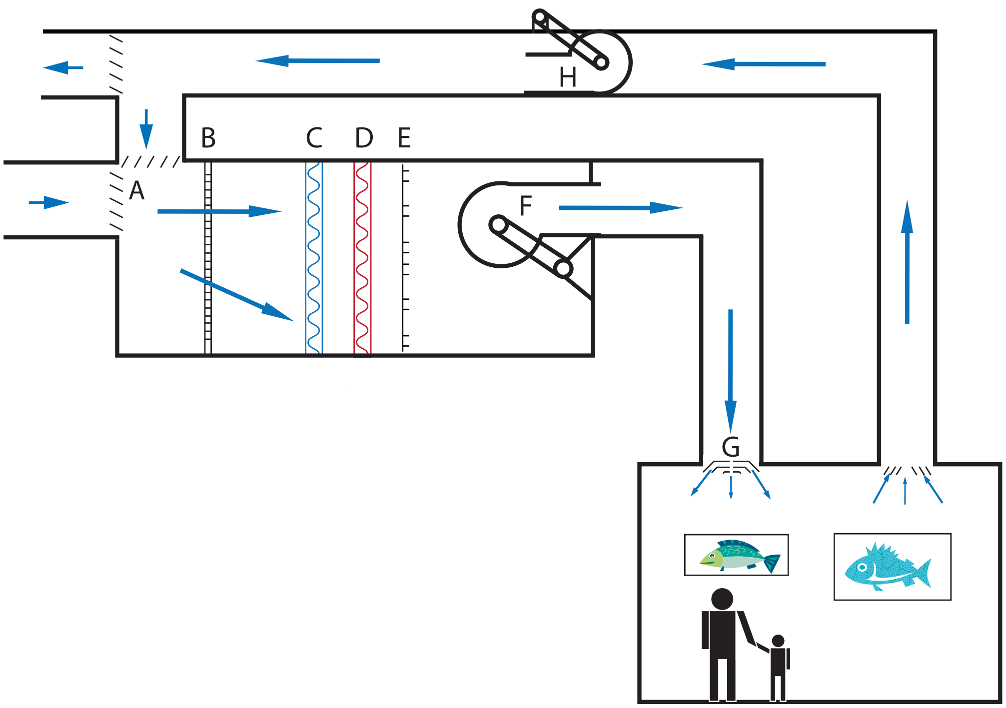
Air Handling System

Components/Layout:

A: Dampers
B: Filters
C: Cooling Coil
D: Heating Coil
E: Humidifier
F: Supply Fan
G: Diffusers
H: Return Fan



Air Flow:

Air enters the system from the outside through an air duct and is mixed just before the filters with return air from the space. The mixed air is pulled through a set of filters (B) where impurities like particulates and gaseous pollutants are removed. As the air moves forward, it passes over a set of cooling coils (C), where the air is cooled, and depending on the dew point of the passing air, may be dehumidified. The air then passes over a set of heating coils (D) where it is heated to the required temperature if necessary. Following the heating coil the air will pass over a set of humidification tubes (E). If the relative humidity of the passing air is too low these tubes will add moisture to the air as it passes. After the humidifier, the air is pulled into the supply fan (F), which then pushes it through the supply ductwork, through the diffusers (G) and into the space. The return fan (H) pulls air from the space and pulls it through the return ductwork. Finally, the air is either exhausted to the outside or returned to the unit to be mixed with new outside air and start the cycle all over again.

Refrigerant/Heating Supply:

The cooling coils are fed from a source of cooling, such as chillers, a cooling tower, or DX unit. The refrigerant enters the cooling coils, absorbs heat from the air passing the coils, and returns to its source to desorb the heat that it took in. The heating coils are fed from a heat source such as a boiler or electricity. The heat from these coils is transferred to the air passing over it.

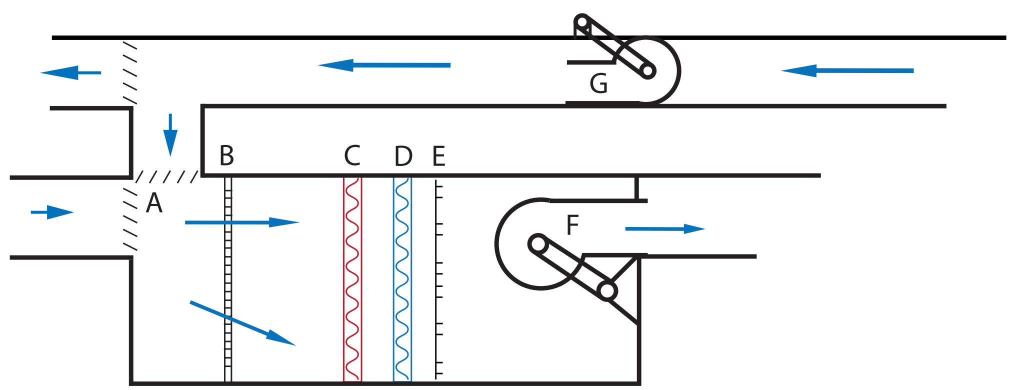
System Variations:

1. A system may have multiple sets of filters to remove different levels of impurities.
2. The arrangement of the cooling coil and heating coil may vary from unit to unit.
3. A cooling coil may not be present in every unit or may be before the outside air dampers for pre-cooling.
4. A heating coil may not be present in every unit.
5. The main heating coil may be farther down the line in the ductwork in what is called a reheat. As a reheat the coil will heat air for a specific space just before it is discharged from the ducts.
6. A system may utilize a bypass setup where the air can be diverted past the coil(s) if it does not need to be treated.
7. Humidification tubes may not be present in every unit or may be farther down in the ductwork just before the diffusers.
8. A return fan may not be present on every unit if the supply fan creates enough of a draw to pull the air back through the space.

Heating/Cooling System

Components/Layout:

A: Dampers
B: Filters
C: Heating Coil
D: Cooling Coil
E: Humidifier
F: Supply Fan
G: Return Fan



Air Flow:

This type of unit is most common in environments where moisture removal from the air is not much of a concern. Starting at the outside air intake, air enters the outside air duct and is mixed with return air from the space just before the filters (B). This mixed air is pulled through a set of filters where impurities are removed. The air then passes over a set of heating coils (C) where it is heated to the required temperature if necessary. Next the air passes over a set of cooling coils (D); here it is sensibly cooled to the desired temperature if necessary. After the cooling coil the air passes over a set of humidification tubes. If the relative humidity of the air is too low these tubes will add moisture to the air as it passes. After the humidifiers, the air is pulled into the supply fan (F), which pushes it through the supply ductwork, through the diffusers and into the space. The return fan (G) will pull in air from the space and push it through the return ductwork. The air is either exhausted or returned to the unit to be mixed with outside air and start the cycle all over again.

Refrigerant/Heating Supply:

The cooling coils are fed from a source of cooling, such as chillers, a cooling tower, or DX unit. The refrigerant enters the cooling coils, absorbs heat from the air passing the coils, and returns to the source to desorb the heat that it took in.

The heating coils are fed from a heat source such as a boiler or electricity. The heat from these coils is transferred to the air passing over it.

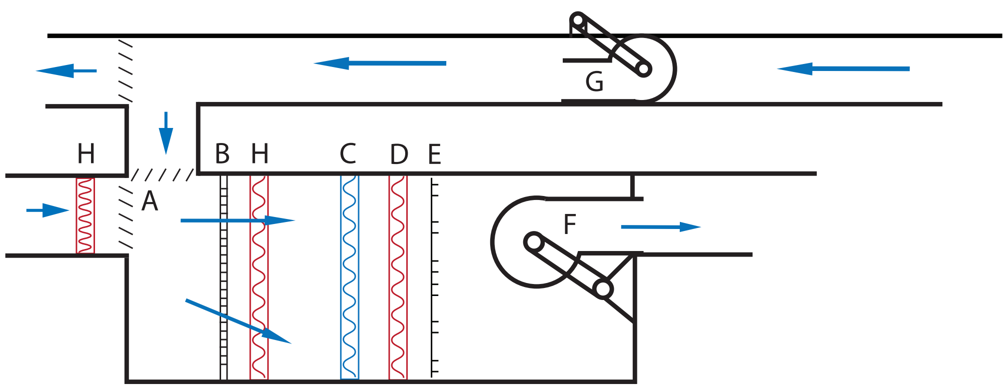
System Variations:

1. A system may have multiple sets of filters to remove different levels of impurities.
2. A cooling coil may be before the outside air dampers for pre-cooling.
3. The system may utilize a bypass setup where the air can be diverted past the coil(s) if it does not need to be treated.
4. Humidification tubes may not be present in every unit or may be farther down in the ductwork just before the diffusers.
5. A return fan may not be present on every unit if the supply fan creates enough of a draw to pull the air back through the system.

Preheat System

Components/Layout:

A: Dampers
B: Filters
C: Cooling Coil
D: Heating Coil
E: Humidifier
F: Supply Fan
G: Return Fan
H: Preheat Coils



Air Flow:

This system is a standard air handling unit that utilizes a preheat coil (H). This coil should only operate during the winter months, if the outside air is below freezing. The goal of this coil is to preheat the incoming outside or mixed air to prevent the cooling coil (C) from freezing. These units are typically found in colder regions where there is greater risk of low winter temperatures. Starting at the outside air intake, air enters the outside air duct and is heated by the pre-heat coil. The air is then mixed with return air from the space just before the filters (B). This mixed air is pulled through a set of filters where impurities are removed. As the air moves it passes over a set of cooling coils (C), here the air is cooled and depending on the dew point of the passing air, may be dehumidified. The air then passes over a set of heating coils (D) where it is heated to the required temperature if necessary. Following the heating coil the air will pass over a set of humidification tubes (E). If the relative humidity of the passing air is too low these tubes will add moisture to the air as it passes. After humidification, the air is pulled through the supply fan (F), which will push it through the supply ductwork, through the diffusers and into the space. The return fan (G) then pulls in air from the space and pushes it through the return ductwork. The air is either exhausted or returned to the unit to be mixed with outside air and start the cycle all over again.

Refrigerant/Coolant Cycle:

The cooling coils are fed from a source of cooling, such as chillers, a cooling tower, or DX unit. The refrigerant enters the cooling coils, absorbs heat from the passing air, and returns to its source to desorb the heat that it took in.

The heating coils are fed from a heat source such as a boiler or electricity. The heat from these coils is transferred to the air passing over it.

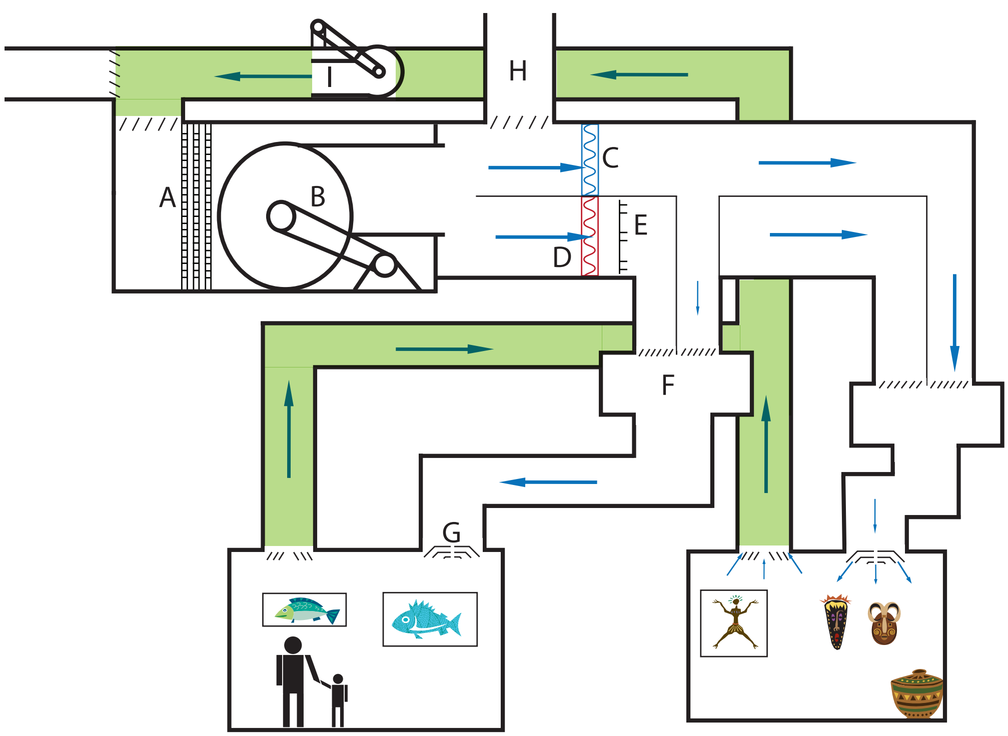
System Variations:

1. A system may have multiple sets of filters to remove different levels of impurities.
2. The preheat location may be directly at the outside air intake or after the mixed air chamber.
3. The main heating coil may be farther down the line in the ductwork in what is called a reheat. As a reheat the coil will heat air for a specific space just before it is discharged from the ducts.
4. A system may utilize a bypass setup where the air can be diverted past the coil(s) if it does not need to be treated.
5. Humidification tubes may not be present in every unit or may be farther down in the ductwork just before the diffusers.
6. A return fan may not be present on every unit if the supply fan creates enough of a draw to pull the air back through the space.

Dual Duct Air Handling Unit

Components/Layout:

A: Filters
B: Supply Fan
C: Cooling Coil
D: Heating Coil
E: Humidifier
F: Mixing Box
G: Diffuser
H: Outside Air
I: Return Fan



Air Flow:

Starting at point A on the diagram above, return air passes through the filters on the system and is drawn into the supply fan. The air is then pushed into the dual duct section of the unit. It will now separate into two ducts, one that will handle the heating functions and one that will handle the cooling functions:

Route One/Cooling – Air enters into the cooling duct (C). Here the air is mixed with outside air. This air now becomes a mixed condition of return air and outside air and passes over the cooling coil. Here the air is cooled and, depending on the dew point of the passing air, may be dehumidified. After passing over the cooling coil the air will proceed through the ductwork and be mixed with the heated air in a mixing box (F).

Route Two/Heating – Air enters into the heating duct (D). Here the air will pass over a set of heating coils that heat the passing air. Next it passes over the humidifier. If the relative humidity of the passing air is too low the humidifier will add moisture to the air and will continue moving through the ductwork towards the mixing box (F).

At the Mixing Box – The mixing box is the location in the ductwork where the heating and cooling ducts combine. Here the heated air is mixed with cooled air to achieve the desired temperature for the space. The mixing of air is controlled by a sensor that adjusts dampers on the entering heating or cooling air, opening or closing them, to ensure that the right mix of air is used to create the desired supply temperature.

After the mixing box, the mixed air continues down the ductwork. The air passes through the diffuser (G) and enters the space. Eventually the air is drawn back into the return ductwork and pushed through the return fan (I). From here it will either be exhausted or returned to the start of the system to begin the process again.

Refrigerant/Heating Supply:

The cooling coils are fed from a source of cooling such as chillers, a cooling tower, or DX unit. The refrigerant enters the cooling coils, absorbs heat from the passing air, and returns to its source to desorb the heat that it took in.

The heating coils are fed from a heat source such as boiler or electricity. The heat from these coils is transferred to the air passing over it.

System Variations:

1. An outside air duct can be found either before the cooling coil or before the filters on the air handling unit, depending on the design.
2. A system may have multiple sets of filters to remove different levels of impurities.
3. If the outside air duct is before the cooling coil the filters may be located before the outside air damper or cooling coil to treat the new air coming into the system.
4. A system may utilize a bypass setup where the air can be diverted past the coil(s) if it does not need to be treated.
5. Humidification tubes may not be present in every unit. A humidification coil may also be present after the cooling coil.
6. A return fan may not be present on every unit if the supply fan creates enough of a draw to pull the air back through the space.

Variable Air Volume (VAV) System

Components/Layout:

A: Heating Coils

B: Air Flow Sensor

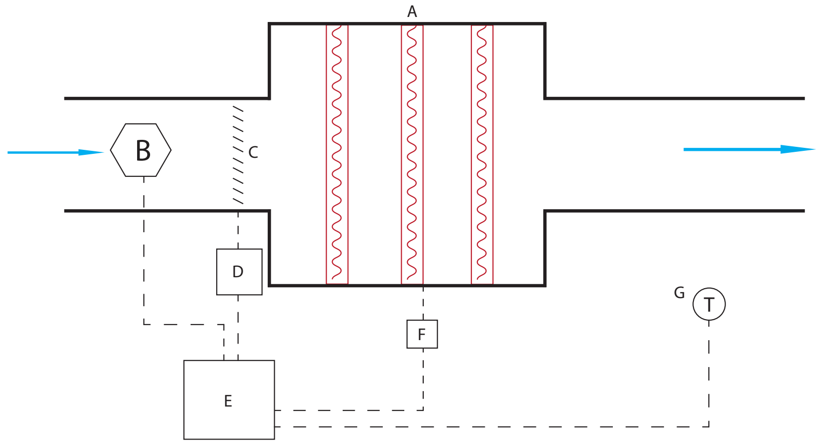
C: Dampers

D: Actuator

E: Controller

F: Contactors

G: Thermostat



Air Flow:

VAV stands for variable air volume, and VAV boxes may be a part of an air handling system. They are located in ductwork before the air reaches a designated space. Primary air from the air handling unit is pushed downstream to a VAV box. Just before the VAV box there are a set of dampers (C). These dampers are controlled by an air flow sensor (B) or a space thermostat (G) that will command the actuator (D) to open or close to adjust the volume of air that is pushed across the heating coils (optional). When air enters a VAV the heating coils inside will heat the air if necessary. As the air is heated it is pushed out of the VAV box and delivered to the space as secondary air. If no heating is required the contactor will not activate the heating coils and the air passes on with no heating.

System Variations:

1. A heating coil may not be present in every unit.
2. A fan may be located inside the VAV to increase air velocity when air volume is low.
3. In some cases a humidifier may be present.

Direct Expansion (DX) Individual Air Conditioning System

Components/Layout:

A: Condenser Coil

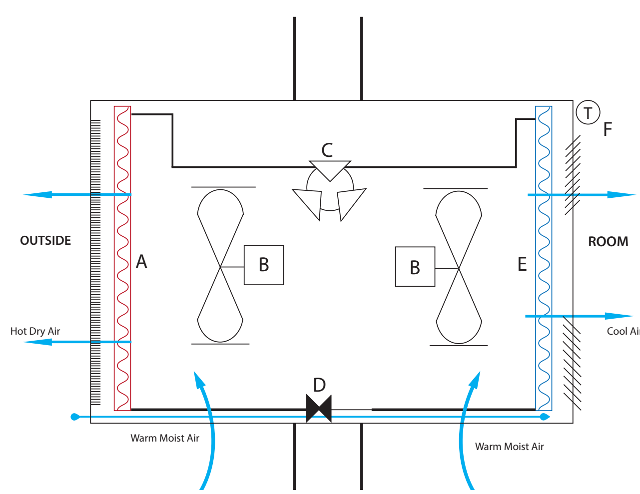
B: Fans

C: Compressor

D: Expansion Valve

E: Evaporator Coil

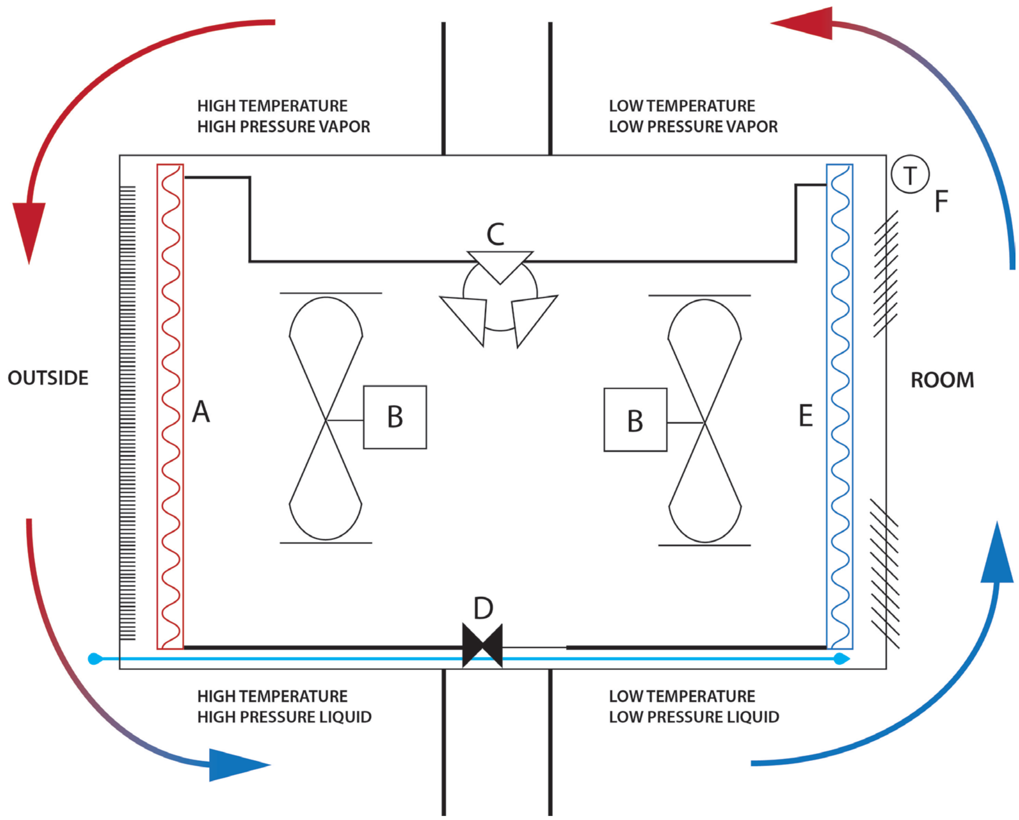
F: Thermostat



Air Flow:

Inside the space air is drawn in through the sides of the unit. This air is pushed across the evaporator (cooling) coils where it is cooled to the desired temperature for the room and pushed out the dampers on the front of the unit. The system is designed to sensibly cool the passing air, any dehumidification that may occur is a byproduct of this action. As the air is treated it may lose some of its moisture in the process, but the exiting cooler air will have higher relative humidity than the entering air.

On the outside portion of the unit, outside air is drawn in from the sides of the unit. This air is pushed by a fan across the condenser coils where the passing air will absorb the heat from the coils and be expelled out the rear of the unit. The expelled air will be hotter and drier than the outside air.



Refrigerant/Coolant Cycle:

Beginning just after the expansion valve (D) the refrigerant starts off as a low temperature, low pressure liquid. Under this low pressure condition the refrigerant has a low boiling point. The refrigerant is pushed through the evaporator coil (E) where it absorbs heat from the warm air that is passing over the coils. The heat absorbed by the warm air causes the refrigerant to boil and become a vapor. The refrigerant continues through the system toward the compressor (C). As it enters the compressor the refrigerant is now a low temperature, low pressure vapor.

The refrigerant enters the compressor where it is pressurized into a high temperature, high pressure vapor. The refrigerant is now under very high pressure and has a high boiling point. At these conditions, the refrigerant can condense easily. As the refrigerant moves through the condenser coil (A) the fan inside the unit is pushing air across the coils. The refrigerant will expel heat to the passing air as it is pushed though the fins by the fan. The passing air will absorb the heat, causing the refrigerant to cool and condense into a liquid. The high-pressure liquid moves towards the outlet of the condenser, the expansion valve (D). The refrigerant will enter the valve as a high temperature, high pressure liquid. The valve will allow the pressure of the refrigerant to change and the refrigerant will exit the valve as a low temperature, low pressure liquid and start the process over again.

Note:

"Cold" is not created in this process. Refrigerant was used to transfer heat from the inside air to the outside air.

System Variations:

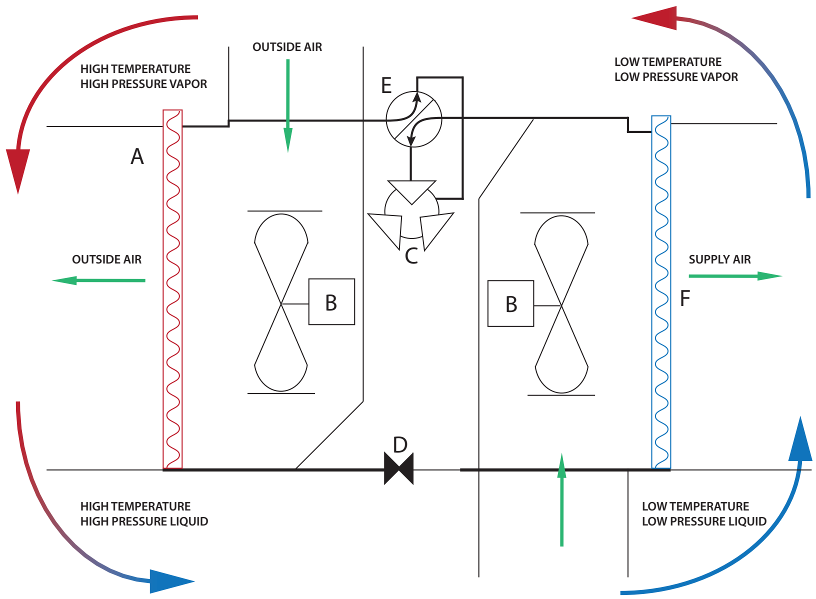
1. Unit may be a stand-alone air conditioning unit with a ducted exhaust.
2. Filters may be located on the sides of the unit to treat the incoming air.

Heat Pump

Components/Layout:

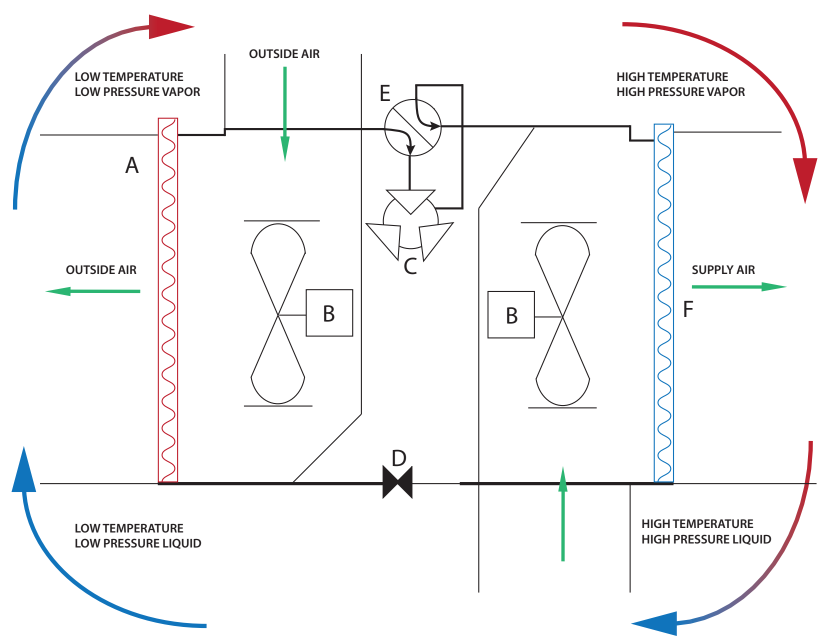
(Cooling Mode Diagram A)

A: Condenser Coil
B: Fan
C: Compressor
D: Expansion Valve
E: Reversing Valve
F: Evaporator Coil



(Heating Mode Diagram B)

A: Evaporator Coil
B: Fan
C: Compressor
D: Expansion Valve
E: Reversing Valve
F: Condenser Coil



Air Flow:

The system operates similar to the way a DX air conditioner works. The major difference is that it is capable of reversing the flow of refrigerant. The reversal of flow makes the unit capable of heating or cooling a space.

Cooling Mode Diagram A:

Air is drawn into the system by the fan through a return duct from the space. The air is pushed across the evaporator (cooling) coil where the air is cooled and returned to the space through the supply ducts.

The condensing coil is cooled by a second set of ductwork that brings in outside air and pushes it across the condenser (heating) coil where the refrigerant desorbs its extra heat to the air. The air is then discharged out of the unit.

Heating Mode Diagram B:

Air is drawn into the system through the return duct from the space by the fan. The air is pushed across the condenser (heating) coil where the air is heated and returned to the space through the supply ducts.

The evaporator coil is treated by a second set of ductwork that will bring in outside air and push it across the evaporator (cooling) coil where the refrigerant absorbs heat from the air. The colder air is then discharged out of the unit.

Refrigerant/Coolant Cycle:

Cooling Cycle Diagram A:

The refrigerant in this cycle will move in a counterclockwise pattern, following the blue arrows in Diagram A for refrigerant flow in cooling mode. Beginning just after the expansion valve (D) the refrigerant starts off as a low temperature, low pressure liquid. Under this low pressure condition the refrigerant has a low boiling point. The refrigerant is pushed through the evaporator coil (F) where it absorbs heat from the warm air that is passing over the coils. The heat absorbed by the warm air causes the refrigerant to boil and become a vapor. The refrigerant continues through the system toward the compressor (C), note the position of the reversing valve. As it enters the compressor the refrigerant is a low temperature, low pressure vapor.

The refrigerant enters the compressor where it is pressurized into a high temperature, high pressure vapor. The refrigerant is now under very high pressure and has a high boiling point. At these conditions, the refrigerant can condense easily. As the refrigerant moves through the condenser coil (A) the fan (B) inside the unit is pushing air across the coils. The refrigerant will expel heat to the passing air as it is pushed though the fins by the fan. The passing air will absorb the heat, causing the refrigerant to cool and condense into a liquid. The high-pressure liquid moves towards the outlet of the condenser, the expansion valve. The refrigerant will enter the valve as a high temperature, high pressure liquid. The valve will allow the pressure of the refrigerant to change and the refrigerant will exit the valve as a low temperature, low pressure liquid and start the process over again.

Heating Cycle Diagram B:

The refrigerant in this cycle will move in a clockwise pattern, following the blue arrows in Diagram B for refrigerant flow in heating mode. Beginning just after the expansion valve (D) the refrigerant starts off as a low temperature, low pressure liquid. Under this low pressure condition the refrigerant has a low boiling point. The refrigerant is pushed through the evaporator coil (A) where it then absorbs heat from the warm air that is passing over the coils. The heat absorbed by the air causes the refrigerant to boil and become a vapor. The refrigerant continues through the system toward the compressor (C), note the position of the reversing valve. The refrigerant is a low temperature, low pressure vapor.

The refrigerant enters the compressor where it is pressurized into a high temperature, high pressure vapor. The high pressure refrigerant has a high boiling point and can condense easier. As the refrigerant moves through the condenser coil (F) it expels heat to the air that is pushed though the fins on the coils by the fan (B). The passing air will absorb the heat causing the refrigerant to cool and condense into a liquid. The warmer air will be exhausted into the space. The high-pressure liquid refrigerant moves towards the outlet of the condenser, the expansion valve. The refrigerant will pass through the valve as a high temperature, high pressure liquid and it will come out as a low temperature, low pressure liquid and start the process over again.

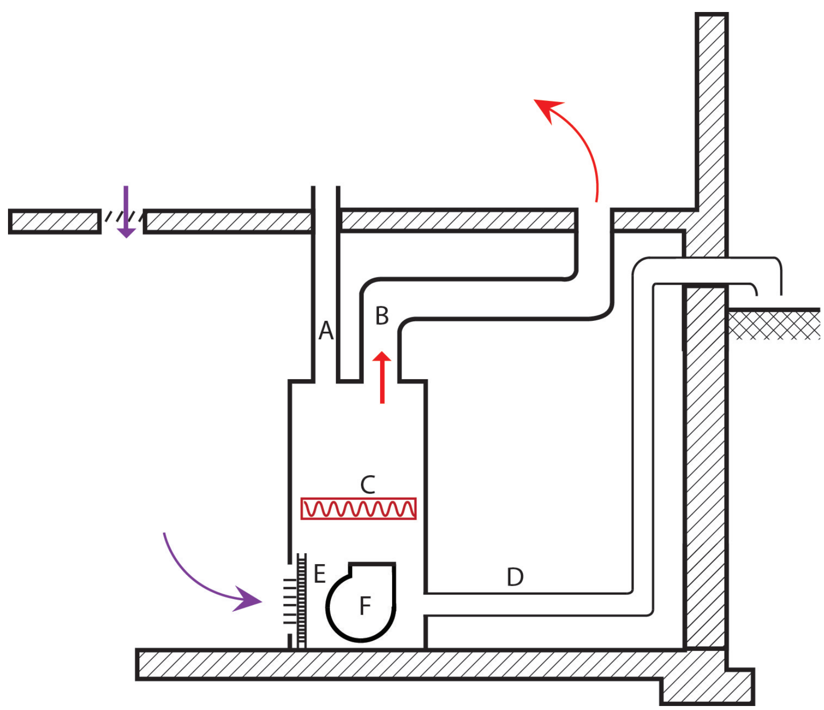
System Variations:

1. The setup and layout of a heat pump can vary depending on the design and manufacturer.
2. The discharge side of the unit may be located outside of the building while the supply side is located inside the building.
3. Depending on design the discharge side of the heat pump may be treated by water or outside air.
4. The overall unit may be built as a complete all-in-one box unit or as two separate units connected by refrigerant lines.

Forced Air Furnace

Components/Layout:

A: Vent
B: Supply Duct
C: Heat Exchange
D: Outside Air Intake
E: Filter
F: Blower Fan



Air Flow:

Air is drawn into the unit through the filter by the blower fan, at point E. The fan pushes air past the heat exchanger (C) which warms the air as it passes through. The resulting warmer air is sent through the supply duct (B) to the space. As the warm air is supplied to the space, the cooler air is pushed down and is drawn into the return and is reused by the system. A unit will typically operate until the space temperature is satisfied, at which time the furnace turns off. These units require a free flow of air to operate and for proper air flow should have open return air ducts and an unobstructed air path to help draw in air when operating.

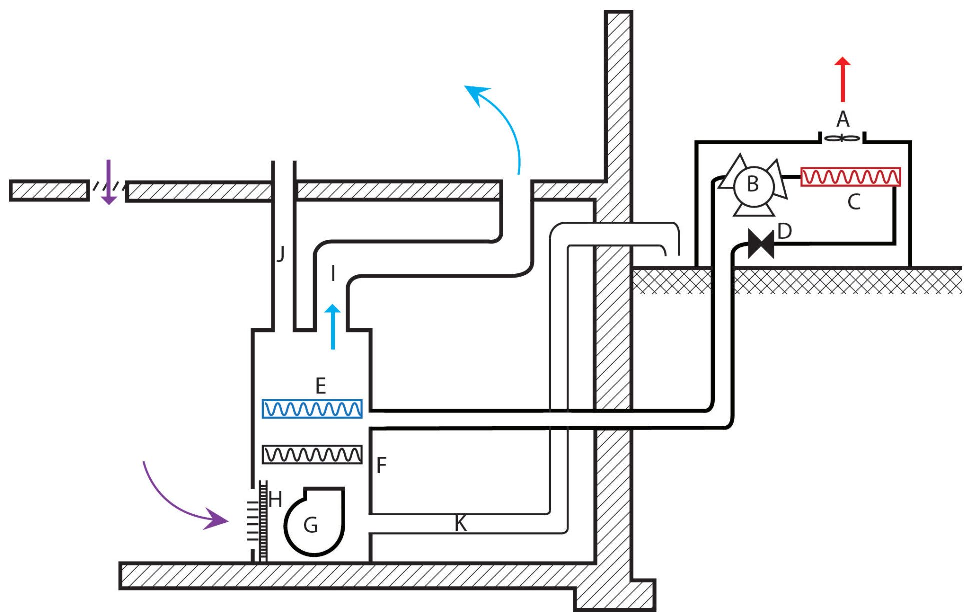
System Variations:

1. A system may utilize one of a number of means to heat the air (gas burner, electric coils, heat pump, or hydronic coils).
2. The return for a unit may be actual ductwork or may be return grates cut into the floors and walls to create circulation.
3. Humidification unit may be present after the heating coil depending on the design.

Forced Air Cooling

Components/Layout:

A: Exhaust Fan
B: Compressor
C: Condenser Coil
D: Expansion Valve
E: Evaporator Coil
F: Heating Coil
G: Blower Fan
H: Filter
I: Supply Duct
J: Vent
K: Outside Air Intake



Air Flow:

This unit utilizes the air circulation methods of a forced air furnace; however it is being used for cooling as well as heating. Air is drawn into the unit through the filter, (H), and is pulled through the blower (G). The blower pushes air past the heating coil or heat exchanger (F), but this coil will not operate when cooling. The air continues past to the evaporator coil or cooling coil (E), which cools the air as it passes through. The resulting air is sent through the supply duct (I) to the space. The systems main goal is to sensibly cool the passing air. Any dehumidification that may happen will be a byproduct of the process. The cooler air that exits the system may have lost some moisture in the cooling process but will have a higher relative humidity. The unit will typically operate until space temperature is satisfied at which time the unit turns off. These units require a free flow of air to operate and must have open return air ducts or an unobstructed air path to help draw in air when operating.

Refrigerant/Heating Supply:

The system works like a basic air conditioner with a few changes in positioning. The expansion valve (D), compressor (B) and condenser (C) are located outside of the building, while the evaporator coil (E) is inside the furnace. The refrigerant must travel through long lengths of tubing from inside to outside

Beginning just after the expansion valve refrigerant starts off as a low temperature, low pressure liquid. Under this low pressure condition the refrigerant has a low boiling point. The refrigerant is pushed through the evaporator coil where it absorbs heat from warm air that is passing over the coils. The heat absorbed from the warm air causes the refrigerant to boil and become a vapor. The refrigerant continues through the system toward the compressor. As it enters the compressor the refrigerant is now a low temperature, low pressure vapor.

The refrigerant enters the compressor where it is pressurized into a high temperature, high pressure vapor. The refrigerant is now under very high pressure and has a high boiling point. At these conditions, the refrigerant can condense easily. As the refrigerant moves through the condenser coil the fan inside the unit pushes air across the coils. The refrigerant will expel heat to the passing air as it is pushed though the fins by the fan. The passing air absorbs the heat, causing the refrigerant to cool and condense into a liquid. The high-pressure liquid moves towards the outlet of the condenser, the expansion valve. The refrigerant will enter the valve as a high temperature, high pressure liquid. The valve allows the pressure of the refrigerant to change and the refrigerant will exit the valve as a low temperature, low pressure liquid and start the process over again.

System Variations:

1. A return for the unit may be actual ductwork or may be return grates cut into the floors and walls to create circulation.

Desiccant Wheel

Components/Layout:

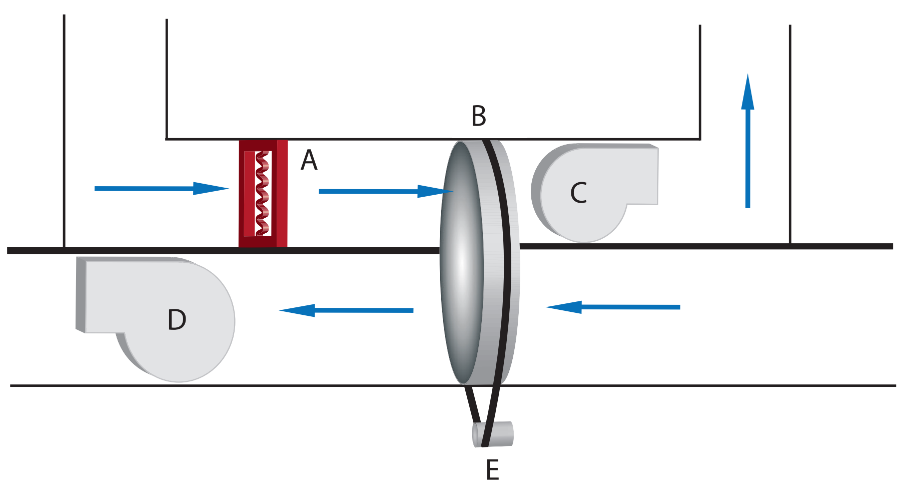
A: Heating Coil

B: Desiccant Wheel

C: Exhaust Fan

D: Supply Fan

E: Wheel Motor



Air Flow:

This system can exist as a stand-alone system or within an air handling unit. The desiccant wheel (B) is a spinning wheel that contains a desiccant material and is connected to a motor (E). The wheel spins inside two sets of ductwork, a large duct and a small duct. Inside the large duct, ¾ of the wheel is exposed. The smaller duct encloses ¼ of the wheel. Air that is to be dehumidified, process air, enters the large duct and is pulled across the desiccant wheel. The moisture in the air is absorbed into the desiccant. The air is then pulled into a fan (D) and pushed out of the unit. The process air leaving the unit has a much lower moisture content that when it entered the unit and is slightly warmer.

Back inside the unit the desiccant wheel turns delivering the moisture laden desiccant to the smaller ductwork. Here, outside air is used to reactivate the desiccant; this is referred to as regeneration air. The outside air is drawn into the system and is heated significantly by a heating coil (A) as it passes. This heated air has a greater ability to hold moisture and is pulled across the desiccant in the opposite direction of the process air. As the air crosses the desiccant it picks up moisture from the wheel and dries the desiccant. The regeneration air is then drawn into a fan (C) and exhausted out of the building as hot/humid air. The wheel continues to turn and the reactivated desiccant is ready to treat the space again.

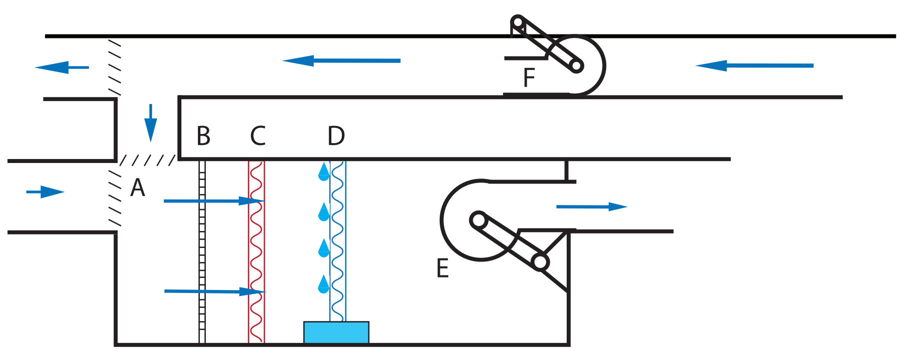
System Variations:

1. The arrangement of the ductwork on the desiccant wheel may vary from unit to unit.
2. A desiccant wheel may pretreat air before it enters an air handler or condition air that is passing through an air handler, depending on design.
3. A desiccant unit does not need to be connected to an air handler, it can be stand-alone.

Evaporative Cooling System

Components/Layout:

A: Dampers
B: Filters
C: Heating Coil
D: Evaporative Media
E: Supply Fan
F: Return Fan



Air Flow:

This type of unit may be common in areas like Arizona and Nevada, where moisture removal from the air is not a concern and where the moisture added to the air from this system helps to improve the low dew point. Starting at the outside air intake, air enters the outside air duct and is mixed with return air from the space just before the filters (B). The mixed air is pulled through a set of filters where impurities are removed. The air then passes over a set of heating coils (C) where the air is heated to the required temperature if necessary. The air then passes through the evaporative media (D). This media is a pad utilizing a honeycomb design that is saturated with cool water. As the air passes over the media, water from the pad is evaporated into the air. This process removes energy from the air resulting in a lower/cooler temperature, while at the same time adding moisture to the passing air, increasing the dew point. Next, the air is pulled into the supply fan (E), which will push the air through the supply ductwork, through the diffusers and into the space. The return fan (F) will then pull in air from the space and push it through the return ductwork. Air is either exhausted or returned to the unit to be mixed with outside air and start the cycle all over again.

Refrigerant/Coolant Cycle:

The heating coils are fed from a heat source such as a boiler or electricity. The heat from these coils is transferred to the air passing over it.

The evaporative media is a pad made of a cellulose material that utilizes a honeycomb design. A supply system adds water by pouring or dripping water onto the face of the media. This water cascades down the media and what is not absorbed or evaporated to the air will collect in a special pool. Water from the pool is pumped back up to the top of the media and reused. The pool is designed with a float to prevent overflow and a water supply line will replace any lost water if the pool gets too low.

System Variations:

1. A system may have multiple sets of filters to remove different levels of impurities.
2. A heating coil may not be present in every unit.
3. A heating coil may be farther down the line in the ductwork in what is called a reheat. As a reheat the coil will heat the air for a specific space just before it is discharged from the ducts.
4. A return fan may not be present in every unit. If the supply fan creates enough of a draw, it pulls the air back through the space.

Hydronic Radiant Heat Systems
(ex: baseboard, radiant floors, radiators, etc.)

Components/Layout:

A: Relief Valve

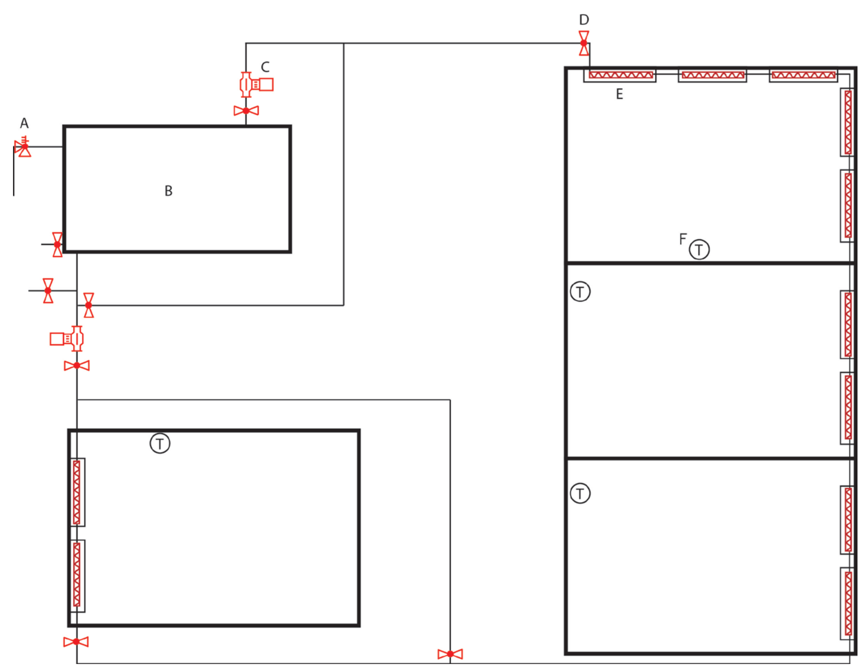
B: Boiler

C: Pump

D: Valve

E: Radiator

F: Thermostat



Air Flow:

Radiators are heat emitting units that transfer a portion of their heat through radiation and a portion of their heat by convection. Air that is in contact with the radiators will absorb heat through convection, while objects near the radiators will absorb heat through radiation. Frames or casings around the inner coils will help direct the heat movement away from the radiators. Blocking or covering these radiators with furniture or window coverings will hinder their efficiency.

Hot Water Radiant System

This system starts off with water heated at a main source (boiler, hot water system, etc.). This water is turned into either steam (220°F) or hot water (170°F). Some systems may even use high temperature water (350°-450°F) or medium temperature water (250° - 350°F). The high and medium temperature systems operate under high pressure to avoid the water flashing to steam.

In a hot water system, the water will be pumped from the boiler (B) through the supply lines to the radiators (E). The water enters the radiators on one side traveling through a fin covered line where the heat from the water is transferred to air from the space as the air passes through the fins. As the water passes through the radiators heat from the water is lost. The water exiting the radiators is cooler than the water that entered the radiators. Upon leaving the radiator the cooler water will either connect in a series to other radiators or return to the boiler, depending on the design of the system.

If the radiators are connected in a series the water will flow from outlet to inlet of the connected radiators until the end of the loop. At the end of the loop they will connect back to the main line and return to the boiler.

Some systems may have multiple loops that will come off a main line, while in other systems there may be a dedicated supply line and a dedicated return line. Radiators that use the dedicated line design will have their own feed from the supply and to the return. All of the loops will connect back to the main line and will eventually return to the boiler. Hot water boilers do not typically need to be installed at a specific level compared to their radiators.

System Variations:

1. A system may have individual valves on each radiator, room, floor, or loop to isolate an area depending on design.
2. Depending on the length of the loop there may be only one supply pump.
3. A system may be zoned to treat each room, area, or floor individually.
4. A system may be stand-alone or a complement to an air handling system.

Steam Radiant System

In this system water is turned into steam which is released from the boiler and travels up the pipes to the radiators. The radiators are connected individually off of the main line, with a high line feeding the radiators steam and a low line out the other side to collect the water that has condensed. The steam and water will exit the radiators to a second line that is installed at a slope so that the condensed water may drain to a return pipe that serves as a wet supply for the boiler. Multiple radiator drains may be connected to one main line, but the radiators will not be connected in series as a hot water system would be. In a steam boiler water system, the boiler may be located at least a floor below the radiators so that the steam can rise to the radiators and the water can run downhill back to the boiler.

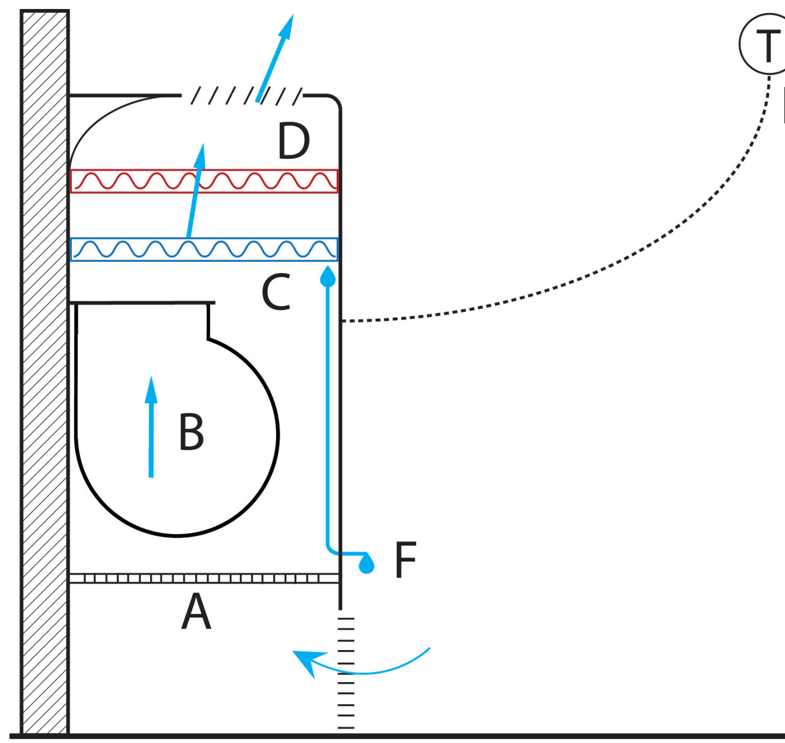
System Variations:

1. The system may have individual valves on each radiator, room, floor, or loop to isolate an area depending on design.
2. The system may be zoned to treat each room, area, or floor individually.
3. The system may be a stand-alone or a complement to another air handling system.

Wall Mounted Unit

Components/Layout:

A: Filter
B: Fan
C: Coiling Coil
D: Heating Coil
E: Thermostat
F: Condensate Drain



Air Flow:

Air enters the system through dampers at the base of the unit. As the air is drawn in it is treated by a filter (A) to screen out any contaminants. This air is pushed by the fan (B) into the heating (D) and cooling coils (C) where the air is treated if necessary. The conditioned air is then pushed out the top of the unit into the space.

Refrigerant/Heating Supply:

The cooling coils are fed from a source of cooling (chillers, cooling tower, DX unit). The refrigerant enters the coils which absorb heat and remove moisture from the air in the ducts. The refrigerant returns to its cooling source to desorb the heat that it has taken in.

The heating coils are fed from a heat source (boiler, electricity). The heat from these coils is transferred to the air passing through it.

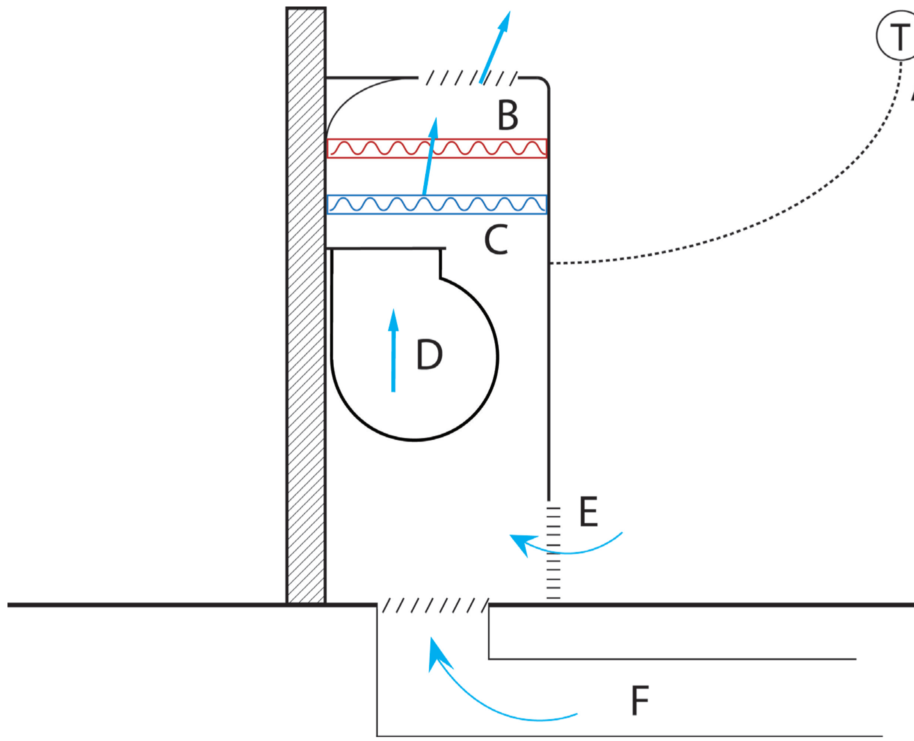
System Variations:

1. Cooling coil may not be present on all units.
2. Heating coil may not be present on all units.
3. Thermostat may be mounted on a panel on the unit or may be found elsewhere in the room depending on design.
4. Unit may be mounted at different heights depending on design.
5. Unit may be in addition to a central AHU.

Induction Heating Unit

Components/Layout:

A: Thermostat
B: Heating Coil
C: Cooling Coil
D: Fan
E: Return Air
F: Pre-treated Air



Air Flow:

These units are similar to the standard wall mounted unit and are typically what many hotel rooms use. Pretreated air is supplied to the unit from a main air handling system (F). The air is mixed with other air from the space that is pulled in through dampers (E) at the bottom of the unit. This mixed air is pushed through the fan (D) into the heating (B) and cooling coils (C) where the air is treated if necessary. The typical function of the cooling coil is to sensibly cool the passing air. Little to no dehumidification is performed by this unit. The conditioned air is then pushed out the top of the unit into the space. These units typically do not have any form of humidification installed on them.

Refrigerant/Heating Supply:

The cooling coils are fed from a source of cooling (chillers, cooling tower, DX unit). The refrigerant enters the coils which absorb heat and remove moisture from the passing air. The refrigerant returns to its cooling source to desorb the heat that it has taken in.

The heating coils are fed from a heat source (boiler, electricity). The heat from these coils is transferred to the air passing through it.

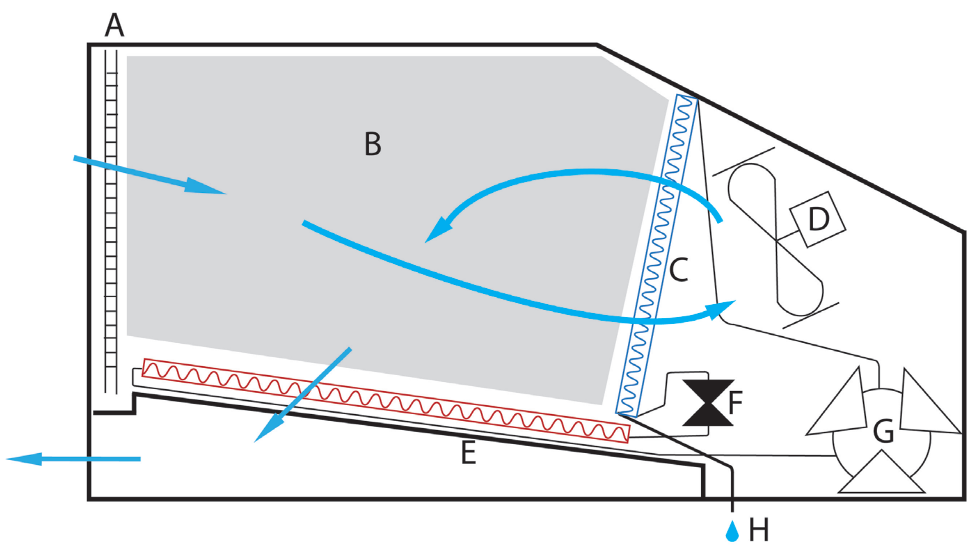
System Variations:

1. The arrangement of the cooling coil and heating coil may vary from unit to unit.
2. A cooling coil may not be present in every unit.
3. A heating coil may not be present in every unit.
4. A unit may not always be oriented vertically.
5. A unit may be installed on a wall or ceiling.
6. A unit may have a set of filters installed before the fan.

Air Dryer

Components/Layout:

A: Filter
B: Evaporator Coil Extension
C: Evaporator Coil
D: Fan
E: Condenser Coil
F: Expansion Valve
G: Compressor
H: Condensate Drain



Air Flow:

Air is brought into the unit through the filter (A). The air enters a large evaporator coil (B), here it is cooled and the temperature of the coil is very low. If the passing air has a higher dew point than the coil temperature, moisture in the air will condense and drop onto a condensation tray. The condensation tray will allow the water to drain out of the unit. The cool air is brought to the back of the unit then pushed downward where it will pass through a condenser coil (E) that is used to heat the air before ejecting it out the rear of the unit.

Refrigerant/Coolant Cycle:

The system works just like a basic air conditioner. Beginning just after the expansion valve (F) the refrigerant starts off as a low temperature, low pressure liquid. Under this low pressure condition the refrigerant has a low boiling point. The refrigerant is pushed through the evaporator coil (C) where it absorbs heat from the warm air that is passing over the coils. The heat absorbed by the warm air causes the refrigerant to boil and become a vapor. The refrigerant continues through the system toward the compressor (G). As it enters the compressor the refrigerant is now a low temperature, low pressure vapor.

The refrigerant enters the compressor where it is pressurized into a high temperature, high pressure vapor. The refrigerant is now under very high pressure and has a high boiling point. At these conditions, the refrigerant can condense easily. As the refrigerant moves through the condenser coil (E) the fan inside the unit is pushing air across the coils. The refrigerant will expel heat to the passing air as it is pushed though the fins by the fan. The passing air will absorb the heat, causing the refrigerant to cool and condense into a liquid. The high-pressure liquid moves towards the outlet of the condenser, the expansion valve. The refrigerant will enter the valve as a high temperature, high pressure liquid. The valve will allow the pressure of the refrigerant to change and the refrigerant will exit the valve as a low temperature, low pressure liquid and start the process over again.

System Variations:

1. This system can take a variety of shapes and sizes.

Mechanical System Acronyms

AC – Air Conditioning

ACH – Air Changes per Hour

ACU – Air Conditioning Unit

AHU – Air Handling Unit

ASHRAE – American Society of Heating Refrigeration and Air Conditioning Engineers

BAS – Building Automated System

BMS – Building Management System

BTU – British Thermal Unit

BTUh – British Thermal Unit per hour

C – Celsius

CAV – Constant Air Volume

CC – Cooling Coil

CFC - Chlorofluorocarbon

CFM – Cubic Feet per Minute

CHW – Chilled Water

CHWP – Chilled Water Pump

CHWR – Chilled Water Return

CHWS – Chilled Water Supply

DB – Dry Bulb

DDC – Direct Digital Control

DP – Dew Point

DX – Direct Expansion

EA – Exhaust Air

EAT – Entering Air Temperature

EER – Energy Efficiency Ratio

EF – Exhaust Fan

EMS – Energy Management System

EWT – Entering Water Temperature

F – Fahrenheit

FCU – Fan Coil Unit

FLA – Full Load Amps

FPM – Feet per Minute

FPS – Feet per Second

GPM – Gallon per Minute

HC – Heating Coil

HEPA – High-Efficiency Particulate Arrestor

HP – Heat Pump or Horse Power

HPS – High Pressure Steam

HW – Hot Water

HWP – Hot Water Pump

HWR – Hot Water Return

HWS – Hot Water Supply

HVAC – Heating, Ventilation and Air Conditioning

Hz – Hertz

IR – Infrared

kW – Kilowatt

KWH – Kilowatt-hour

LAT – Leaving Air Temperature

LEED – Leadership in Energy and Environmental Design

LL – Low Limit

LP – Low Pressure

LPS – Low Pressure Steam

LWT – Leaving Water Temperature

LWB – Leaving Wet Bulb

MA – Mixed Air

MAT – Mixed Air Temperature

MUA – Make Up Air

NC – Normally Closed

NO – Normally Open

OA, OSA – Outside Air

OAI – Outside Air Intake

OAT – Outside Air Temp

PM – Preventative Maintenance

PH – Preheat

PSI – Pounds per Square Inch

RA – Return Air

RF – Return Fan

RH – Relative Humidity

RPM – Revolutions per Minute

RTU – Roof Top Unit

SA – Supply Air

SD – Smoke Detector

SF – Supply Fan

T – Temperature or Thermostat

V – Volts

VAV – Variable Air Volume

VD – Volume Damper

VFD – Variable Frequency Drive

VSD – Variable Speed Drive

W – Watts

WB – Wet Bulb

ZD – Zone Damper