration diagnosis is concerned, it is not necessary to be a weatherman, but snow or ice form for different reasons. Snow forms in fine crystals on an evaporator that is constantly cold with humid air blowing over it. An evaporator with a defrost problem will plug up with white frost or snow. The snow is soft enough to stick a screwdriver through.

When operating correctly, defrost heaters come on every eight hours for twenty minutes and melt all of the snow off of the evaporator. It turns to water and dribbles into the evaporator drain pan. Suppose the drain pan outlet is clogged. The water will back up and form a miniature pond.

When the cooling system comes back on, the water will turn to ice. Each subsequent defrost cycle will form a new layer. Now the drain pan is really clogged.

Fig071_22
Frozen Drain Pan

Uncle Harry's

Trick of the Trade # 103

A turkey baster or battery tester are ideal for thawing frozen drains

Eventually, two things happen:

1. The ice gets thick enough to block the air passages to the evaporator. The air gets blocked enough to affect the temperatures on the fresh food side. Also, the evaporator will begin to frost up faster than normal, because no air is flowing over it.

2. The defrost water overflows the drain system, and begins to trickle out the door onto the floor.

Paying attention to the ice or snow pattern is very helpful in diagnosing a clogged drain pan and a defrost heater problem. The presence of the ice tells you that the heating system is working.

Uncle Harry's

Trick of the Trade # 104

Ice only forms where thawing and refreezing occur.

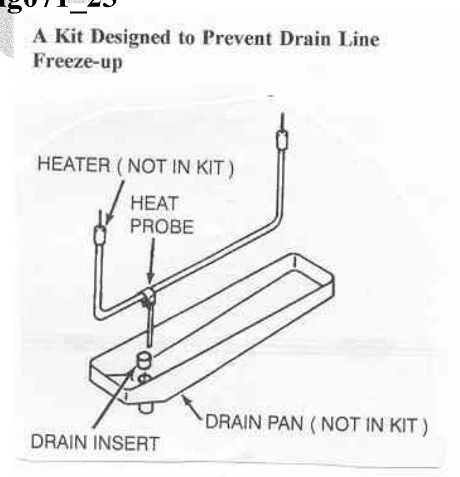
If only <u>snow</u> is present, there is reason to suspect a problem with the heaters or the heating circuit, not the drain system.

In order to form ice anywhere in the freezer section, some warming must be going on. Something is melting the frost that naturally forms. Knowing this information gives you a big clue, guiding you to the correct diagnosis.

Ice and snow that form around the evaporator can exert enough force to break the glass rod heaters and bend components of the evaporator. Recall that, ice can break up a sidewalk in the wintertime.

A child, innocently leaving open the refrigerator door for a few hours, can cause breakage of the defrost heaters in addition to simple frost build-up.

Fig071_23



Uncle Harry's

Trick of the Trade # 105

A piece of copper wire wrapped around a calrod heater and extended into the drain works just fine

Diagnosing Frost System Failures

Frost -free systems fail in several ways:

1. Frost build-up

2. Ice build-up

3. No cooling

The difficulty in diagnosing refrigeration systems is that the defining line between problems is seldom clear. One problem will soon cause others. It is often hard to find the root problem without careful investigation.

For instance, consider this typical example. On a humid summer day, a homeowner leaves the children with a baby sitter. One of the kids leaves the refrigerator door ajar a few inches. A few hours later, the baby sitter automatically closes it. The next day, the homeowner notices that the ice cream is soft. Something is wrong and she calls for help.

The service man arrives. He finds a badly defrosted evaporator, and poor temperatures. The freezer is 25 °F instead of 15°F and the fresh food section is 48°F instead of 38°F. No one, but the absent baby sitter, is aware that the door was left open.

Before a good serviceman can draw any conclusions, he must first run a thorough test on the defrost system, the lights, and the fans. A full understanding of the proper operation is necessary for a proper diagnosis. A failure of many individual components can cause the same symptoms.

To reach that level of understanding, we will study each type of failure and learn how the system is interconnected and balanced. Then we will study each component and see how it fits into the overall picture. Once a full understanding is achieved, it is quick and easy to accurately diagnose a refrigerator.

1. Frost Build-Up

Frost build-up in a frost-free refrigerator is the most common problem of all. Excess frost can be caused by an excessive amount of humid air, like the baby sitter example, or lack of heat in the defrost cycle. Poor air circulation can even cause frost. A high flow of air helps to dry out the evaporator.

Following is a list of the reasons for frost build-up:

1. Bad defrost clock.
2. Open defrost limit.
3. Open defrost heater.
4. Door left open.
5. Bad door gaskets.
6. Bad evaporator fan motor.
7. Restricted airflow.

2. Ice Build- Up

Continual melting and thawing of water cause ice build-up. The source of the water maybe defrosted snow, spillage, or the icemaker system.

Following is a list of reasons for ice build-up:

1. Clogged drain pan or drain pan tube.
2. Bad drain pan heater.
3. Deteriorated insulation around the drain system.
4. A spill.
5. A leaking icemaker.
6. A leaking icemaker fill valve.

Fig071_24

Typical Frost-up

3. No Cooling

The primary reason for no cooling has been covered under compressor problems. However, the defrost system can also be the guilty party. The power to the compressor flows through the defrost clock (to be covered shortly). If the clock motor fails during the defrost cycle, it may never turn the compressor back on.

Component by Component

Following are the components of the refrigeration system not covered by our discussion of the freon system. We will cover their properties, configurations, and failure patterns individually.

1. Defrost clocks and defrost heaters
2. Defrost limits
3. Evaporator fans
4. Door switches
5. Door gaskets
6. Cold controls

1. Defrost Clocks and Defrost Heaters

The defrost clock is a small black box with four wires connected to it. Since it's introduction it has gone through many design changes and improvements. Overall, the clock's logic and function have remained the same.

Fig071_25

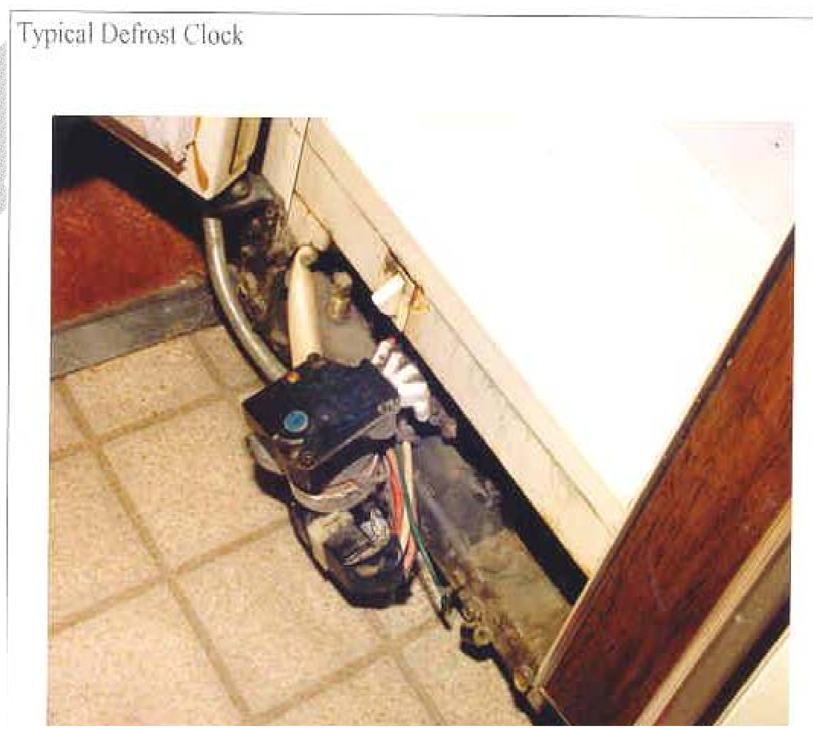
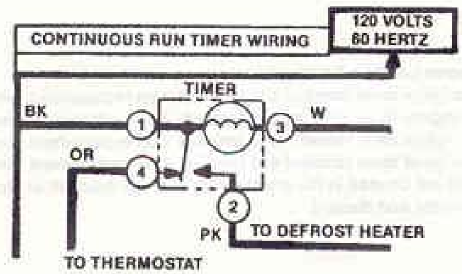


Fig071_26

Typical Defrost Clock Wiring

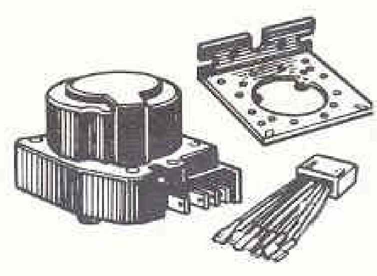


The power for the compressor and the defrost heater are controlled the defrost clock. The time sequences vary between brands and models. Following is a chart of available times and clock duration's.

Various Defrost Sequences

EATON Universal Domestic Defrost Timers

Part Number	Reference No.	Defrost Cycle Hours	Defrost Time Minutes
8-801	CC801	12	31.5
8-802	CC802	12	21
8-803	CC803	8	28
8-804	CC804	8	21
8-805	CC805	8	14
8-806	CC806	6	25
8-807*	CC807	6	25
8-808	CC808	6	21



*Westinghouse special timer motor wiring to terminal 2E4.
CC800 Timer Kit – 8 timers offer 100% coverage, provides replacement for over 20,000 refrigerators and freezers.

Skilled technicians tend to be very casual about matching exact times to factory specifications. Most technicians carry only one clock to fit nearly all models.

The consensus of opinion is that a little extra defrost time causes no harm. The defrost limit controls the upper temperature of the evaporator anyway. If a clock comes on a little more often than the original design, so what. The result is no different from opening the door a few extra times.

Defrost Clock Diagnosis

The following method is the fastest and most reliable way to diagnosis a frosted up evaporator. First locate the defrost clock. (They're mounted all different ways.) Remove it from it's housing.

> *Uncle Harry's*
> Trick of the Trade # 106
>
> Turn the defrost clock over so that you can see the back of it. Feel the defrost clock motor. Is it warm? The timer motor that runs 24 hours a day. A good motor will be warm, unless it's mounted in the cold compartment.

If it's room temperature and there's no sign of warmth, replace it.

Often the back of the defrost clock has a small window. Peering through the window it is possible to see the armature of the motor spinning. If you can see the motor through the little window and the armature has stopped, again you know that the clock is bad. In other cases, a small rotating shaft is visible in the center of the advancing knob.

If the defrost clock is warm and there is no window to confirm that the clock motor is spinning, then another method is employed.

By the way all of these tests can be done while the refrigerator is still running. Take care not to touch any exposed terminals of the clock to any metal or your fingers. Most often, the spade ends connecting the defrost clocks are in insulated housings.

Turn the clock back over so that you're looking at the main shaft. With your fingernails or with a wide-bladed screwdriver, slowly advance the defrost clock until you can hear it audibly click. The loud click indicates the beginning of the defrost cycle. At this point, two things should happen.

The compressor shuts down and the defrost cycle begins. Sometimes when you try to advance the clock, it's extremely tight. Again, it's a bad clock.

Assume that it turns easily, the motor is warm, and the refrigerator is now in the defrost cycle. Remember at this point, the evaporator is <u>badly frosted</u>.

Uncle Harry's
Trick of the Trade # 107

Defrost heaters make a noise. Listen carefully for a crackling and faint popping noise as the snow begins to crack from the heat of the defrost heaters.

Using a penknife or a sharp screwdriver, carefully mark the position of the defrost clock. In ten minutes, it will be possible to detect if it has advanced.

With the clock set in defrost, current should be flowing through the defrost heater. Other than the sound, there are several ways to confirm, if in fact, the defrost heater is operating.

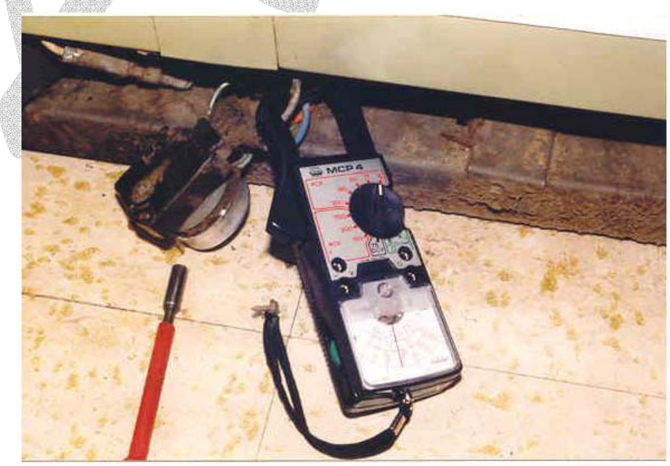
Fig071_27
Using an Amprobe to Test for Defrost Current

1. In radiant heat models with glass tube heaters, it is possible to see the red glow. Turn off any lighting and look into the evaporator. Any sign of a red glow confirms that the defrost limit and the defrost heater circuit are intact.

2. A second method is to jerk the refrigerator plug out of the socket. Watch for a medium-sized blue arc as the current flow to the heater circuit is cut off. A tiny spark indicates only that the lighting circuit has been cut off.

3. A third option is to pull the defrost wire off of the defrost timer and look for an arc.

4. Last but not least. Use an Amprobe and clamp it around the defrost heater lead. There should be several amperes of current flowing.



If, after performing one of these quick tests, you have determined that no current is flowing through the heater system, then either the defrost heater or the defrost limit is bad. In most cases the defrost heater is the culprit.

If the defrost system does begin to heat up, you have confirmed that the heating system is okay. The only component controlling the heat is the clock.

Conclusion, the clock must not be advancing, as designed, and turning on the heat.

In review, observe the procedure that is used. Separate the problem into two sections:

1. Is the defrost clock bad?

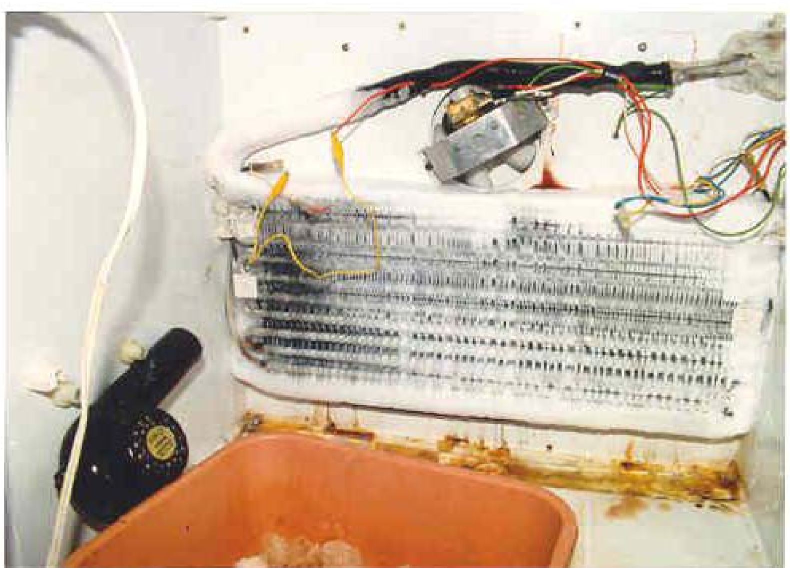
2. Is the heater circuit bad?

If the heater circuit is bad, it's time to quote the customer. There's no need to try to separate the diagnosis between the defrost limit and the defrost heater. Replace both items. The bulk of the work, and therefore the price, is in the labor. The hard part is getting the unit totally defrosted.

Defrosting an evaporator can take up to an hour. It requires the use of lots of hot water, a blow dryer (heat gun) or both.. Customers must put their food in a freezer chest while you work.

Fig071_28

Defrosting a Freezer



Servicemen don't like to either spend all their time defrosting or require the customer to put the food elsewhere and turn off the refrigerator for a day. Slow defrosting requires a second trip for parts installation. Better customer relations are built doing the job quickly without inconveniencing the customer.

Fig071_29
Speed Defrosting a GE

Uncle Harry's
Trick of the Trade # 108

Speed Defrosting

First, thaw out the area where the heaters go, install the heaters while the unit is still frosted up, and turn on the defrost cycle, while you're manually defrosting the rest of it. In doing so, you're getting the benefit of a heat gun, in addition to the defrost heat from the built-in radiant heaters.

Note: Keep heat away from the defrost limit until the very end. It will break the defrost heater circuit as soon as it warms up.

At any time during the discussion did we unplug the refrigerator? No. Sometimes it is just difficult, and risky to pull a refrigerator out from the wall. It may be on a spongy linoleum floor or ceramic floor. The fresh food section is usually chock full of heavy food items. It is not necessary to unplug it.

Special plastic skids are available to prevent floor damage

However, care must be exercised in disconnecting and re-connecting the heater. There may be 110 VAC on the heater wiring. The cautious move is to check between the heater connections and the metal case before touching the wiring and working on the heater circuit. The safest method is to use insulated pliers to make the final connection and assume that the wire ends are hot.

Notice that the diagnosis of the defrost system does not require removing any food from the freezer. It can be done remotely by making a few tests at the defrost clock. The last thing you want to do is take all the food out of the freezer and put it back twice. You want to be prepared to properly fix it, when you decide to take it apart.

Fig071_30
Moving a Heavy Refrigerator

Condenser Fan Motors

Customers frequently will use the phrase,

"My refrigerator has been "humming and clicking" and now my food is beginning to thaw out."

The "humming and clicking" sequence is a telltale sign of either an overheated or damaged compressor. The condenser-cooling fan, which circulates the air over the compressor, can often be the responsible party. A blocked or bad condenser fan motor will cause the compressor to overheat. This condition is commonplace in the summertime when the temperatures are high and the usage on the refrigerator is also abnormally high.

Fig071_31
A Bad Condenser Fan Motor

Cleaning a condenser is easily accomplished with a vacuum cleaner using a long, skinny tool or using a special condenser cleaning brush. It's common to find all sorts of debris jamming a condenser fan motor. It is also common to find a stuck condenser fan motor. (A lot of endplay on the shaft of the condenser fan motor is normal.)

One condenser fan motor will fit nearly every refrigerator. The only exception is Sub-Zero. There are two problems changing condenser fan motors

1. It's really hot. It is easy to fry your hands on the side of the compressor.

2. The working area is dirty and very tight. Replacement requires a stubby 5/16" and 1/4" nut driver in order to remove the mounting brackets.

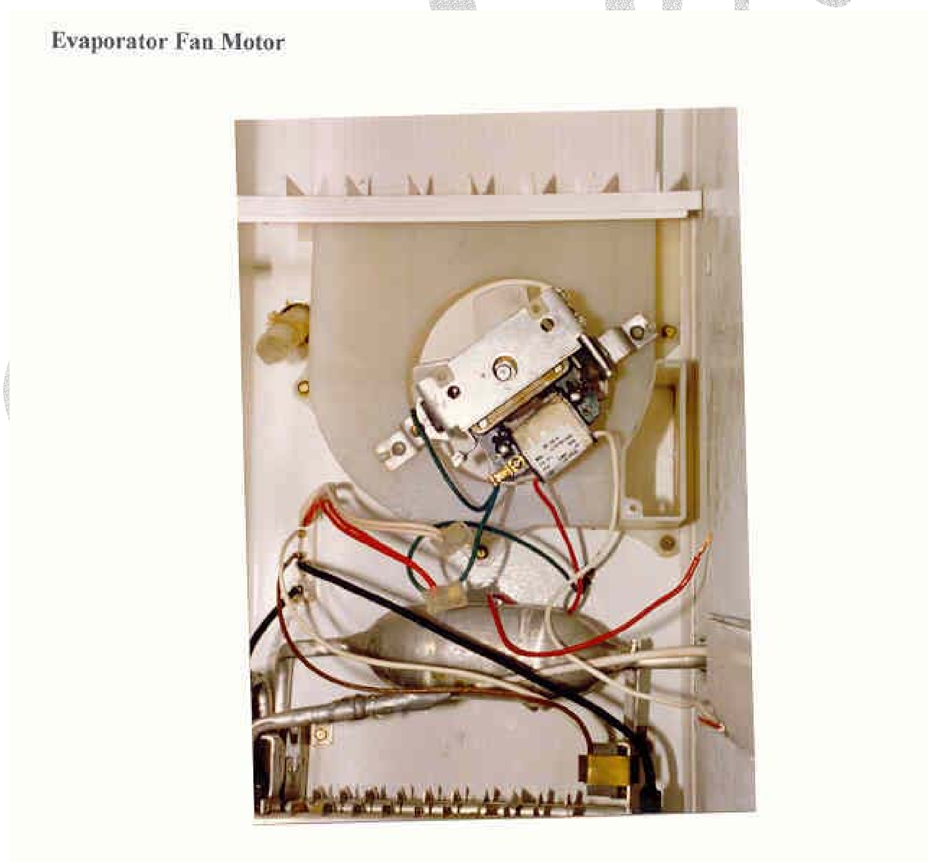
Evaporator Fan Motors

Most of the time, evaporator fan motors give plenty of warning before they fail. They start to chirp like a bird. The chirp eventually becomes constant; finally the customer can't stand it anymore. Sometimes the homeowner will put oil on the fan. It doesn't fix it; in about a week the noise will return.

Sometimes, the fan motor just quietly dies or binds up. Also, the fan motor can get lodged in ice from a spill or lodged in frost from frost-up. Often, thawing out the housing in which the fan blade sits will allow the evaporator fan motor to come back to life.

On side-by-side refrigerators, the evaporator fan motor is always mounted on top of the evaporator. It sucks air across the evaporator and blows it out the top and over into the fresh food section

Fig071_32



The diagnosis is simple if the fan motor is noisy. Replace it! Things can be a little more difficult if the fan motor is simply stopped. Make sure that you have the door switches depressed when you're testing an evaporator fan motor.

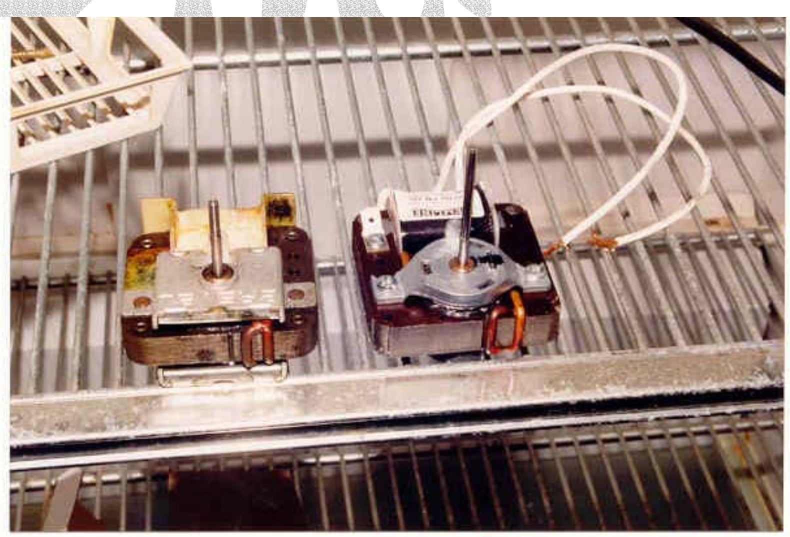
Sometimes, when you suspect that the fan motor's bad, the only sure method is to empty out the freezer enough to get the cover off. It is necessary to get to the fan motor itself. . Test to see if you have 110 VAC at the fan motor terminals. If power is present, the motor is obviously bad. Often, a bound fan motor will be too hot to touch.

Fig071_34
Old and New Fan Motors
(Note matching shaded poles)

However, if the fan motor is cold, disconnect the leads to the fan motor, apply 110 VAC to it from a test cord. Make sure that it is, in fact dead, and that you don't have a problem elsewhere.

In replacing fan motor attention must be paid to the fan rotation. Universal replacement motors may need to be reversed. Remember the discussion of shaded pole motors back under electricity.

Kits of fan motors are available that fit nearly every refrigerator.



Door Switches

Door switches on the refrigerator and freezer perform two functions. They turn off the lights and turn on the fans. Sometimes, they also disable the icemaker and disable the power to the circuits, which supply ice and water in the door. Often, a door switch will be visibly stuck, bent, or broken. These are easy to figure out. Once in a while you will find a switch that appears to be good, but it is in fact faulty.

A bad door switch can cause very embarrassing problems. It is wise to operate the door switches manually early in a diagnosis check, it only takes a second. There is nothing worse than taking a whole freezer apart to check a fan motor, only to find a simple door switch problem.

Fig071_35
Changing a Door Switch

On some refrigerators, it's hard to bypass a switch. Some are difficult to get it out of the housing. They are tightly snapped in. If a switch is suspect, dig it out, and short it out to test it.

Overall, fan and light door switches are a minor source of problems. A small stock of switches will cover most needs.

Cold Controls

The cold control is the thermostat that controls power to the compressor and is manually set by the temperature control knob. A cold control is a capillary tube device with a sensing probe that dangles into refrigerator air. The probe is usually up at the top of the refrigerator and is an air-sensing device.

Overall, cold controls are highly reliable and rarely a source of service calls. **Technicians that replace a lot of cold controls usually don't know what they are doing.**

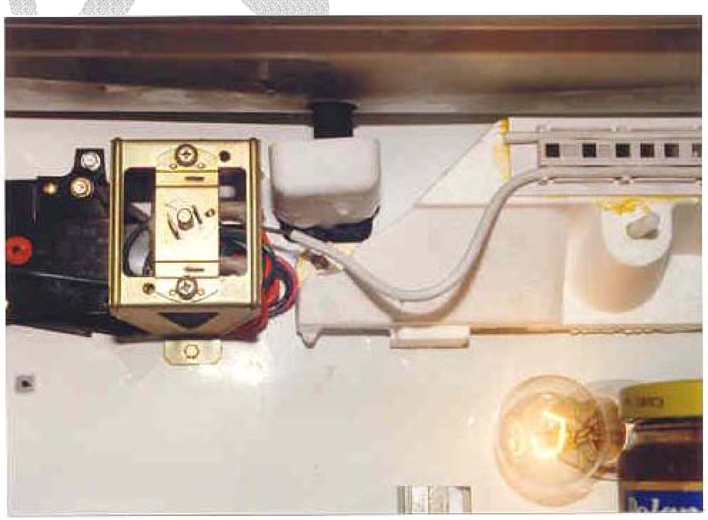
Once in a while you might find one that won't turn the refrigerator to turn on. First make sure the unit is not in the defrost mode.

Fig071_36
Typical Cold Control

> *Uncle Harry's*
> Trick of the Trade # 109
>
> "The Knuckle Sandwich Diagnosis".
>
> A sharp rap with the knuckles on the control knob of the cold control will often pop a refrigerator back into life.

A bad cold control represents less than 1% of the failures on refrigerators. Cold controls never seem to drift off in temperature control.

They are either shorted and never open or open-circuited and never close, nothing in between.



Door Gaskets

Replacing a door gasket on a refrigerator or a freezer is one of the most difficult jobs in the field of home appliance repair. Customers perceive it as being very simple, but in fact it is very difficult. It is necessary to charge for at least an hours time when installing a door gasket.

When does a door gasket need replacing? As a door gasket gets old, the rubber hardens, cracks, splits and tears, and the gasket, particularly down at the bottom, will begin to come apart. Discoloration and mildew spots on the gasket don't really hurt the seal. They just look bad. For a gasket to actually cause a problem with the refrigeration, it needs to be gapped 1/4" or more over an entire corner of the door at least half way along the bottom. There has to be enough of an opening for a reasonable amount of air flow both in and out.

Fig071_37
A Bad Door Gasket

Very often what appears to be a bad door gasket is really only a twisted door. People pulling the handle hundreds of times get the door twisted out of shape. Holding your foot or your knee against one portion of the door and pulling on the other portion can correct door distortion. By working gently with your arms, you can straighten the twists and get the door gasket to seat evenly.

In many cases, gaskets are in need of cleaning rather than replacement. Dried liquids on the gasket will cause it to twist and stick.

Door hinges, particularly at the top will come loose and the door will sag slightly. Sometimes the bottom of the inner liner will rub against the plastic interior of the refrigerator. This will make the door hard to close and twist the door as the customer forces it closed.

Replacing a Door Gasket

If the gasket is torn or deteriorated beyond cleaning or adjustment, then replace it. With the door still hinged in place, never remove all the screws at the same time. This is the layman method. If all the screws are removed at one time, the door will sag and lose its shape and you're in deep trouble. Use the following procedures:

The technique to use for installing the door gasket is fairly simple, at least it may sound fairly simple. Actually there is no way to make it easy.

The new gasket comes all folded up in the box with creases and wrinkles throughout. In the wintertime, a stiff gasket that has been folded up for a couple of years can be a tough repair. Even in warmer weather, it's a good idea to unfold the gasket in advance of the job. Time will remove some of the wrinkles. Even a tub of hot or warm water is useful to soften up the rubber and eliminate wrinkles.

Some technicians prefer to empty the door, remove it from the refrigerator, and lay the door panel flat on the ground. This is one style.

Fig071_38
Replacing a Door Gasket

Uncle Harry's
Trick of the Trade # 110

Personally, I prefer to remove 1/4 of the gasket at a time or 25% of the screws. Install the new gasket on the loose corner. Repeat the procedure on each corner. In doing so, work your way around the door, without ever having the door lose its shape. The integrity of the door is dependent on the liner and the doorframe being bolted together to create a solid box.

Once the gasket is installed the fun begins. In about two thirds of the cases, the new gasket will not evenly seat. Big gaps will be visible between the gasket and the jamb.

"Oh great, now I'm in real trouble."

Use the following tricks to mold it:

1. Smear Vaseline on the front surface of the door gasket, where it hits the doorjamb. The Vaseline will cause the gasket to stick, once it's held up against the doorjamb. This will encourage it to re-form itself and hold against the jamb.

2. Apply heat from a hair dryer to the gasket. This will soften up the seal and help it re-form into the proper shape.

3. Work the gasket with your fingers to stretch it and encourage it into the correct shape.

4. Push or pull on the door to get it to conform to the straight shape of the jamb.

Molded inside the door gasket rubber is a very weak magnetic strip that over a period of time will pull the rubber up against the metal doorjamb of the refrigerator. Eventually the magnet will give the gasket that snug feeling that you're familiar with.

Sometimes it's necessary to quit after doing the best you can and pray that over the period of the next few days, the gasket will seat itself against the refrigerator door jamb.

Some brands, like Admirals, have very large, cross-section gaskets and it's very difficult to get them seated properly the first time. The percentages of callbacks to re-adjust are around 30%. Accept it and charge accordingly.

Fig071_39
Typical Component Layout

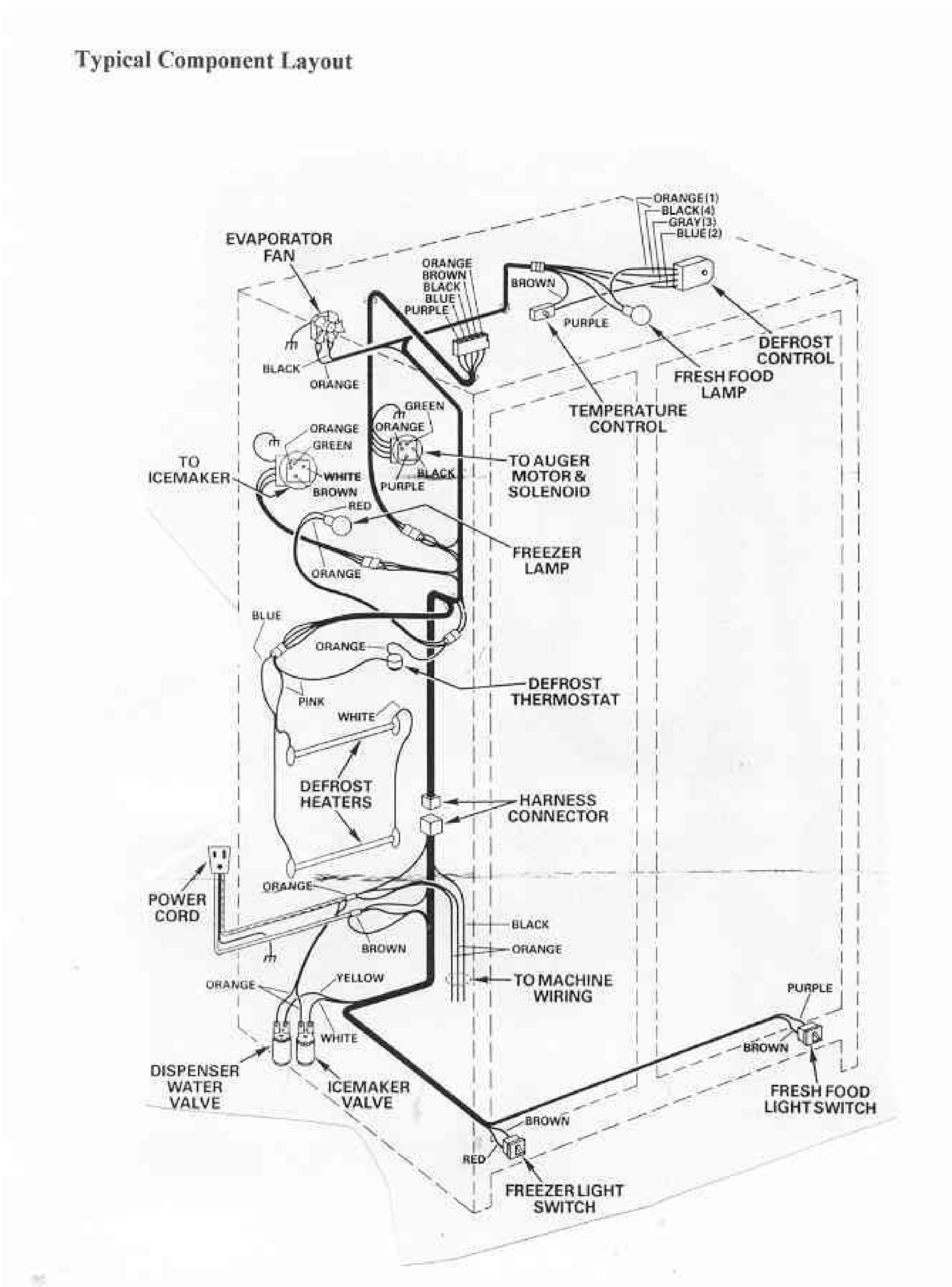
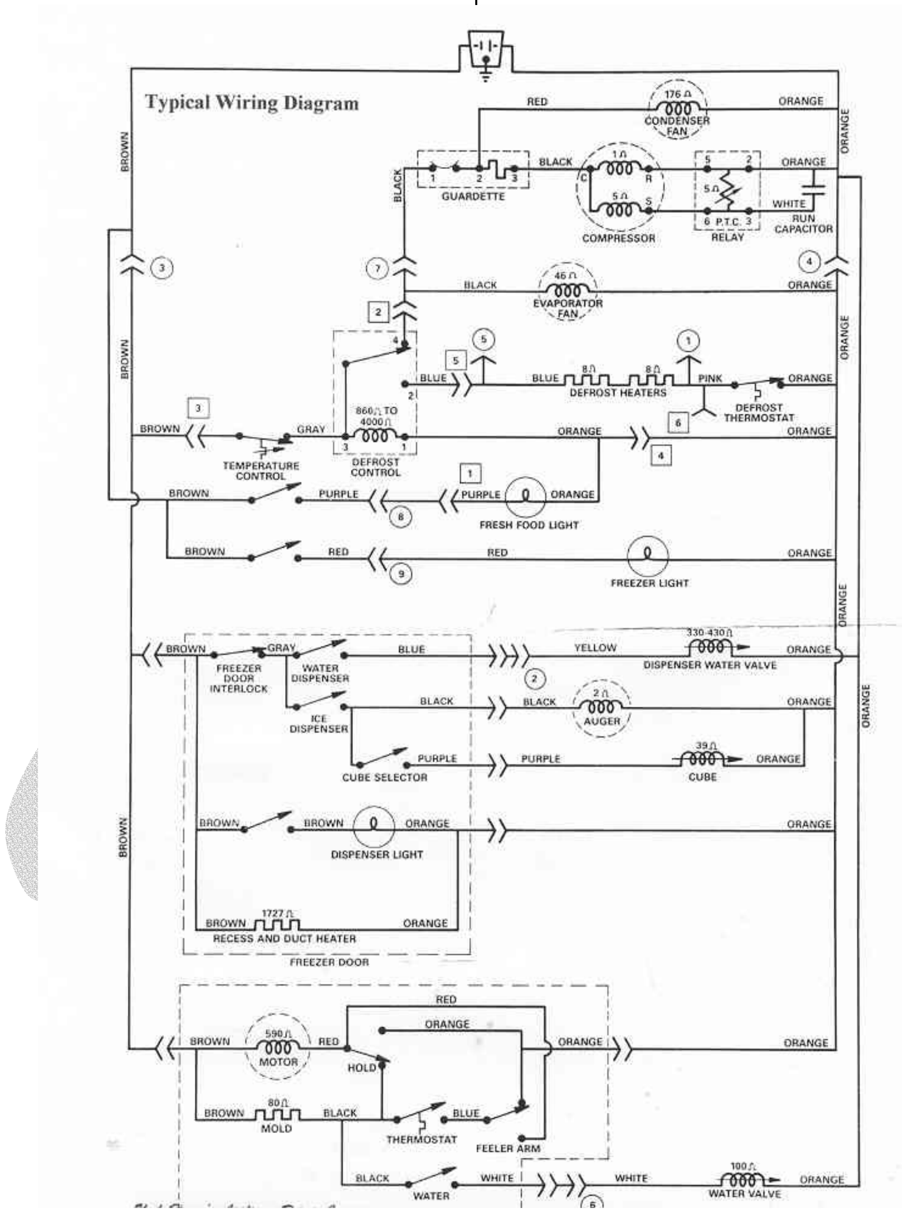


Fig071_40

Typical Wiring Diagram



Sample Flat Rate

Following is *Uncle Harry's* suggested pricing for typical refrigeration repairs. A complete set of flat rates is in the Flat Rate Book.

Refrigerators Flat Rate Guide

Description of the Job	Price
1) Melt out ice and unplug drain line	$115.00
2) Clean condenser	72.00
3) Replace condenser fan motor (WX4X990)	155.00
4) Replace evaporator fan motor, various	155.00
5) Replace defrost clock and defrost unit	160.00
6) Replace defrost limit	145.00
7) Replace defrost heater & limit	165.00
8) Replace cold control	145.00
9) Replace door switch (fan & light)	98.00
10)Install new door seal (add $85.00 for second seal)	155.00
11)Replace door cams	125.00
12)Install hard start kit	145.00
13)Replace compressor (advise against it)	400.00+
14)	
15)	

Examination

Manual 7

Refrigerators & Freezers

(Note: More than one answer maybe correct.)

1. Refrigeration repairs are
A. usually obvious.
B. like washers and dryers.
C. very subtle.
D. easy for homeowners.

2. Before your start any repair work on a refrigerator
A. wash your hands.
B. take the temperatures.
C. pull out the refrigerator.
D. eat lunch.

3. When liquids evaporate they
A. cool off.
B. generate heat.
C. change into a gas.
D. disappear.

4. Freon inside an evaporator is
A. a warm gas.
B. a cool gas.
C. under a low pressure.
D. a mixture of liquid and gas.

5. The capillary tube
A. controls the flow of freon.
B. clogs with ice and dirt.
C. is about 12” long.
D. is in the sealed system.

6. Replacing a refrigerator door seal
A. is recommended for even tiny air leaks.
B. takes only a few minutes.
C. involves taking the seal off all at once.
D. is much more difficult than it appears.

7. A bad defrost limit
A. can create frost like a bad heater.
B. should be replaced with a new heater.
C. can be tested at room temperature.
D. A & C.

8. Sealed system work
A. is an easy way to make money.
B. can be done with your eyes closed.
C. is worse than the plague.
D. requires a large investment.

9. A cap and suction line
A. transfers heat between the two lines.
B. is soldered.
C. can cause condensate.
D. A, B, & C.

10. Evaporator fan motors
A. often make noise, when they fail.
B. are shaded pole motors.
C. can be reversed.
D. are hard to stock

11. Partial frost patterns indicate
A. a restriction.
B. a short system.
C. money for you.
D. a trashed refrigerator.

12. Water in a sealed system
A. can be easily removed.
B. is serious contamination.
C. means a major expense.
D. causes rust.

13. A hard start kit
A. is a temporary fix.
B. is used to test compressors.
C. rarely works.
D. is helpful for testing.

14. Closing a damper control
A. will warm up the freezer.
B. will not hurt anything.
C. will raise the fresh food temperatures.
D. will unbalance the system.

15. A defrost heater
A. can be tested with an ohmmeter.
B. melts out accumulated frost.
C. is about 12” long.
D. is in the sealed system.

16. Defrost clocks
A. are largely interchangeable.
B. must be exact.
C. are easy to find.
D. control the freon pressure.

17. The difference between ice and snow
A. is critical to diagnosis.
B. is a silly statement.
C. is important in the winter.
D. all of the above.

18. Major frost build-up can be caused by
A. an open door.
B. a short system.
C. a bad defrost limit.
D. a bad defrost clock.

19. Ice build-up can be caused by
A. a bad defrost clock.
B. a separated cap and suction line.
C. a clogged drain.
D. A, B, & C.

20. A bad defrost clock can be determined
A. by the noise they make, when they fail.
B. with your hand.
C. with an Amprobe.
D. without instruments

Extra credit: Why is system repair discouraged by *Uncle Harry?*

____

____

Examination Answers

Manual 7

Refrigerators and Freezers

1. C. Refrigeration repairs require experience and attention to details.

2. B. Do not lose accurate temperature readings by opening doors while talking to the customer. Take the temperature first.

3. A & C.

4. C & D.

5. A, B & D. The tiny cross section of the capillary tube in the sealed system can clog with any debris.

6. D. Replacing a refrigerator door seal is difficult and time consuming. It is often hard to get adjusted.

7. A & B. A defrost limit cannot be tested at room temperature. They will only close at their set points of 50-90 degrees F.

8. C & D. The new EPA regulations and the cost of doing sealed system repairs make for far are more trouble than it is worth.

9. D. Failure of the solder joint between the cap and the suction line reduces the heating transfer between the two lines causing condensation and even frost.

10 A, B & C. Evaporator fan motors often squeal when they fail. Replacement motors can be reversed to fit either rotation.

11. A, B & D.

12. B & C. A sealed system contaminated with water can seldom be repaired.

13. A, B & D. In some cases, a hard start kit is a long-term repair, but most often the compressor is nearing the end of its useful life.

14. C & D.
15. A & B.

16. A. Defrost clocks are mounted in many locations. They can be difficult to find.

17. A & C. C. has nothing whatever to do with appliances, but nevertheless, it is true.

18. A, C & D.

19. C A bad defrost system results in the buildup of snow rather than ice.

20. A, B, C & D. There are various methods for determining a bad defrost clock and they are all effective.

Extra Credit (worth 5 points):

Knowledge, licensing, high investment and regulatory requirements all combine to discourage any new company from getting involved in freon system repair.