Chapter 13

THE ABSORPTION SYSTEM

The absorption system differs from the compression system in that it uses heat energy instead of mechanical energy to make a change in the conditions necessary to complete a refrigeration cycle. This system uses gas, kerosene, or an electric heating element as a source of heat supply.

13-1. TYPES OF ABSORPTION SYSTEMS

There are several usable combinations of chemicals that have the property that one may absorb the other without any chemical action taking place. The substance has the property to absorb the other chemical when cool, but will release the chemical when heated. If the substance is a solid, the process is sometimes called adsorbing while if the substance is a liquid, the process is called absorbing.

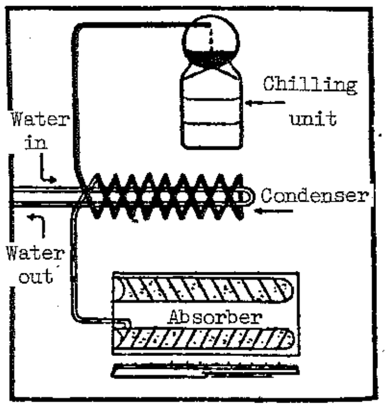
There are two principal types of absorption refrigerators: one utilizing a solid absorbent material, the other using a liquid absorbent. The liquid absorbent machine is the most popular.

These two types of absorption refrigerators are typified by the Faraday, which is a solid absorbent type and by the Electrolux, which uses a liquid absorbent.

13-2. THE ABSORPTION SYSTEM

Fig. 13-1 illustrates a simple absorption system. This diagram is of the solid absorbent type and is produced for the purpose of comparison with mechanical types of refrigerators.

The condensing coil, receiver, and cooling coils are quite similar to those used in the compression system. The compressor, however, has been replaced by a heater or generator. The system does not work so simply as the illustration portrays, but functioning of it may be more easily followed

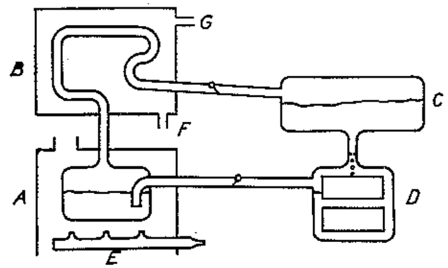


13-1. Elementary solid absorbent cycle.

by leaving out the various controls that are explained in detail later.

The most appealing feature of this system is the elimination of moving parts down to a few valves, while certain domestic applications have moving parts reduced to a minimum.

Fig. 13-2 illustrates a simple absorption system of the liquid absorbent type.



13-2. Elementary liquid absorbent cycle. A. Generator; B. Condenser; C. Receiver; D. Cooling coil; E. Burner; F. Water-in; G. Water-out.

13-3. THE SOLID ABSORPTION SYSTEM

Michael Faraday, in 1824, performed a series of experiments to liquefy certain "fixed" gases -- gases which certain scientists believed could exist only in vapor form. Among them was ammonia, for it had always been regarded as a "fixed" gas. Faraday knew that silver chloride, a white powder, had the peculiar property of absorbing large quantities of ammonia gas. He therefore exposed silver chloride to dry ammonia gas. When the powder had absorbed all of the gas it would take, he sealed the ammonia-silver chloride compound in a test tube which was bent to form an inverted "V." He then heated the end of the tube containing the powder and at the same time cooled the opposite end of the tube with water. The heat released ammonia vapor and drops of colorless liquid soon began to appear in the cool end of the tube. Thus liquid ammonia was produced for the first time.

Faraday continued the heating process until sufficient liquid ammonia had been produced for his purpose. When this was accomplished he extinguished the flame under the powder and proceeded to observe the characteristics of the newly discovered substance.

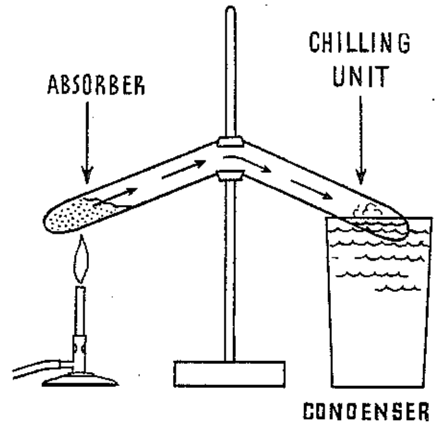
A few moments after the flame had been extinguished, Faraday began to note a most unusual occurrence. The liquid ammonia, instead of remaining quietly in the sealed test tube, began to bubble and then to boil violently. It was rapidly changing back into a vapor, and the vapor was being reabsorbed by the powder. Upon touching the end of the tube containing the boiling liquid, Faraday was astonished to find it intensely cold. Ammonia, in changing from liquid to vapor form, extracted heat and it took this heat from the nearest thing at hand, which was the test tube itself.

The diagram in Fig. 13-3 illustrates the Faraday experiment.

13-4. ABSORPTION SYSTEM CHEMICALS

Several different chemical combinations have been used in absorption units.

Ammonia as the refrigerant and



13-3. Elementary operation of the intermittent absorption cycle.
(Faraday Refrigerator Corp.)

water as the absorbent is the most popular.

High temperature units (air conditioning) are now using water as the refrigerant and lithium bromide or lithium chloride as the absorbent. The pressure in these systems varies between 15 psia in the cooling coil to 1 psia in the condenser.

One company is using methylene chloride as the refrigerant and dimethyl ether of tetraethylene glycol as the absorbent. The pressures are 3psig and 24 in Hg. vacuum.

13-5. TYPICAL SOLID ABSORBENT SYSTEM

From Fig. 13-1 the following elementary cycle may be traced. Heat is applied to the generator or absorber, which will liberate ammonia gas from its absorbent and will increase the pressure to the point where the air or water cooled condenser will remove sufficient heat from the high pressure gaseous ammonia to reduce it to a liquid.

The liquid refrigerant is forced from the condenser to the receiver or storage tank by the pressure of the vapor entering the condenser.

After sufficient ammonia is driven into the condenser and receiver, the heat is discontinued and the generator or absorber cools. When the temperature of the absorber is lowered sufficiently, it begins taking back or reabsorbing the ammonia gas. As the absorber cools it attracts the gas ammonia molecules and as they enter the absorber and are changed to a liquid two things happen. First, the absorber heats up and this heat must be removed. Second, the pressure in the container is reduced to the level where the liquid ammonia can convert again to a gas at such a low heat level that refrigerating temperatures are produced. The apparatus is so constructed that it can obtain this ammonia only from the cooling unit, which necessitates an evaporation taking place there. From elementary physics one knows that this will cause the removal of heat from the cooling unit and its surroundings, and if this cooling unit is located in an insulated box (a refrigerator box) that box will be refrigerated.

As the ammonia evaporates from the cooling unit it is replaced by liquid ammonia from the receiver. This operation continues until the proper amount of ammonia is reabsorbed by the generator, when heat is again applied and ammonia is again moved to the receiver.

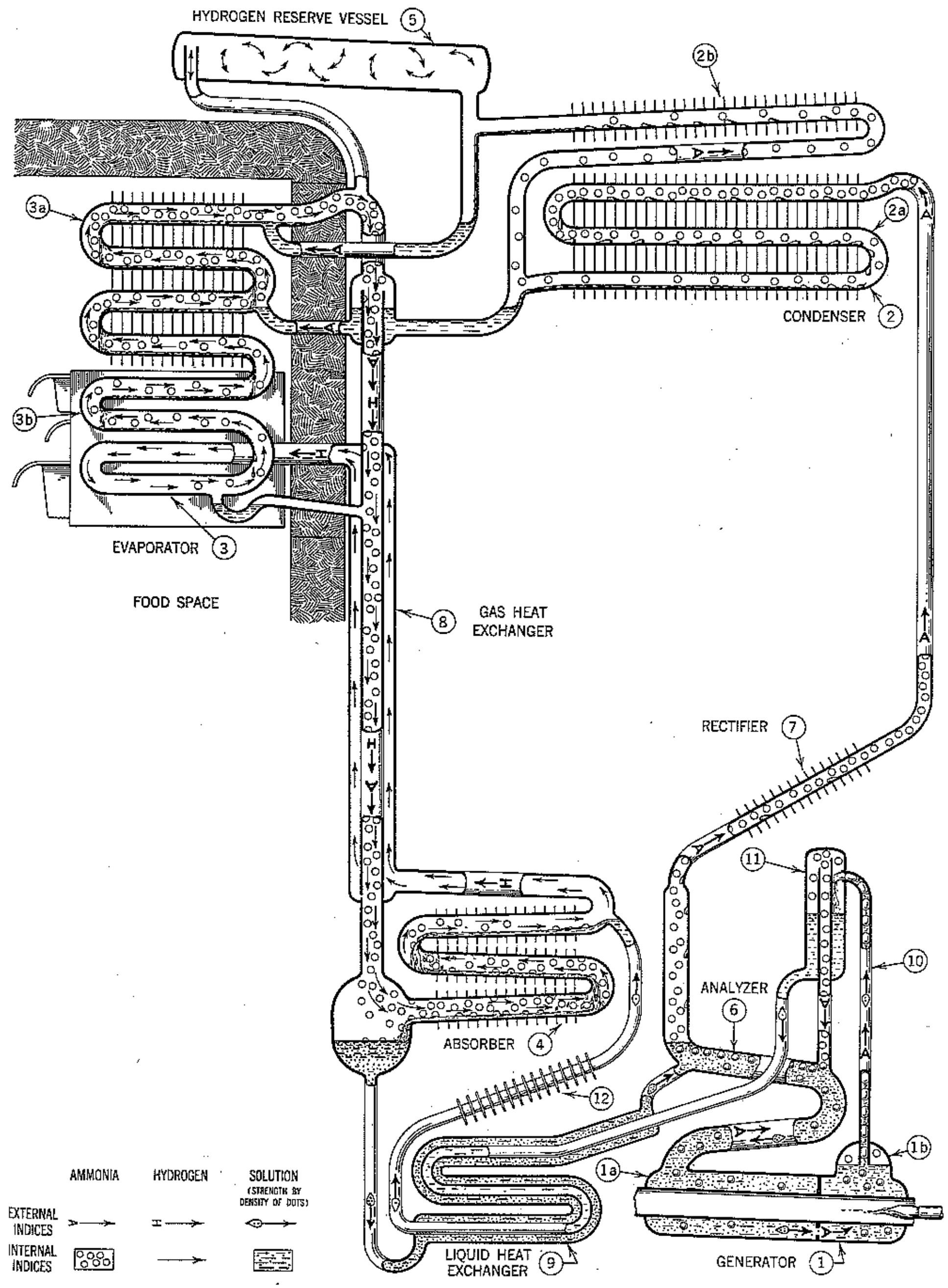
From the description it is seen that the cycle is intermittent and that the complete cycle embraces both a generating period and an absorbing period. This cycle may be easily traced from Fig. 13-2.

This in principle is the Faraday refrigerator and its cycle is explained in detail in Chapter 14.

13-6. TYPICAL LIQUID ABSORBENT SYSTEM

The liquid absorbent system seems to possess some very desirable characteristics. Water at ordinary pressures and temperatures will absorb great quantities of ammonia. Ammonia absorbed in water may be easily driven from the water by the addition of heat. Also liquid ammonia has a high latent heat of vaporization.

The Servel is a domestic refrigerator which is designed to operate in a continuous cycle and has no moving parts or valves other than to control the burner flame. The refrigerant is ammonia with water used as the absorbent; hydrogen gas is utilized to create a partial pressure (Dalton's Law, Paragraph 1-18) to allow the



13-4. Diagram of the Servel absorption cycle 1, 1a, 1b generator, 2, 2a, 2b, condenser, 3, 3a, 3b, cooling coil, 4 absorber, 5 hydrogen reserve vessel, 6 analyzer, 7 rectifier, 8 gas heat exchanger, 9 liquid heat exchanger, 10 percolator tube, separator, 12 precooler. (Copyright 1955 by Servel Inc.)

ammonia to evaporate at a low pressure.

In Fig. 13-4, A represents ammonia, and H is hydrogen.

When the burner is lighted and its heat applied through the center of the generator, ammonia vapor is released from the solution. This hot vapor in part (1b) passes upward through the percolator tube (10), and as the hot ammonia vapor rises through this tube it carries the solution to the upper level of the separator (II).

Most of the liquid solution settles in the bottom of (11) and flows through the liquid heat exchanger (9) into the absorber (4). The hot ammonia vapor being light rises to the top of (11) tube. The hot ammonia vapor then passes downward through the center tube, into the analyzer (6). Here any water vapor is removed while the hot ammonia vapor rises into the rectifier (7).

The rectifier consists of a series of small baffle plates, surrounding the tube. If the hot ammonia vapor still has some traces of water vapor, it must be removed to insure pure ammonia vapor.

The heat has at this point completed its work. For the remainder of the cycle, the natural force of gravity is depended upon to create circulation.

The pure hot ammonia vapor continues into the condenser (2).

The air, passing through the fins takes out the heat from the ammonia vapor, thus condensing some of the vapor in liquid in (2a). This ammonia is now in a pure state, and it flows into the evaporator (3d).

The ammonia gas that does not condense in (2b) where the rest is condensed drains to the upper tube or trap.

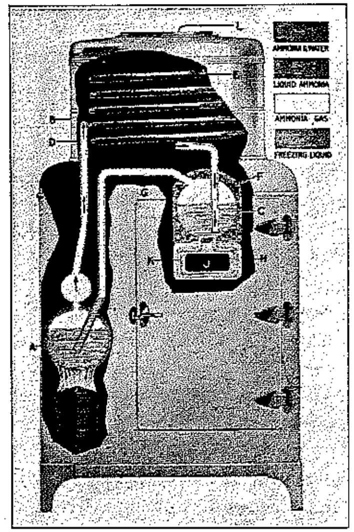
The U-tube is the receiving and storage compartment in the cycle where the liquid ammonia is allowed to build up to a predetermined level; then it flows into the cooling coil (3a). Because a liquid will always seek its own level, the liquid ammonia flows by gravity through the liquid ammonia tube and spills into the cooling unit.

As the liquid ammonia falls into the cooling unit, (3a and 3b) it forms in large shallow pools on a series of horizontal baffle plates. The hydrogen that is being fed to the cooling unit permits the liquid ammonia to evaporate, (Dalton's principle) at a low temperature. During this process of evaporation, the ammonia absorbs heat from the food compartment of the refrigerator and causes the water in the ice-cube containers to freeze. The more hydrogen and less ammonia the lower the temperature. The evaporator vapor formed by the evaporating of the liquid ammonia, mixes with the hydrogen. This mixture is heavier than hydrogen alone and moves downward through the middle of the gas head exchanger (8) into the absorber (4). This circulation is continuous in the cooling unit. The mixed gases that pass through the gas heat exchanger cool the hydrogen rising in the outer tube.

During this time a weak solution of ammonia and water is flowing from the generator (11) to the top of the absorber (4) by way of the liquid heat exchanger (9). Here it meets the mixture of hydrogen and ammonia vapor coming from the evaporator by way of the gas heat exchanger. The weak solution absorbs the ammonia vapor. The hydrogen is left free; since hydrogen is insoluble in water and is very light, it now rises to the top of the absorber and returns to the cooling unit by way of the gas heat exchanger (8).

The absorber (4) has fins and is air cooled. The cooling of the weak solution helps it to absorb the ammonia gas out of the mixture of ammonia and hydrogen. Also when the weak water solution absorbs the ammonia gas, considerable heat is liberated and the air cooled fins must remove this heat to permit refrigeration to continue.

The solution, now a strong solution of ammonia and water, drops to the bottom of the absorber (4) and continues down through the liquid heat exchanger (9).



13-5. The generation or heating interval in a typical intermittent type absorption refrigerator. (Perfection Stove Co., Inc.)

The liquid heat exchanger carries the strong liquid, or refrigerant, back to the analyzer (6) and to the generator where it again starts its cycle.

The rectifier (7) insures that any water vapor still in the ammonia will condense and drain back to the analyzer.

The apparatus is a welded assembly. There are no moving parts to wear out and go out of adjustment. The total pressure throughout the cycle is about 200 psig, necessitating a rugged construction which insures a long life.

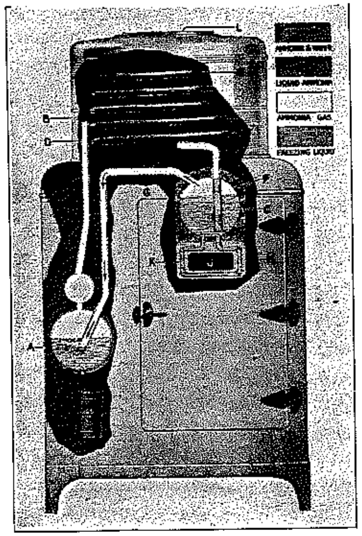
To produce a 0 F refrigerant in the cooling coil the ammonia must boil at 15.7 psig, which means that the hydrogen must make up the remainder of the pressure (184.3 psig). This refrigerator is considered to be unique among the domestic ones sold in the United States. A more detailed study is made of the Servel in Chapter 14.

13-7. KEROSENE BURNING REFRIGERATORS

A very convenient refrigerator cycle for localities not furnished with gas or electricity is the Superfex and Trukold cycle. The Superfex cycle is basically the Faraday principle but incorporates features which warrant a description.

Ammonia is mixed with water in a tank or generator (A) under which are located some kerosene burners (M). The burners are lighted and the heat produced drives the ammonia in vapor form out of the mixture. This ammonia vapor is forced up a pipe (D) and through a coil (E) which is immersed in water contained in a tank (B) on top of the refrigerator (note arrows Fig. 13-5). The lower temperature causes the ammonia vapor to change back to a liquid at the high generating pressure. This liquid ammonia drops through a pipe into the liquid receiver (C) and from here it passes to the cooling unit (K) which is surrounded by a brine (H). The liquid receiver is insulated (F) to prevent this container from overcooling the food compartment by acting as the cooling coil. This process continues for a relatively short time until all the kerosene is consumed and the burners automatically go out. As the absorber cools to room temperature, the ammonia will evaporate at a very low temperature in the cooling unit because as the generator cools it tends to re-absorb the ammonia gas, thereby reducing the pressure and permitting the liquid ammonia in the evaporator to boil at low temperatures. This evaporation causes the cooling effect on the contents of the food compartment which is called refrigeration.

In detail, the water in the generator (A) cools very quickly after the burners have gone out, and as cool water has a strong affinity for ammonia, the ammonia vaporized in the cooling unit passes back (note arrows Fig. 13-6) to the generator through a connecting pipe (G) and is re-absorbed by the water in the generator maintaining a low evaporating pressure in the cooling unit.



13-6. The cooling period in an intermittent type absorption refrigerator.
(Perfection Stove Co., Inc.)

In other words, the heat from the oil burners drives the ammonia from the generator (A) to the cooling unit (K) in a short time; the ammonia in the cooling unit vaporizes and passes back to the generator slowly over a period of twenty-four to thirty-six hours. The vaporization of the ammonia in the cooling unit produces the refrigerating effect.

For additional efficiency in unusually hot climates or for handling extra large loads, a depression (L) in the top of the condenser tank may be filled with water which will evaporate rapidly and aid the cooling of the tank.

This refrigerator is also explained in Chapter 14 along with the Trukold and Icy-ball which are fundamentally similar to it.

Without exception the absorption mechanisms are provided with a fuse plug which will release the charge from the mechanism when the temperature of the unit becomes excessive 175-200 F. This device prevents any possibility of the complete mechanism exploding.

An absorption refrigerator using sulphur dioxide as the refrigerant was produced a few years ago but did not continue on the market. It was of the intermittent type using silica-gel as the absorbent material. The action was very similar to action in the intermittent types just explained. This absorption system is used on some railroad freight cars.

13-8. REVIEW QUESTIONS

1. Name the lettered parts of Figure 13-2.
2. Why is the ammonia and water combination so popular?
3. What purpose does the hydrogen serve in the Electrolux?
4. What localities are especially in need of the kerosene-fired intermittent absorption refrigerators?
5. Who first discovered the absorption principle?
6. Why must the absorber be cooled in the Servel cycle?
7. What is the purpose of a heat exchanger?
8. How can burning more gas in the Servel cycle produce more cold?
9. Why is the storage cylinder or receiver in the Superfex refrigerator insulated?
10. Why are these mechanisms provided with a fuse plug?
11. Name three substances used in absorption refrigerators to absorb the refrigerant gas.
12. In absorption refrigerators, does the liquefication of the refrigerant depend upon compression?
13. Does the generator serve any other purpose in the Superfex? What?
14. Have absorption refrigerators using sulphur dioxide ever been used?

Chapter 14

ABSORPTION SYSTEMS CONSTRUCTION FEATURES

The refrigeration systems of the absorption type have entirely different construction features and service operations than the compression cycle systems. In Chapter 13 the absorption cycles are explained in detail. It is the endeavor of this chapter to bring out the construction features of these refrigerators.

14-1. DOMESTIC ABSORPTION SYSTEMS

Absorption system domestic refrigerators have been marketed since the 20's. These units have several advantages. They have no moving parts and therefore are virtually noiseless. Some do not require electricity and can provide refrigeration where electricity is not available.

There are two types of absorption machines; the intermittent type and the continuous type. The intermittent type however has practically ceased to exist. The continuous type is becoming increasingly popular.

14-2. INTERMITTENT TYPE ABSORPTION SYSTEMS

The intermittent absorption machine was very popular in the 30's. The Crosley Corp. manufactured the Icy-Ball, the Superfex was made by the Perfection Stove Co. and the Trukold was sold by Montgomery Ward.

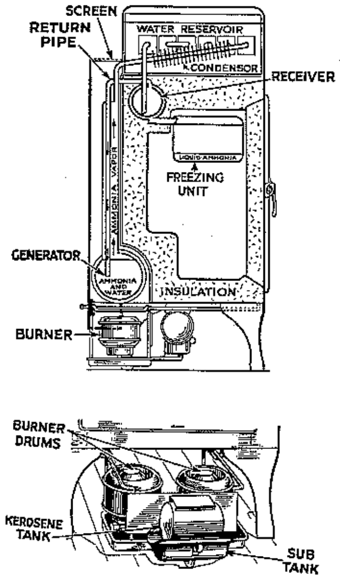
These units were operated by a kerosene heater which when lighted heated the generator for approximately one hour. After the burner used up its fuel and ceased to burn, the refrigerator would provide excellent refrigeration for about twenty-three (23) hours. Therefore, the housewife only needed to fill and light the special kerosene units once each day.

14-3. SUPERFEX

The Superfex refrigerator was designed to produce good refrigeration using kerosene as the source of energy. The system had the generator on the left side of the cabinet with the kerosene burners mounted on racks and accessible through a small door on the lower left side. The condenser was immersed in a tank of water mounted on the top of the cabinet.

The system used ammonia as the refrigerant and water as the absorbent. Note that the cooling coil was surrounded by a cold retainer which served to keep the refrigerator cold during the heating portion of the cycle.

The cycle is explained in Chapter 13. With this unit there were two precautions to be observed: The water-cooled condenser is immersed in a non-flowing water tank located in the top of the box. This water level must



14-1. The Trukold cycle and burners. (Montgomery Ward)

be kept up to the indicated level, especially just before lighting. The kerosene burners must be clean, dry, and in good condition. They must be filled to the correct indicated level and must be in a level position when burning or an improper flame will result. No obstructions should be placed over the heating flue as this will restrict the efficiency of the cycle.

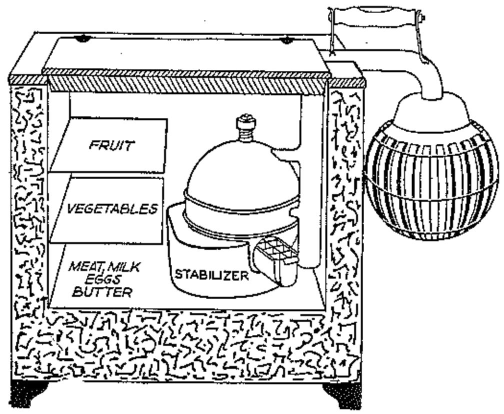
14-4. TRUKOLD

Another kerosene-fired absorption refrigerator was distributed by Montgomery Ward. This refrigerator was intermittent in operation; it used ammonia and water as the refrigerant and absorbent. A kerosene stove was located under the box and the heating flue was behind the box, Fig. 14-1.

Note the location of the liquid ammonia receiver inside the insulation of the cabinet behind and above the cooling coil. This location is to prevent the receiver from acting as the cooling coil. The burners are mounted on racks to make shifting of them very simple. The water reservoir must be kept filled to the correct depth at all times.

14-5. ICY-BALL

A refrigerator, called the Icy-Ball, was made by the Crosley Corp. It was an insulated box with a top door (chest

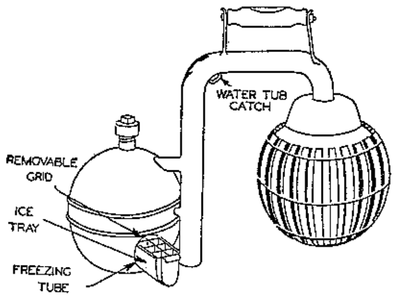


14-2. The Icy-Ball refrigerator.

model), and a portable generator and a cooling unit, Fig. 14-2. It is the absorption type and operates as follows: each refrigerator is provided with a kerosene stove and a water bucket. To start operating, place the generator over the lighted stove and the cooling unit in the bucket filled with cold water for about 90 minutes. Then place the cooling unit in the refrigerator box and the generator out in the open air. Refrigeration will be obtained for about 24 to 36 hours, Fig. 14-3. An insert in the cooling unit is provided with an ice-tray to make ice cubes. The unit weighs 39 pounds and is inexpensive to operate. It uses ammonia as the refrigerant and water as the absorbent.

14-6. CONTINUOUS TYPE ABSORPTION SYSTEMS

The continuous type absorption system has been used in the United States since about 1927. Two systems have been manufactured. The Servel system



14-3. The refrigerating mechanism used in the Icy-Ball Refrigerator.

originated in Sweden and the Servel Inc. organization has the manufacturing rights. The Faraday unit was made during the early 30's. It was not a true continuous system but operated the generating and freezing portions of the cycle automatically.

The continuous absorption system is one that can simultaneously condense and evaporate the refrigerant.

14-7. THE SERVEL ABSORPTION SYSTEMS

As explained in Chapter 13, the Servel system operates on the principle of Dalton's Law of partial pressures. The Servel has been manufactured in three basic styles. The original unit used water to cool the condenser and the absorber. In Europe, an electric heating element was used, while in the United States all the units were heated with artificial or natural gas. The water-cooled units were produced between 1927 and 1933.

In 1934 and 1935, a secondary cooling system was used in place of water cooling. The ammonia condenser was air cooled and the absorber was cooled by a methyl chloride coil and the hot methyl chloride was in turn cooled by an air cooled condenser located just beneath the ammonia condenser.

Starting in 1936, the secondary system was discontinued and both the ammonia condenser and the absorber are now directly air-cooled. See Fig. 14-4.

14-8. THE SERVEL WATER COOLED SYSTEM

The first absorption refrigerator to become popular on the market was the Servel. In both Chapters 13 and 15 the operation and control of the Servel refrigerator are discussed in detail. In Chapter 13 the cycle is discussed, while in Chapter 15 the valves and their adjustments are explained.

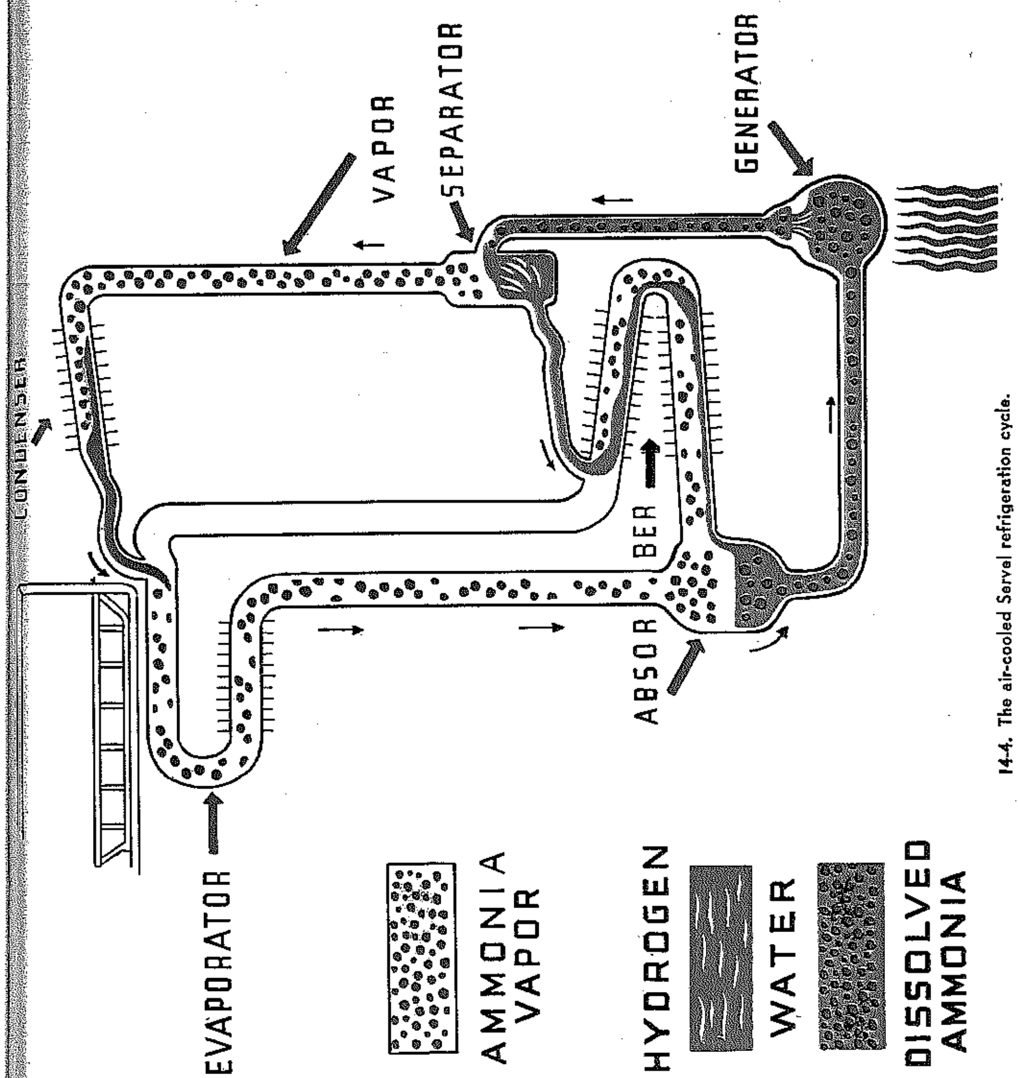
Gas is used to supply the heat energy necessary for operation, and water is used as the cooling medium. When connecting the refrigerator to the sources of supply of gas and water, valves both manual and automatic must be installed. A manually adjustable pressure reducing valve, a strainer, and a manual shut-off valve are installed in the water line. A pressure reducing valve, a manual shut-off valve, a strainer, an automatic temperature shut-off, a temperature control, and a safety cut-out are installed in the gas line to handle the gas supply to the burner.

The Servel, besides being offered in the domestic cabinet, is also obtainable in water coolers.

14-9. THE AIR COOLED ELECTROLUX SYSTEM

Servel, Inc. announced their secondary system air-cooled unit in 1933 and continued the model with cabinet refinements in 1935.

The Servel air-cooled unit is charged with a small quantity of aqua-am-



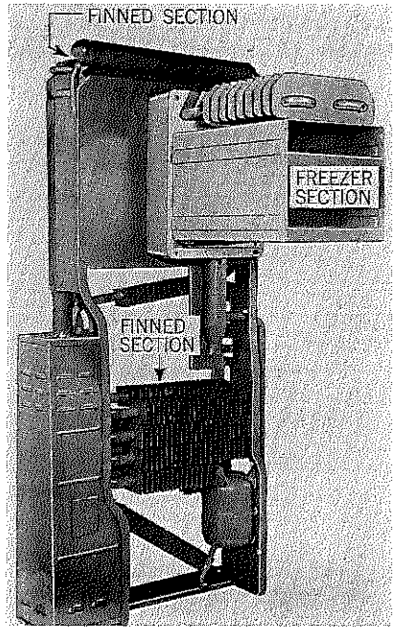
14-4. The air-cooled Servel refrigeration cycle. (Servel, Inc.)

monia (distilled water and ammonia) and hydrogen. The charge distributes naturally in the unit; the liquid seeks the lowest levels and the hydrogen and ammonia gas fill the remaining space.

Referring to Fig. 14-4, the application of heat at the generator, ammonia vapor is driven from the strong solution, is raised through the pump tube to the weak liquid separator. Ammonia vapor with traces of water vapor, is driven off in the separator, leaving the aqua-ammonia solution comparatively weak in ammonia (weak solution). The hot ammonia vapor then passes from the separator to the condenser. When the hot ammonia vapor reaches the condenser it is liquefied by cooling. The condenser is finned, and natural convection produces a steady flow of air over it. The liquid ammonia maintains a level in the condenser, causing the liquid ammonia to flow into the cabinet evaporator. The ammonia evaporates and absorbs heat in the evaporator.

An atmosphere of hydrogen gas, continually sweeping the surface of liquid ammonia in the evaporator, keeps removing the ammonia vapor and causes continued evaporation. The ammonia vapor thus formed in the evaporator mixes with hydrogen gas, and the mixture is made to flow through the evaporator. The long column of heavy gas, rich in ammonia (ammonia and hydrogen mixture) readily overbalances the short column of heavy gas in the evaporator, thereby causing the desired flow in the cooling coil. A flow of weak solution, being returned from the generator, contacts the ammonia and hydrogen gas mixture entering the absorber, and the ammonia is dissolved. The hydrogen being light returns to the evaporator.

The heat, which is liberated by absorption of ammonia in the absorber is carried away by air cooling. From the absorber the strong solution is returned by gravity to the generator. Continued refrigeration is merely a repetition of this cycle.



14-5. An air-cooled Servel System which uses a kerosene burner as the heat source.

The refrigeration mechanism that contains the ammonia is made of welded steel. The fins on the ammonia condensers are made of copper, although the tubing is steel. The gas controls are almost identical with those used in the water-cooled unit (Chapter 15).

Several different types have been manufactured. The refrigerators can be obtained with:

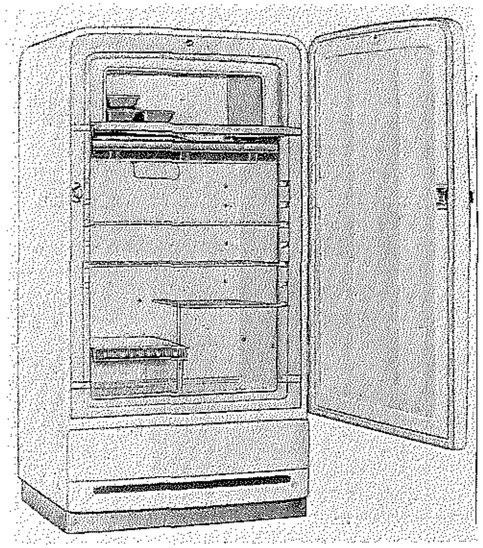
1. Gas heat
2. Electric heat
3. Kerosene heat, Fig. 14-5.

Another difference in the models is the type of generator. These generators have been made in both horizontal and vertical models.

Fig. 14-6 illustrates a late model Servel unit with an across the top

freezer. The freezer inner door is open. A phantom view of a Servel refrigerator with a horizontal generator is shown in Fig. 14-7.

The units are now equipped with automatic defrosters and some of the units use an automatic ice cube maker.



14-6. A late model Servel cabinet. Note the across-the-top freezer. This cabinet uses a kerosene burner that is located in the base of the cabinet. (Servel, Inc.)

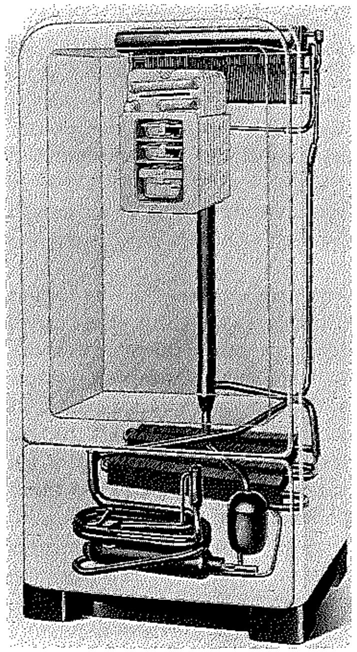
The electrical system for the more recent Servel units is shown in Fig. 14-8.

14-10. THE FARADAY SYSTEM

The Faraday Absorption Refrigerator was built by the Faraday Refrigerator Corp. It was of the solid absorbent type. The generator or absorber assembly was built as a complete unit which is located either in the bottom of the refrigerator cabinet, installed remotely, as installation conditions required.

The evaporator or cooling unit was of the plate type, and so arranged that each ice tray came directly in contact with a section of the cooling unit containing liquid refrigerant.

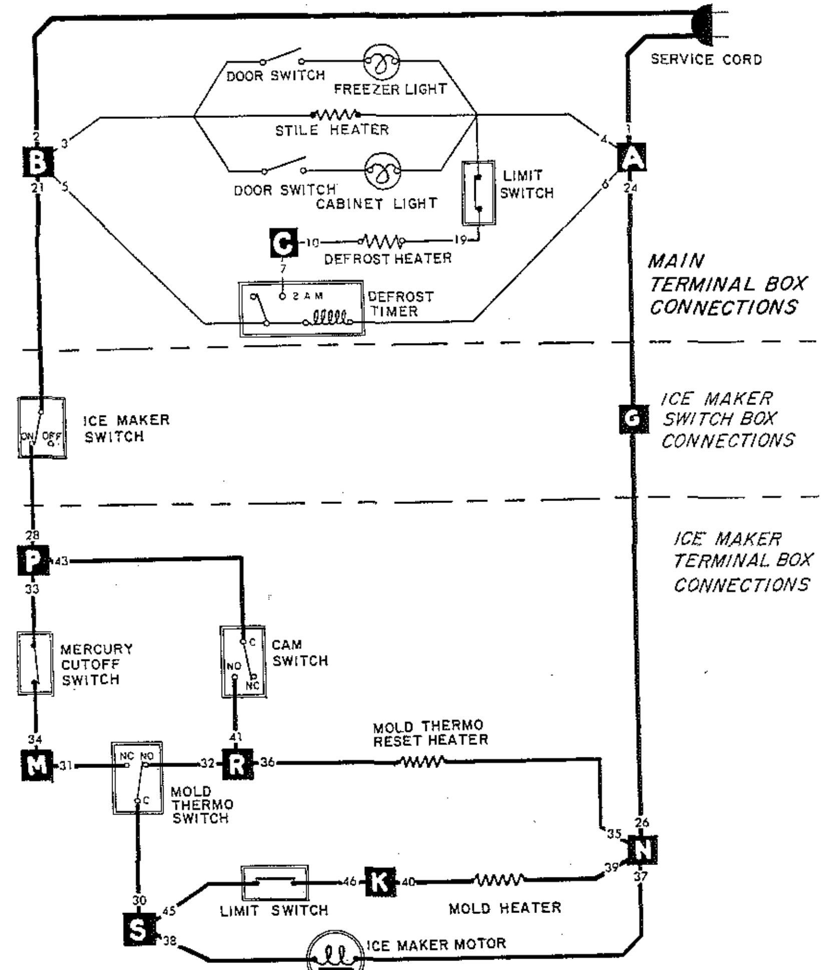
The Faraday refrigerator required a water and gas supply and employed adjustable valves to cut down and maintain constant pressure in both the supply lines. As explained before, the Faraday cycle was intermittent; therefore the main gas burner operated only a portion of the time. This necessitated a constant pilot burner and suitable control devices to open and close the gas supply to the main burner at the proper time.



14-7. A Servel refrigerator showing the installation of a horizontal generator unit. (Servel, Inc.)

14-11. THE GENERATING PERIOD

As in the original Faraday experiment, the gas burner forced the am-



14-8. The electrical circuits on the Servel. This model has both automatic defrost and automatic ice cube maker.

monia over to the other portion of the system, but the method of transferring the refrigerant was more involved than in the original setup.

First of all, in order to give a uniform heat application to the ammonia in the absorber generator, a steam bath of a low boiling temperature liquid, called F-11, was used.

From the illustration it may be seen that as this vapor became heated, its pressure rose; as the valve in this vapor circuit was closed, the vapor was locked in the chamber constructed around the ammonia absorbent.

As this vapor heated the heat was transferred to the absorbent powder, released the ammonia in gaseous form, which passed up into the water-cooled condenser. From here the ammonia passed on through the liquid line to the cooling unit, where it was stored.

However, because ammonia gas condenses at the coolest point of its circuit, a provision had to be made so the condensation would take place in

the condensing unit rather than in the cooling unit, which was naturally very cold, being inside the refrigerator box. All that was necessary was a pressure-controlled needle valve in the ammonia line which would prevent the ammonia from seeping into the cooling unit until its pressure has reached that point where it was condensable at the temperature of the cooling water. When this pressure was reached the valve would open and allow the condensed ammonia to collect in the cooling unit.

14-12. ABSORBING PERIOD

After all of the ammonia had been driven into the cooling unit, some method had to be employed to shut off the gas burner. The method used was very simple.

When all of the ammonia had been driven from the absorber there was nothing to remove the heat applied to the absorber and naturally the vapor surrounding the absorber became hot and developed a higher pressure. This pressure operated upon the F-11 vapor valve and when it had become high enough forced it open, shutting off the gas supply and allowing the F-11 vapor to recirculate.

The opening of this valve naturally caused a great drop in the F-11 pressure and due to its original spring pressure it tends to close. This, however, was prevented by a trip arrangement and lock.

It will be noticed from the main diagram that the absorber heating medium, the F-11, was so circulated that it came in contact with the condensing water. When the vapor valve was opened and this heat transfer gas allowed to recirculate, the absorber became surrounded immediately with a cold fluid. This caused a very rapid drop in the temperature of the ammonia absorbent in the absorber, which naturally put this absorbent in a position to reabsorb the ammonia driven away from it. This it did as rapidly as it could. If it were allowed to reabsorb the ammonia uncontrolled, a very low temperature would be achieved in the refrigerator box.

However, this was prevented by the temperature control unit and storing unit as illustrated. This unit operated as follows: It had a valve bellows and a spring tension manually adjusted which allowed the evaporated ammonia gas in the cooling unit to go back to the absorber and be reabsorbed only after the gases reached a certain pressure corresponding to the freezing temperature desired in the cooling unit.

When this pressure had been reached, it overcame the spring tension on the bellows; the valve opened and then closed again after the pressure had dropped.

Because this valve was manually adjustable, a temperature ranging from about 0 F. to 20 F. was obtainable in the cooling unit. This continued until the generator had reabsorbed as much ammonia as possible after which the pressure in the absorber approached the pressure of the cooling unit.

When this condition was reached it was desired that the gas valve be reopened. This was accomplished by installing a pressure bellows valve in the ammonia line, which was attached to the trip arrangement on a combination gas and F-11 vapor pressure valve.

This was designed so that, as pressure rose in the line located between the temperature control valve and the absorber, the bellows contracted and tripped the gas valve arm, which was already under spring pressure. It reopened simultaneously with the closing of the vapor valve which was attached to the same arm.

From the above explanation it will be seen that there were three liquids used in the system--ammonia as the refrigerant. F-11 (trichloromonofluoromethane) which was the heat transfer fluid or bath surrounding the absorber, and water which was used to condense both of the above liquids.

The system used about three pounds of ammonia and two pounds of F-11. These were, of course, sealed in the system.

The temperature control valve and the gas trip valve were also designed as service valves. The one (temperature control valve) was used to seal the cooling unit and the pressure trip valve sealed the absorber generator unit.

Whenever a remote installation was made, the chief precaution to take was in connection with the installation of the tubing connecting the above two valves. This tubing had to be dehydrated, that is, freed from water. It also had to be very clean. After hooking up this tubing to the two valves, it had to be sealed tightly to the temperature control valve and only loosely to the gas trip valve. The temperature control valve was then opened a little and the added tubing purged; that is, cleared of air by the ammonia leaking out. Then the connection of the gas trip valve was sealed.

If by chance the gas pilot light were extinguished, by becoming clogged or smothered, a thermostatic control attached to a gas valve in the circuit and the cooling of this thermostatic valve tripped to shut off the gas supply.

The water supply was practically continuous, because part of the time it was used to cool the ammonia vapor and the remainder of the time to cool the heat transfer fluid. However, the amount of water flowing was so controlled by actual requirement that the minimum amount was used most of the time.

The water valve was mounted on the side of the absorber assembly at the rear so that connections could be conveniently made. The inlet water entered the opening (A) and passed from the valve chamber to the condenser past the water valve. The water then flowed through the condenser chamber, returning to the opposite end of the water valve.

Surrounding this bellows was a liquid which expanded and contracted with the temperature of the outlet water. This expansion and contraction of liquid caused the metal bellows to move, operating the water valve. Any changes of temperature of the discharged water would change the adjustment of the valve; that is, if the discharged water became too hot, the water supply valve would be opened farther or if it became too cold, the valve would be closed more.

The gas supply was controlled by a leather valve and the gas, before it passed through this valve into the burner, was passed through a filter.

A further safety feature was introduced in a safety device operating on the thermostatic strip controlling the gas operating valve. This device was so arranged that if the absorber assembly reached too high a temperature, either from the failure of water supply or any other unusual condition, the device would trip the gas valve and shut off the gas supply.

14-13. REVIEW QUESTIONS

1. What three substances are used inside a Servel mechanism?
2. What was the purpose of the F-11 in the Faraday?
3. Why was a pilot flame used in the Faraday?
4. Why was copper tubing used in the Faraday?
5. How was the Faraday water valve manipulated?
6. What did the water cool during the freezing portion of the Faraday cycle?
7. What two purposes did the temperature control valve serve in

the Faraday?

8. What is methyl chloride used for in the secondary-cooled Servel?
9. What precautions must be taken with the kerosene in the intermittent units?
10. How is the cabinet temperature adjusted in the Servel refrigerator?
11. Why are two cooling coils used on the air-cooled Servel refrigerator?
12. Why was the liquid receiver in the Trukold placed above the cooling coil?
13. What was the refrigerant used in the Crosley Icy-Ball refrigerator?
14. What was the purpose of the tank on the top of the Superfex refrigerator?

Chapter 15

SERVICING ABSORPTION SYSTEMS

The absorption systems differ only in the mechanism for producing refrigeration. The cabinet construction is almost identical to the mechanical refrigerator cabinet and the installation and care of these cabinets is explained in Chapter 9.

15-1. GENERAL INSTRUCTIONS

The absorption refrigerator is a device to move heat from the interior of the cabinet to the outside of the cabinet. This outside heat is transmitted to the air and this air must be removed from the vicinity of the cabinet to allow cooler air to receive heat from the condensers.

Also the kerosene or the piped gas when burned form carbon dioxide gas (harmless) and steam vapor (harmless). However, to provide good air flow past the burner, these products of combustion must be moved away from the cabinet. Because warm gases rise, the absorption cabinets must have proper air flow space beneath, in back, and over the top of the cabinet.

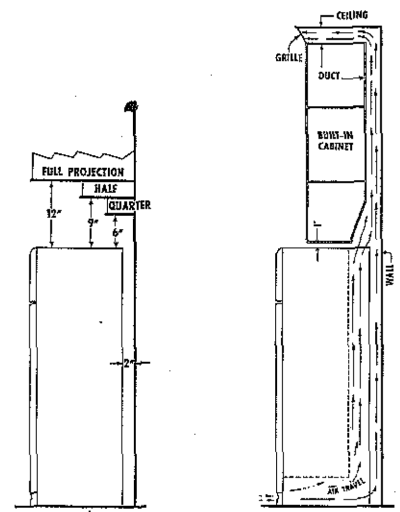
Inside the mechanism the liquids flow by gravity and the mechanism must be properly leveled or the movement of the liquids and gases inside the unit will be uncertain.

The condensers and flues of the unit must be kept clean to allow proper air flow and flue gas flow. It is recommended that the condensers and flues be cleaned at least twice each year.

15-2. LOCATION OF REFRIGERATOR

One should be careful in regards to locating the absorption refrigerator, Fig. 15-1.

1. It must be away from the sun or any other source of heat, for economical refrigeration.
2. It must be conveniently located indoors for efficient use.



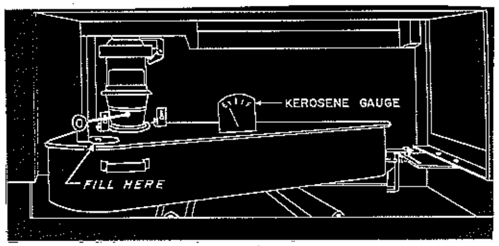
15-1. The proper location of an absorption refrigerator to allow good air circulation. (Servel, Inc.)

3. It must be placed in a room that has sufficient air movement to provide enough air for combustion and cooling.

4. It should be as near as possible to a gas supply if piped gas is to be used.

5. It must be mounted on a firm floor to maintain its position.

6. It must be mounted with the unit level to allow the mechanism liquids and gases to flow properly. A spirit level must be used to check for unit level. It is more important to level the cooling coil and the burner than it is to level the cabinet.



15-2. An absorption system kerosene burner. (Servel, Inc.)

15-3. AIR CIRCULATION

The air circulation is very important. Air must be able to freely enter the burner space and the condenser space. This same air must be able to return to the same room. If the air is ducted to another room or outside, air pressure changes may seriously hamper the operation of the flame.

Good air circulation can be easily obtained by allowing at least a 2 in. clearance in back of the refrigerator (small spaces may be used). At least 12 in. clearance must be provided above the cabinet to allow adequate escape of the condenser air and combustion products.

15-4. INTERMITTENT SYSTEMS

The intermittent systems that use a kerosene burner require very little servicing. They are manual in operation and eliminate controls by having the owner refill and light the kerosene burner. The previous instructions about air circulation and location of the cabinet also pertain to the kerosene heated units.

15-5. PROPERTIES OF KEROSENE

The kerosene needed with kerosene fired absorption units should be of the highest quality. It must burn as cleanly as possible to eliminate fuel odors and soot deposits in the flue. Kerosene is a hydro-carbon and when properly burned the products of combustion are carbon dioxide and steam. However those kerosenes with the higher flash point (up near 140F) are more likely to contain heavy carbons that may form free carbon or soot (amorphous carbon) on the flue or this soot may escape into the air. The kerosene has a heat value of about 19,000 Btu. per pound.

15-6. KEROSENE BURNERS

The kerosene burners used in the intermittent absorption refrigerators are of standard construction. A circular (cylindrical) asbestos wick carries the liquid kerosene by wetting action up to the upper edge of the wick. The height of the wick is adjustable. This wick should be in good condition, that is, it must be charred and then trimmed to match the guides. The wick must be perfectly level to its adjustable ring and the complete unit must be level, Figure 15-2.

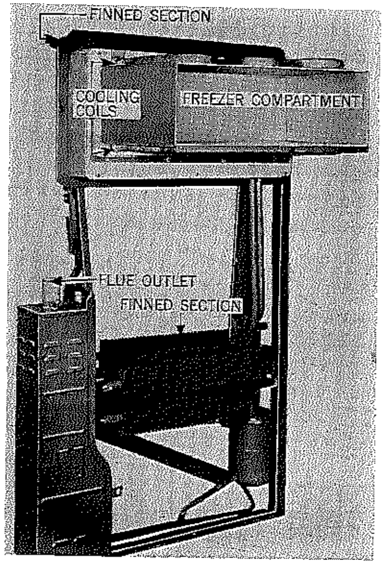
The correct flame, a blue flame with faint yellow tips is obtained by first raising the wick, igniting it, and then lowering the wick until the correct flame is obtained.

The burner must be accurately fitted to the generator flue. The distance must be closely adjusted. If the flame is too

far away, the flame will not be efficient because of excess air. If the burner is too close there will be insufficient air for good combustion.

15-7. FLUES

The heat from the burners must be efficiently transmitted into the generator. The kerosene flame and the hot gases from it are conducted along a flue that extends around the generator



15-3. The refrigerating system for a kerosene burning domestic refrigerator. (Servel, Inc.)

or through it. These flues sometimes have spiral metal fins inside them to make the hot gases more efficiently give up their heat to the flue walls.

Because these flues carry the combustion gases they must be kept open or the combustion will not be complete. The flues must also be kept clean or much of the heat will be lost by poor heat transmission into the generator. The flue should be cleaned at least twice each year. Special flue brushes should be used for this purpose.

15-8. CABINET CARE

The cabinets are serviced exactly like those described in Chapter 9. The cabinet leveling devices are the same, the door gaskets, and the door hardware is much the same, the shelf arrangement and design are the same.

Porcelain interiors and enamel exteriors are just like the other cabinets. The door gaskets can be checked for leaks with a light bulb.

15-9. CONTINUOUS SYSTEMS

At the present time there is only one continuous absorption system in the domestic refrigeration field. The Servel (or Electrolux as it used to be called). These units receive their energy from piped gas (either artificial or natural), bottled gas, electricity or kerosene, Fig. 15-3.

The piped gas systems are equipped with gas pressure regulators, thermostats for controlling flame size, burners and burner safety shut-offs.

There are now 56 different model R-4000 series available for replacement purposes for units dating as far back as 1933. No units were made during World War II 1943-44, and 45.

These units contain less than two pounds of ammonia and use the Platen Munters system as devised and patented by the two Swedish scientists. A five cubic foot refrigerator unit contains about 1.1 pounds of ammonia, 2.6 pounds of water and 0.03 pounds of hydrogen.

The refrigerators carry two identification plates. One plate is located in the control compartment and this one is the cabinet identification plate. The other plate is located in either the frozen food compartment or the control compartment. The latter has the

heading "Absorption Refrigerating Unit."

The units are factory tested to 800 psig. which is about four times their operating pressure.

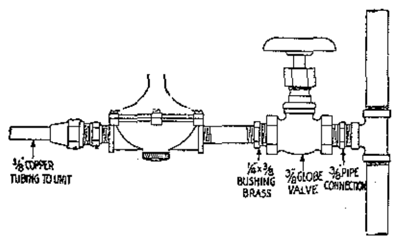
Each unit serial plate has the Btu rating of that system recorded on it.

The burner and the necessary controls are about the only parts that may need adjustment or replacement. If, however, a unit fails to operate and the trouble is not found to be in the burner or controls then the entire unit should be replaced. This is easily accomplished by removing the back from the cabinet, disconnecting the gas supply and electrical circuits and removing the entire assembly and replacing it with a new one.

15-10. GAS SUPPLY

The fuel most commonly used for the absorption system refrigerators is city or illuminating gas, although electrical heating elements are sometimes used. It must be clean fuel in order to prevent a pollution of the burner or deposit on the burners. The cleaner the fuel the less frequently the burners have to be cleaned.

The piped gas refrigerators should be supplied with gas under a steady



15-4. The gas line installation of an early model Servel refrigerator. (Servel, Inc.)

pressure and should have a special burner for each type of gas. The gas must be strained before being admitted to the burners and must also have a pressure regulator to insure an unvarying pressure on the burner, Fig. 15-4.

It is good practice to become acquainted with the local rules on installation of these refrigerators before attempting to install them.

In all cases of burner difficulty, a check should be made to determine that the burner being used is the correct one for the gas used.

The four different gases in use as a fuel for the Servel units are:

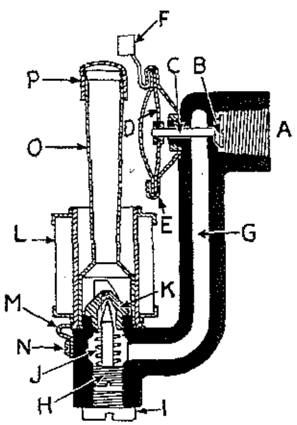
Artificial gas (425 to 600 Btu per cu. ft.)

Natural gas (600 to 1600 Btu per cu. ft.)

Liquid petroleum (LP) gas (1600 Btu per cu. ft.)

Propane gas (1600 Btu per cu. ft.)

Butane gas (1600 Btu per cu. ft.)



15-5. The "Klixon" valve and the burner used on the older model Servel units. A. Gas in; B. Poppet valve; C. Poppet valve stem; D. "Klixon" snap button; E. Retaining housing; F. Klixon disk heater; G. Gas passage to the burner; H. Manual adjusting screw for maximum gas flame; I. Seat cap; J. Spring; K. Gas nozzle; L. Screen; M. Screen retainer; N. Screen retainer screw; O. Burner venturi; P. Burner cap. (Servel, Inc.)

15-11. CONTINUOUS SYSTEM CONTROLS

The method of heating may be by

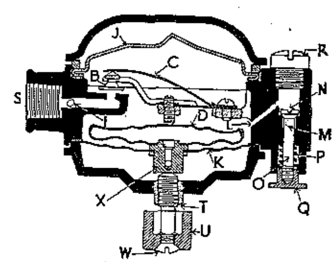
gas, liquid fuels, or electricity. At present gas is the most popular, and the method of controlling the supply is explained later.

Aside from cabinet care and cleaning, the only service (outside the factory) that may be needed on the refrigerator are heating controls. The adjustments determine the efficiency of the unit to such a great extent that these must be done carefully.

Heating gas valves are used in the absorption system to enable the automatic control of the amount of the heating gas.

The systems use a continuous gas flow.

The refrigerators must have a heating gas control of some kind. The Servel being of continuous operation, has a



15-6. The secondary system air-cooled Servel thermostatic gas control. B. Maximum flow valve; C. Maximum flow valve spring assembly; D. Thermostatic diaphragm; I. By-pass outlet; J. Body gasket sealing diaphragm; L. Burner lighter passage; M. Opening to burner lighter; N. Burner lighter valve; O. Burner lighter valve stem; P. Burner lighter valve stem; Q. Burner lighter push button; R. Burner lighter cap; S. Gas outlet; T. Thermostat adjusting screw; U. Thermostat adjusting screw knob; W. Set screw; X. Diaphragm and bulb assembly. (Servel, Inc.)

gas volume control and a safety control. A disk valve "Klixon," temperature-controlled by the flame itself, will automatically close the gas supply if the flame goes out, Figure 15-5. A bulb pressure-temperature control located at the cooling unit controls the amount of gas burned according to the needs of the refrigerator, Figure 15-6.

It is seen from the above explanation that a great deal of the successful operation of domestic refrigerators is dependent on the functioning of the automatic control valves; it is obvious that the more the service man knows of these valves and their troubles and remedies, the less difficult the servicing operations will be.

It is also important to know about these controls for the reason they must always be in excellent condition in order to give satisfactory, dependable service. It cannot be emphasized too much that these valves are the control board for the refrigerator.

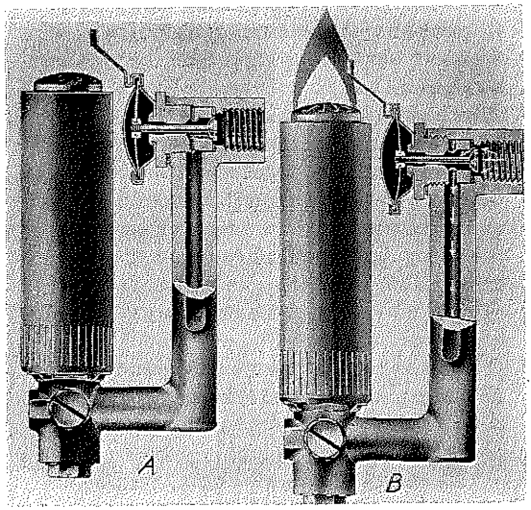
The Servel generally has its heat energy supplied by a gas burner. Several different methods have been devised for the regulation and control of this gas. In the Servel refrigerator, between the gas main and the operation controls of the refrigerator, are placed a manual shut-off valve, a strainer, and a pressure-regulating valve. As explained previously, the Servel operates on the continuous cycle and therefore gas is continually being consumed. However, to take care of variations of demand on the refrigerator itself, the amount of gas fired must be automatically controlled. This is done by the use of a pressure control valve operated by a power element located at the cooling unit. As the cooling unit warms up, the gases in the power element expand, and pressing upon a diaphragm in the control valve, open the gas control, which allows more gas to escape to the burner.

The larger flame speeds up the cycle in the mechanism and continues to speed it up until the cooling unit has again become cold enough.

As the cooling unit cools, the power element located there will cool, reducing the pressure on the gas valve diaphragm. This reduction closes the heating gas opening, somewhat reducing the size of the flame. This valve operates

similar to a temperature controlled expansion valve. Turning the adjustment clockwise or in, reduces the gas supply.

The Servel people have designed a unique valve for preventing useless waste of gas in case the flame should be extinguished. This valve is of the dished-button type and is thermostatically controlled, Figure 15-7. Being located adjacent to the flame it remains hot as long as the gas is ignited, but if the flame is extinguished, this disk will become cold; it is so designed that if it does it will snap and become dished in the other direction. This movement closes a valve in the gas line, completely shutting off the supply of the gas. If this happens, the only method possible of re-igniting the gas is to heat up this "Klixon" disk in order that it will open the safety valve again. This may be done with a match and a special burner push button mounted on the thermostat body provided for this purpose.

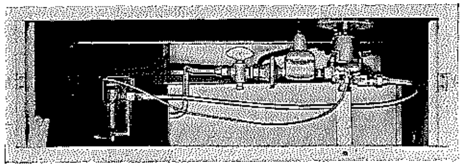


15-7. A safety shut off valve. This valve will close the gas line if the gas flame should accidentally be extinguished. A. Shows the valve in closed position; B. Shows the valve in open position.
(Servel, Inc.)

Each refrigerator has an automatic pressure control for maintaining a constant gas pressure. This valve reduces the fluctuation in pressures which always exist in the gas mains all over the country to a minimum. The supply of gas must be very constant when being fed to the Servel.

15-12. CONNECTING UNIT

The gas lines must be installed according to the local building laws, plumbing codes and recommendations. One should use the best materials available; all new materials; and the best craftsmanship.



15-8. A gas line installation for a Servel gas refrigerator. This installation varies as to the type generator used.

The gas line should be either 3/8 in. O. D. copper tubing (soft) or 3/8 in. O. D. annealed aluminum tubing. The tubing should be attached to the main gas line as close to the refrigerator as possible. The tubing must be protected from abuse. It should be protected from kinking or bending and it should be protected from heavy objects to prevent crushing. A hand shut off should be installed between the main gas line and the tubing.

At the refrigerator end the tubing has a hand shut off cock. The tubing is fastened by means of the 45° SAE flare to the end fittings, Figure 15-8.

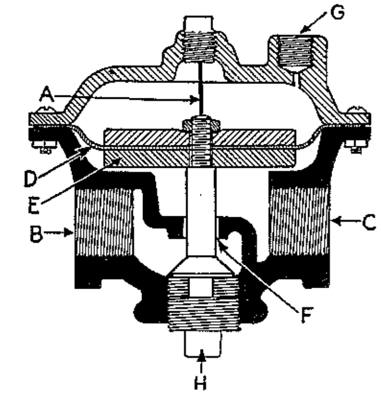
A strainer is mounted at the outlet of the shut-off cock. This strainer is of very fine mesh and it removes any dust or dirt that might injure the pressure regulator and thermostatic control.

The gas now passes through a pressure regulator to the thermostatic control, then to the burner.

After the installation is complete all the joints must be tested for leaks with a soap and water solution while under pressure and before lighting the burner.

15-13. PRESSURE REGULATING VALVES

The purpose of the pressure regulating valve is to supply a steady flow of gas to the burner. If the burner gas



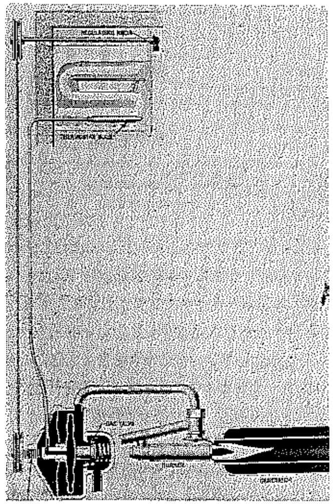
15-9. A pressure regulating valve for gas. A. Shipping pin; B. Gas in; C. Gas connection to the thermostatic control; D. Flexible diaphragm; E. Weights; F. Valve and seat; G. Bleeder Connection; H. Valve cap.
(Servel, Inc.)

pressure should change, the flame would change and may even be extinguished.

The pressure regulator both reduces the pressure and provides a constant gas pressure, Fig. 15-9.

Liquid petroleum (LP) gases do not need a pressure regulator at the refrigerator because the pressure regulator mounted on the LP cylinder performs the same duty.

The pressure regulator operates much as an expansion valve does. The outlet pressure presses against a diaphragm (synthetic rubber, fabric reinforced) and if the pressure attempts to lower the diaphragm will move, opening the gas valve allowing more gas to flow. The increased gas flow will press the diaphragm up tending to close the valve. The pressure regulator is very delicate. It is accurate to 1/100 of an inch water pressure. The pressures the regulator has to maintain vary from 3.9 inches of water to 1.6. This pressure needed varies with gas flow in cu-ft per hour. This gas flow is controlled by the orifice size in the burner. The pressure also varies with the density or specific gravity of the gas. The greater the gas flow the greater the pressure needed. The pressures must be adjusted to within .1 inch water pressure for good results.



15-10. A diagram of the operation of the thermostat on the Servel refrigerator.
(Servel, Inc.)

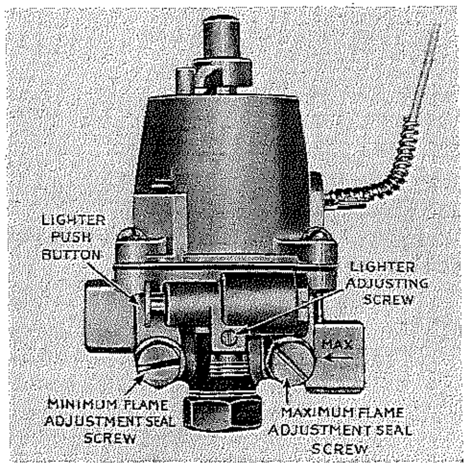
The Servel company should be consulted in reference to the best gas pressures for each particular refrigerator. They use different capacity

orifices to enable them to bring the units to maximum efficiency.

15-14. THERMOSTAT

The mechanism varies the amount of cooling by varying the amount of heat. The more heat fed to the generator the cooler the evaporator will become. A thermostat is used to perform this job. A thermal bulb clamped to the cooling coil will create pressure if the cooling coil becomes warmer. This pressure is carried to a diaphragm by a capillary tube. An increase of pressure in the diaphragm opens the gas valve and more gas flows to the burner, Fig. 15-10.

The increased cooling resulting from the added heat will cool the thermal bulb and the diaphragm pressure will decrease, closing the valve. This control was put on 1947 models and later. Note the capillary tube, the temperature adjusting knob on the top of the body, and the minimum and maximum devices located on the body, Fig. 15-11.



15-11. The Servel thermostat showing adjustments and lighter push button.
(Servel, Inc.)

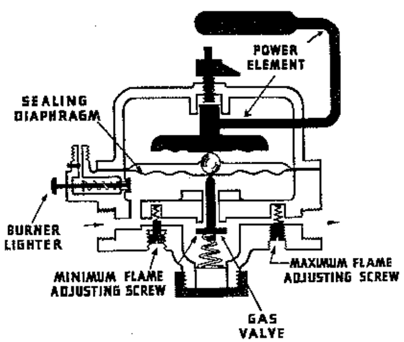
The inner working of the thermostat is shown in Figure 15-12. This illustration shows the construction of the minimum and maximum flame adjustments, and also the details of the burner lighter mechanism.

The amount of primary air is adjustable. The outer casing of the burner, called the air shutter barrel, can be turned. It should be very carefully adjusted to give an all-blue-flame just as the yellow disappears from the flame. Too much primary air will also give a blue flame but the flame cone will be sharp and the flames will hiss more sharply.

15-15. BURNER

The burner is the mechanism used to carefully mix the air with gas in the proper proportion and burn the mixture to provide the most efficient heat. It is basically a Bunsen type burner, Figure 15-13.

The gas enters at the top, travels past the safety valve and passes through the turbulator, through the carefully sized orifice sperd, mixes with the primary air, burns at the end of the mixing tube where the secondary air and the heat enters the generator tube and flue. The fitting at the lower right (at the bottom) is the opening that is connected to a manometer to check the gas pressure.

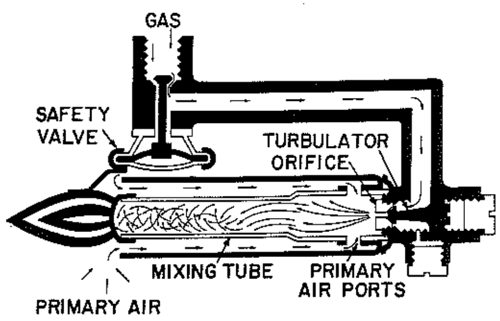


15-12. A sectional diagrammatic view of the Servel thermostat. The gas flows from left to right. Note the burner lighter button and mechanism.
(Servel, Inc.)

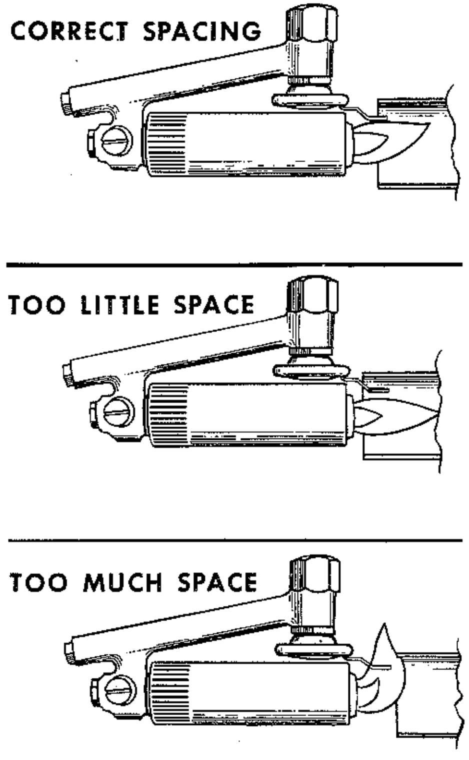
Four different types of burners are available, each for a different kind of gas. Type A is for fast burning gases and Type D is for liquified petroleum (LP) (bottled) gas.

The turbulator is available in different models; one groove type is for L P gases, the two groove type is for piped gases.

The burner must be exactly the right distance from the generator flue to obtain the correct amount of secondary air, Figure 15-14.



15-13. A sectional view of the horizontal type burner, the safety valve and the flame.
(Servel, Inc.)



15-14. The effect of burner spacing on the minimum flame.
(Servel, Inc.)

The burner can be adjusted to the distance it is mounted from the generator flue and it can also be moved to center the flame in the center of the generator flue. The flame must never touch the flue. Use a mirror if it is difficult to see the flame location.

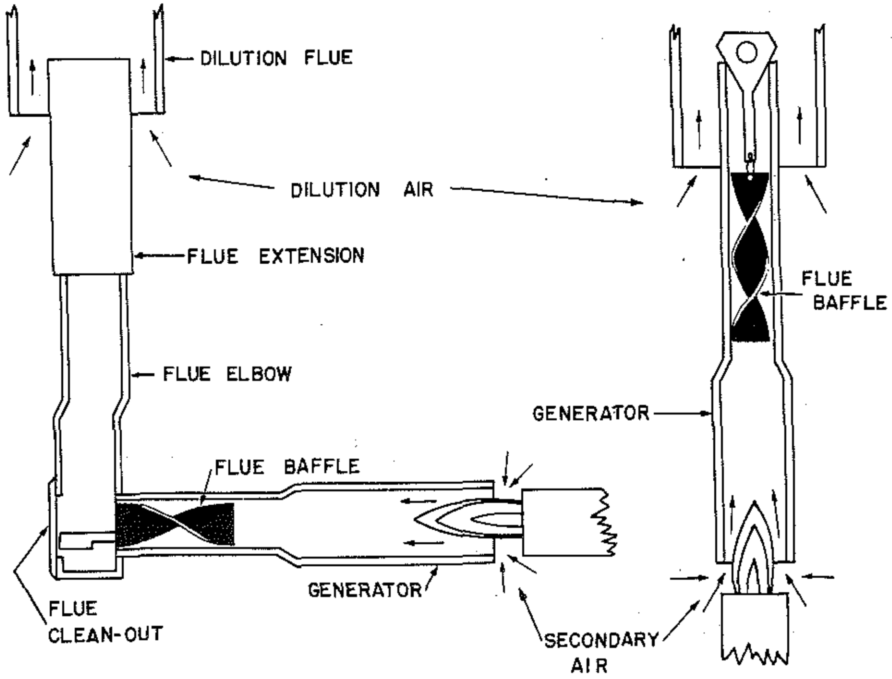
The products of combustion are harmless and there is no odor.

15-16. BURNER SAFETY VALVE

It is very unlikely the burner flame will ever be snuffed out. But if someone should shut off the gas accidentally and then turn it on or if someone accidentally puts out the flame by spilling mopping water the burner has a positive safety device that prevents unburned gas from escaping.

This safety valve is operated by the flame. A metal plate touches this flame and becomes quite hot. This heat is transmitted to a bi-metal disc, which will move with a snap action and open the gas valve when hot. If this disc cools somewhat the bi-metal disc will dish the other way pulling the valve shut and stopping all gas flow.

It is important that the heat conductor strip be kept up against the outer edge of the flame.



15-15. The flue construction for both the horizontal and the vertical generator type Servel units. (Servel, Inc.)

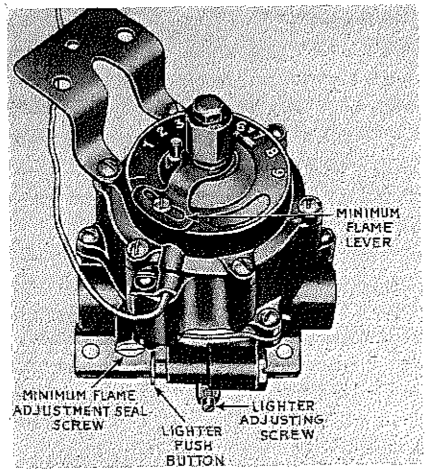
15-17. FLUE

The flue is a circular passage through the generator and then up the back of the unit. Its purpose is to provide passage for the flame gases. It must work efficiently to provide enough air movement to allow the flame to operate correctly, Figure 15-15.

The first section of the flue is within the generator itself. This is the heat transfer surface and the hot gases must transfer as much heat as possible to the generator. A twisted metal flue baffle is inserted in this part of the flue to twist the hot gases to make this heat transfer efficient.

This baffle is removable and movable. It can be used to clean out the flue periodically by moving in and out of the generator flue (it is best to turn the thermostat to minimum flame during this operation).

The second section of the flue is the



15-16. A semi-automatic defrosting thermostat for Servel units. (Servel, Inc.)

flue extension. An air opening is provided where the two meet. This opening permits dilution air to enter the

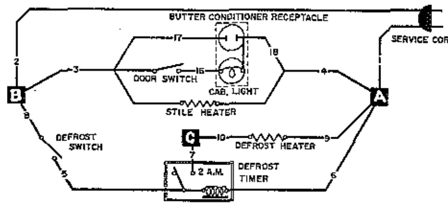
flue. This flue is basically the chimney and it must be kept clean to insure correct air movement.

15-18. AUTOMATIC DEFROSTER

Several models of the Servel continuous system have defrosting devices.

The semi-automatic defroster consists of setting the thermostat to a minimum flame (or defrost position) and when the cooling coil has defrosted, the thermostat will automatically start normal operation again, Figure 15-16.

The automatic defroster is controlled by an electric timer. At whatever time the owner prefers usually



15-17. A wiring diagram of the automatic defrosting system. (Servel, Inc.)

in the early morning hours (1 a.m.) the electric clock stops the operation of the thermostat and sends electrical energy through resistance wires located under the cooling coil. The heat from these wires quickly defrosts the outer portion of the cooling coil without disturbing the frozen foods within the coil. When the coil is defrosted, the system automatically returns to normal operation, Figure 15-17.

15-19. ICE CUBE MAKER

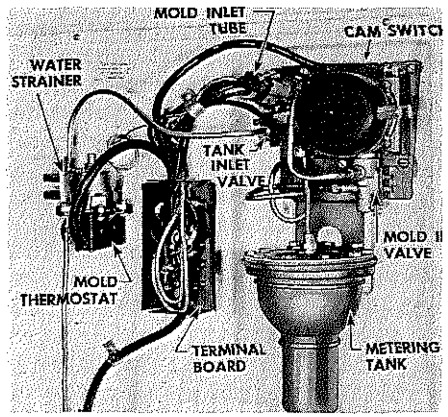
Some of the Servel units have a device which automatically manufactures ice cubes as they are needed.

A wire basket is used to hold the ice cubes. If this basket is not full, an electrical circuit is closed which opens a water valve and fills the ice cube freezer trays. When the water is at the correct level, the water flow stops, Figure 15-18. Then when the water is frozen, a thermostat closes a heating circuit to loosen the ice cubes, a small electric motor rotates the ice cube apparatus and the cubes are unloaded into the basket. If the basket is still not full, the cycle is repeated.

15-20. SERVICING THE SERVEL

It is strongly recommended that one take training from a Servel service engineer before attempting to service the Servel units.

The most important observation to be made in servicing the Servel gas-fired refrigerator is to determine that the gas furnished the refrigerator is supplied in the correct amounts and pressure.



15-18. The Servel automatic ice cube maker. (Servel, Inc.)

The amount of gas fed to the refrigerator may be checked by the size of the flame and may be adjusted by the use of the automatic temperature-

controlled gas valve which has a manual adjustment on it. Always check the gas pressure using the water filled manometer. The flue must be kept perfectly clean to allow a good transfer of heat. Brushes are used for cleaning the flue.

The fins on the ammonia condenser, and, or the absorber must be cleaned periodically to insure good heat removal from these surfaces.

First, temperature control dial set too cold which may be the case when the customer has not been properly instructed in its use.

Secondly, the temperature of the cooling unit may be lower than that indicated by the temperature control dial setting.

A time temperature graph should be taken of such a machine which will tell much more clearly what is wrong.

15-23. LITTLE OR NO REFRIGERATION

Little or no refrigeration may be due to an overloaded cabinet but if this is not the trouble, it may be due to one of the following: little or no refrigeration is due principally to either improper condensing temperatures, or little or no heating of the generating unit. If the condenser or absorber are dirt and lint covered, poor refrigeration will result, due to the high temperature of these two parts.

If the gas supply has been shut off, or if the line has become clogged, resulting in a very small consumption of gas there is naturally little or no refrigeration. This trouble may be traced by checking the gas pressures at the burner.

Two other reasons for poor heat transfer or poor heating of the generating unit are: a restricted gas flue, or an insulated gas flue. After a certain period of use the flue of the generator may become coated with a soot deposit, preventing a rapid transfer of heat from the gas flame to the generator body. This soot deposit should be removed periodically (1-2 months) to insure proper refrigeration and to reduce gas consumption.

When scraping the flue of a generator or when removing the soot from any surface of the generator, considerable care should be taken to prevent injury to the surface. Always put papers or a cloth under the refrigerator when cleaning the flues. The gas-fired and kerosene-fired refrigerators are equipped with flues to direct the hot gases around and away from the generating units. Occasionally these flues are clogged by placing the refrigerator too close to the wall, by placing objects over the opening, or by having some obstruction fall into it. These flues must be kept clean to insure proper functioning of the refrigerator.

A Servel unit which has not been used for a period of time may refuse to freeze when started. To remedy this trouble, remove the unit from the cabinet and invert it for approximately 1/2 to 1 hour. Right the unit and install it in the cabinet.

15-24. REVIEW QUESTIONS

1. Why must the absorption unit be leveled?
2. How is proper air flow obtained?
3. Is kerosene sometimes used as the fuel for continuous systems?
4. What is a flue?
5. How is the gas pressure in a piped gas system measured?
6. Why don't L P systems need a pressure regulator in the base of the cabinet?
7. How is the temperature regulated in a piped gas continuous system?
8. Why doesn't the flame go out when the cabinet is cold enough on the continuous piped gas systems?
9. What are the two basic causes for insufficient refrigeration in a continuous system?
10. How are some of the Servel units automatically defrosted?