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SERVICE NEWS

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Hercules Air Conditioning

SERVICE NEWS

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SERVICE NEWS



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Cover : Three early Hercules photographed from the cargo compartment of another Hercules.

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Hercules Air

Air conditioning is a matter of comfort. If you have never become accustomed to it, you don't miss it. But once you become accustomed to it and don't have it, the squawks start. As with most aircraft systems, the Hercules air conditioning system is not a system where you can always immediately pin point the trouble. It generally requires troubleshooting - and often the best question is where to begin.

We believe troubleshooting begins with a good basic knowledge of the system. With this in mind, we will present in simplified form the basic components in the air conditioning system, their relationship to each other, and then show the operation of the complete system. We will address ourselves primarily to the cargo compartment air conditioning system; in general, you can also apply this information to the flight station system.

In an effort to make this article all inclusive, we will begin with the first Hercules system and add the changes that have been incorporated. We will include the temperature control system changes through LAC Serial 4652. Beginning with LAC Serial 4653 a new Auxiliary Power Unit and new refrigeration packages are installed. These will be covered in future articles.

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Conditioning

The Cargo Compartment System

The air which exits from the outlet ducts in the cargo compartment is a mixture. It starts out as bleed air from the engine, at a temperature of about 600°F. Part of this hot air goes through a heat exchanger which lowers the temperature to around 140° to 200°F. We call this cool air. Part of the cool air is passed through an expansion turbine which reduces its temperature further to approximately 35°F. We call this cold air. A mixture of cool and cold air is directed through a water separator and then to the cargo compartment distribution ducts. Temperature within the compartment is controlled by mixing hot air with the cool-cold air going to the distribution ducts. The temperature control valve regulates this mixture (see Figure 1).



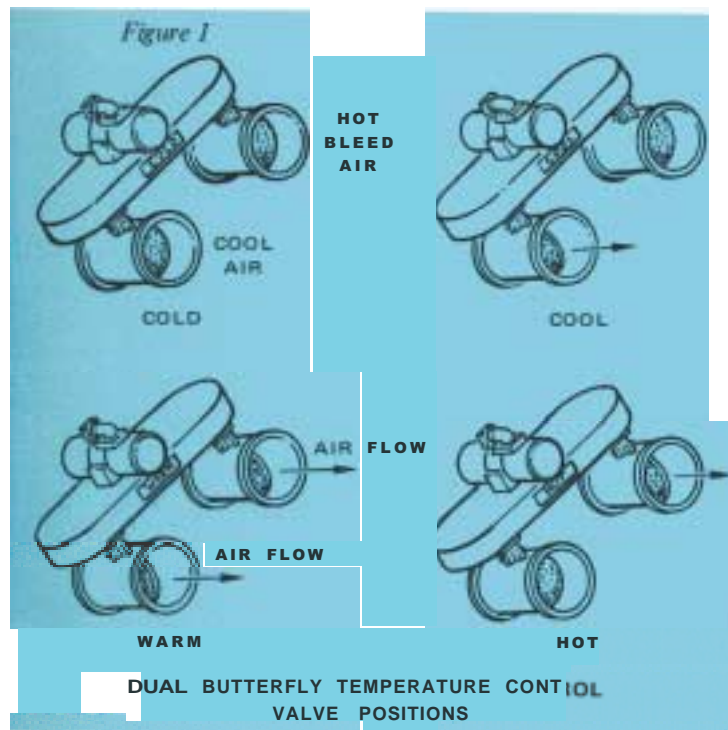
AIR CONDITIONING CONTROL PANEL

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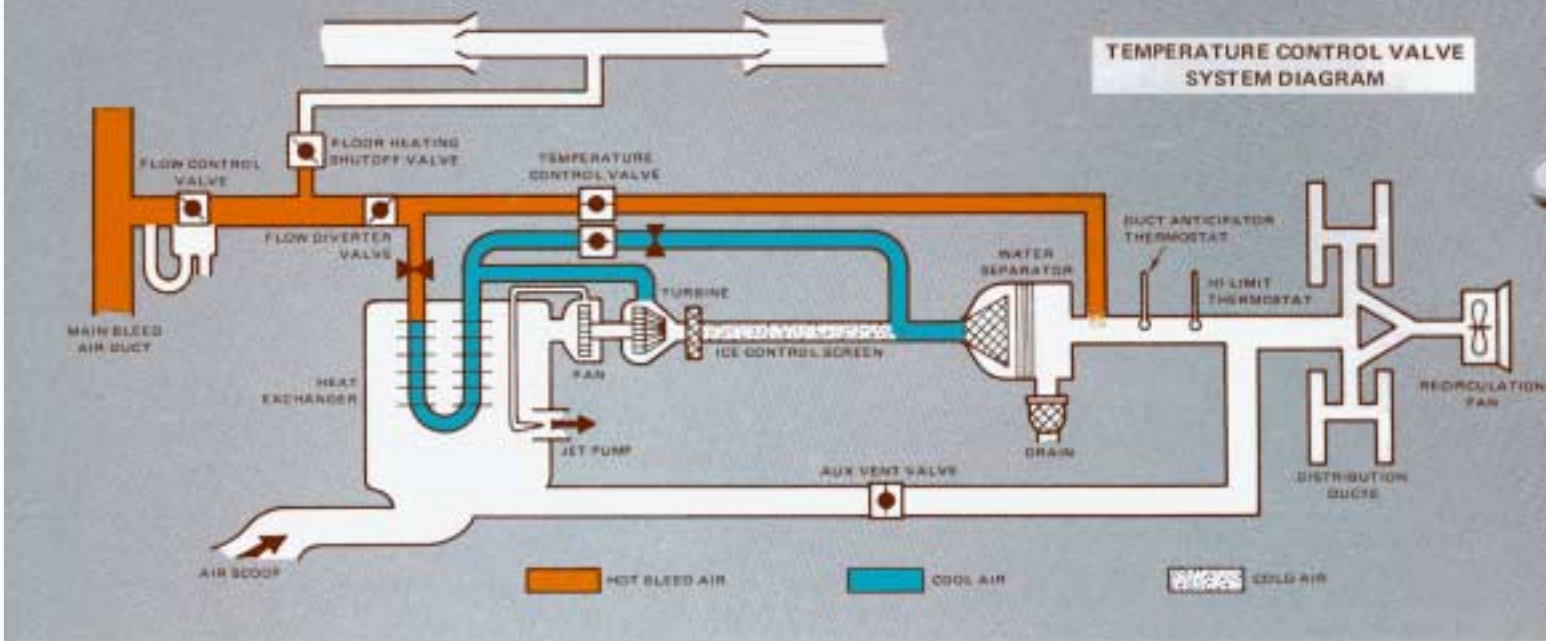
The temperature control valve is actually two valves with one control. One valve is installed in the hot bleed air duct, the other in the cool air duct. They operate together. For example, on a 10°F day you would want a lot of cold air. Both valves would be closed and the compartment would be getting full cold air from the expansion turbine. On the other hand, you might be operating in an Arctic or Antarctic climate and want as much heat as you can get. In this case, the valve in the hot bleed air duct would be full open and the valve in the cool air duct closed. The compartment would be getting a mixture of hot and cold air, but much more hot than cold.

The temperature control valve has a visual marker on it which indicates the position of the valves. The callouts on the marker are HOT, WARM, COOL, and COLD. The valve may assume any intermediate position between the extremes of hot and cold. Further, both valves in the assembly are marked so you can tell them apart. The bleed air valve is marked HOT, and the cool air valve, COLD.

System controls include the Air Conditioning Master switch, the Temperature Control switch, and the cargo compartment temperature rheostat located on the air conditioning panel. Automatic operation or manual operation can be selected by the operator.



DUAL BUTTERFLY TEMPERATURE CONTROL VALVE POSITIONS



The position of the temperature control valve, and hence the compartment temperature, is controlled by three thermostats:

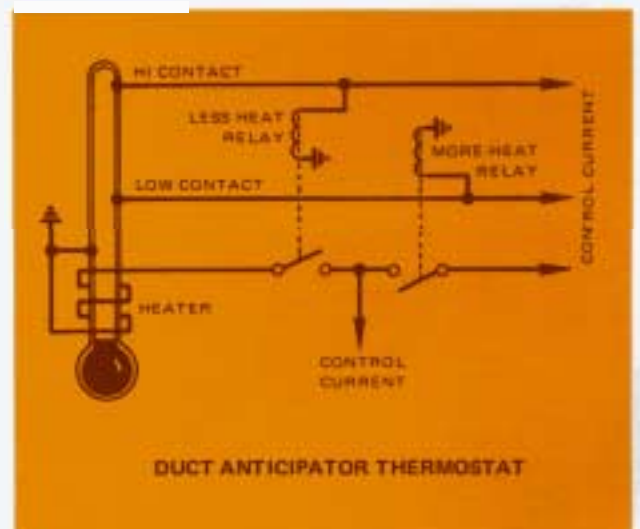
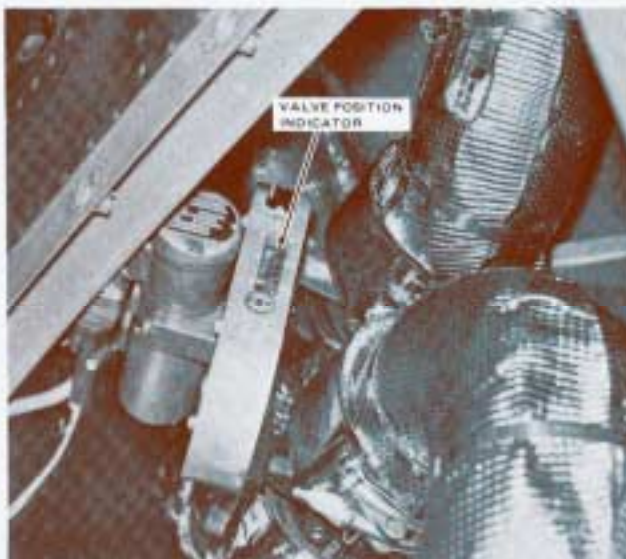
- *The cabin thermostat* is the system's basic control. It establishes the temperature base line which the system must meet. The thermostat is installed within the cargo compartment on the left side at fuselage station 357 (approximately).
- *The duct anticipator thermostat* is installed in the ducting downstream from the water separator in the right wheel well just forward of the flow control valve. It keeps the system temperature at a steady value ... prevents excessive hunting (overshooting in one direction and then going too far in the other direction).
- *The hi-limit thermostat* is a safety control. It limits the temperature so that the ducts will not be subjected to excessive heat. This thermostat is installed in the ducting above the duct anticipator thermostat.

Now to put the thermostats in their control circuits and see how they perform their given tasks.

But first, notice in Figure 2 the three relays in the circuit – the cabin relay, more-heat relay, and less-heat relay. These relays are part of a control box assembly installed under the flight deck forward of the 245 bulkhead. The position of each relay directly determines temperature control valve operation.

The three thermostats, in turn, control relay operation and hence, control the operation of the temperature control valve. Let's look for a minute at the design of the thermostats. In schematic form one of the thermostats – the duct anticipator thermostat – looks like this:

DUAL BUTTERFLY TEMPERATURE CONTROL VALVE



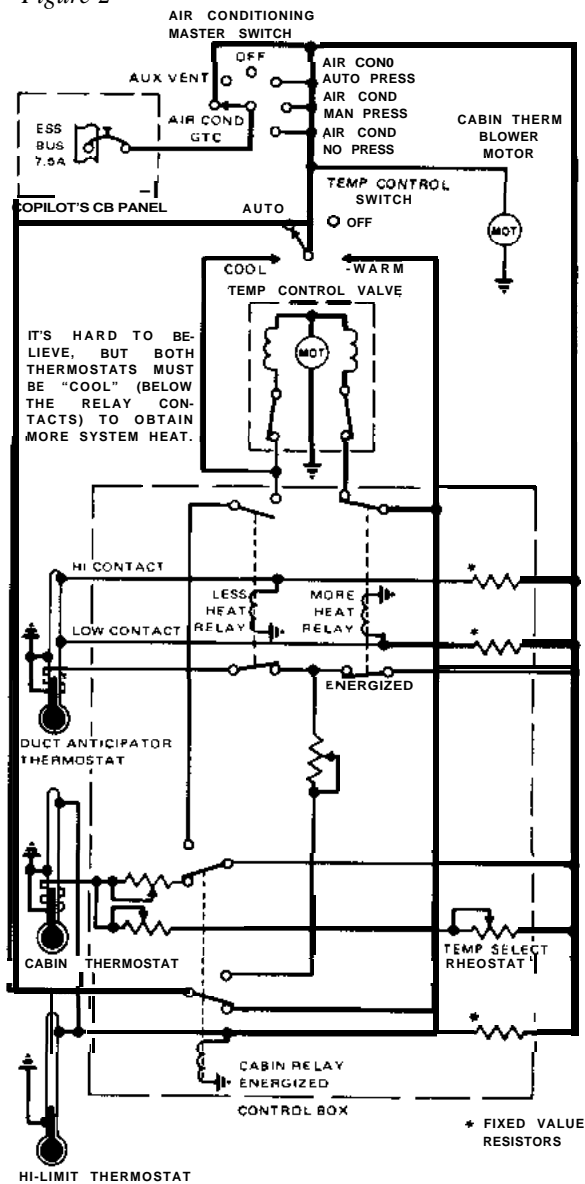
Note the heater coil, the three contacts, and the ground. The position of the mercury in the thermostat column determines whether the heater coil, more-heat relay, and

less-heat relay are energized or deenergized. When the mercury is down in the bulb, a circuit through the heater coil to ground is possible. With the heater coil energized, the mercury will rise. However, as soon as the mercury reaches the low contact a direct electrical path through the mercury to ground is provided. The more-heat relay and heater coil will be deenergized. If the mercury continues to rise until the hi contact is reached, the

thermostat will provide a ground in the less-heat relay circuit. The less-heat relay will be deenergized.

Refer to Figure 3 and you can see that the cabin thermostat and hi-limit thermostat are similar but not identical in design. These two thermostats control the operation of the cabin relay.

Figure 2

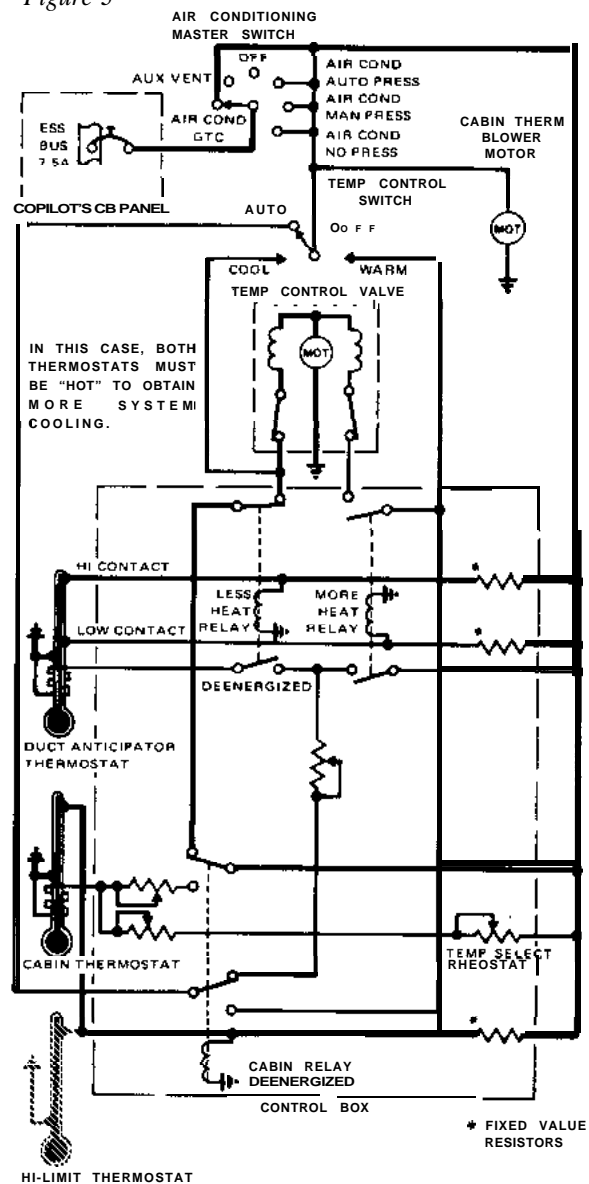


TEMPERATURE CONTROL VALVE DRIVING TO A HOTTER (MORE-HEAT) POSITION

WHEN THE CABIN RELAY AND THE MORE-HEAT RELAY ARE ENERGIZED THE TEMPERATURE CONTROL VALVE DRIVES TOWARD A MORE-HEAT (HOTTER) POSITION.

WHEN THE RELAYS ARE IN ANY OTHER POSITION, THE CONTROL VALVE WILL NOT MOVE WILL REMAIN IN THE LAST POSITION TO WHICH IT WAS DRIVEN.

Figure 3



TEMPERATURE CONTROL VALVE DRIVING TO A COOLER (LESS-HEAT) POSITION

WHEN THE CABIN RELAY AND THE LESS-HEAT RELAY ARE DE-ENERGIZED, THE TEMPERATURE CONTROL VALVE DRIVES TOWARD A LESS-HEAT (COOLER) POSITION.

Automatic Operation, Warm Selection

Now that the bits and pieces have been covered, let's put them together into a complete circuit and see what happens. Say we have a cold day condition; the Cargo Temperature Control switch has just been placed in AUTO position, the temperature rheostat turned to WARM, and the Air Conditioning Master switch placed in one of the air conditioning positions: AIR COND GTC, AIR COND AUTO PRESS, AIR COND MAN PRESS, AIR COND NO PRESS.

(It is assumed that the Air Conditioning Shutoff switch and the Emergency Depressurization switch are in their NORMAL positions.)

In this situation, as shown in Figure 2, grounds are provided for all three relays, the relays are energized, and

the temperature control valve moves toward a hotter position.

With the relays energized, both the cabin thermostat heater and the duct anticipator thermostat heater are heated. The mercury columns in both thermostats rise rapidly. The mercury reaches the low contact of the duct anticipator thermostat first. The more-heat relay is deenergized and the temperature control valve stops at some position of heating.

At this point the cabin thermostat heater is still heating but the anticipator thermostat heater is deenergized. The heat output from the temperature control valve now determines whether the valve moves again or remains unchanged.

If the duct temperature keeps the duct anticipator thermostat mercury between the hi and low contacts and if the cabin temperature plus cabin thermostat heater heat are not sufficient to raise the cabin thermostat mercury to its contact, the system is in balance. The temperature control valve will not move. The balance will continue until a change in outside temperature influences the system. Figure 4 shows this balanced condition.

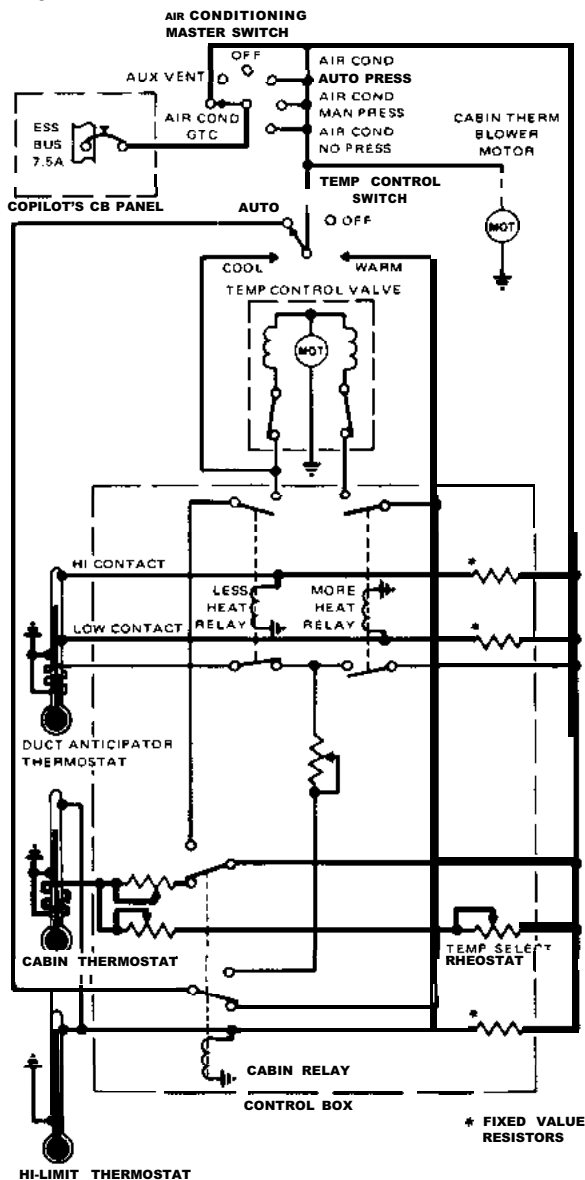
The operation just described can happen, but usually doesn't. In actual practice the temperature control valve won't reach a stabilized position until it goes through a series of diminishing cycles.

When the system is first turned on, the valve will generally move too far toward hot, then slightly overshoot in the cold direction and after reversing itself a few times will finally stabilize. That's why you should give the system a minimum of five minutes before expecting a stabilized temperature.

Again, there are other reasons why you should not attempt to analyze temperature control valve operation by noting outlet air temperature in the compartment until the system has stabilized.

Suppose the temperature control valve was in the full cold position when the air conditioning system was last turned off. When the system is started again and a warm selection is made, you will get a few puffs of warm air caused from hot bleed air slipping past the cooling turbine. Then as the turbine stabilizes, it will put out some cold air. The relays will close during this time and the temperature control valve will slowly move toward a warmer position. When it gets there, the system will be putting out warm air.

Figure 4



CONTROL SYSTEM IN BALANCE - NO MOVEMENT OF THE TEMPERATURE CONTROL VALVE

Automatic Operation, Cool Selection

Let's start over again. The temperature select rheostat is positioned to COOL. All thermostats have their mercury columns below the contacts.

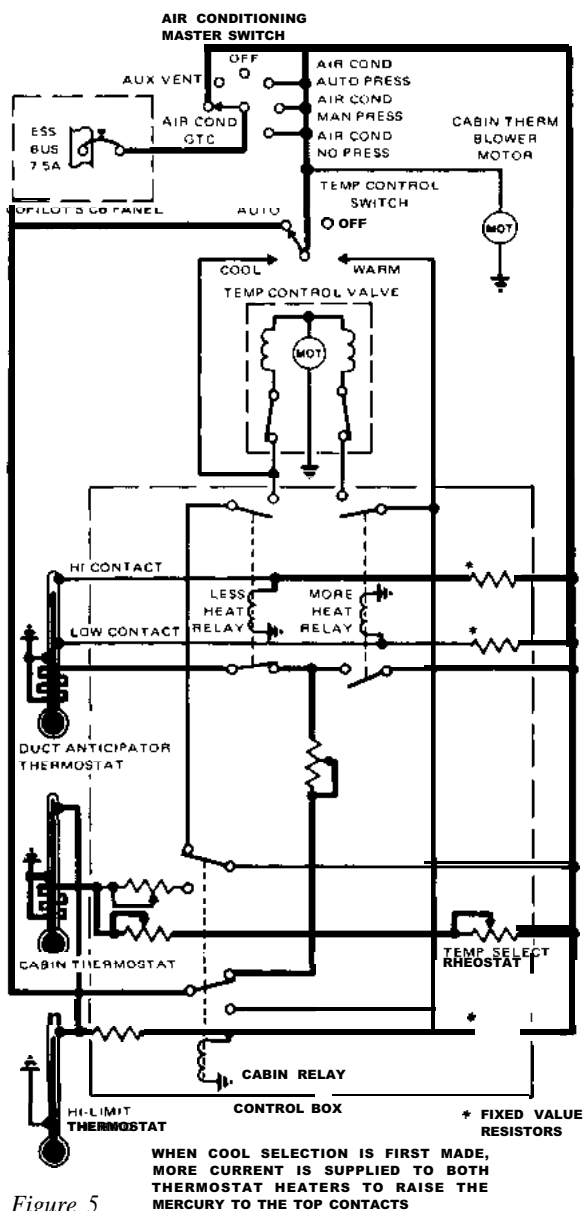


Figure 5

Only one condition in the control system is changed: The rheostat offers less resistance to current in the cabin thermostat heater circuits. This makes a hotter heater, causing the cabin thermostat mercury to rise faster and higher than it did with the rheostat at the WARM selection. Upon first turning the system to COOL, the temperature control valve will start moving toward a warmer position. It won't take long, however, before the cabin thermostat heater has raised the mercury to the thermostat's top contact. At this time the cabin relay is deenergized and the temperature control valve is stopped.

Of equal importance, additional current is supplied to the duct anticipator thermostat heater through a contact of the deenergized cabin relay. This circuit is shown in Figure 5.

As soon as the mercury reaches the top contact of the duct anticipator thermostat, the less-heat relay deenergizes. The circuit to the less-heat side of the temperature control valve is completed and the valve moves toward a

cool position. (Figure 3 shows this circuit.) The valve may overshoot the cool selection and then cycle about the selected temperature until a balanced condition (as shown in Figure 4) is reached.

The important thing to remember about this cooling operation is that the thermostat heaters are power boosted to give more heat. The mercury will quickly rise and stay above the thermostat's top contacts. System balance is achieved when the system's cool air passes over the thermostat and lowers the mercury below the contacts. Cabin temperature is stabilized when it agrees with the compartment rheostat setting.

Manual Control

As you can see from the schematics, the Temperature Control Switch completes a circuit from the Air Conditioning Master switch directly to the less-heat side of the temperature control valve. The valve moves toward cold.

The warm side is similar but not identical. It is wired through the more-heat relay contacts as a protective measure to prevent excessive heating of the system. When you hold the switch in the WARM position, the temperature control valve motor runs until the more-heat relay is either deenergized by the duct anticipator thermostat or until the switch is released. This results in heating by cycles or steps. Each time the mercury reaches the low (more-heat) contact the relay is deenergized, stopping valve movement and opening the circuit to the thermostat heater. As the mercury falls below the contact, the valve starts moving again (providing the switch is still in WARM position). It takes about three and one-half minutes to move the valve from cold to hot by this method.

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Floor Heat System

This system is for one purpose only: To provide more heat in the cargo compartment floor area when it is needed. The system is controlled by the Underfloor Heating switch located on the air conditioning control panel. It is necessary to position the switch to OFF when you desire to cool the cargo compartment. Otherwise cargo compartment cooling will be fighting cargo floor heating and the cooling will come out second best.

Two valves control floor heating: A solenoid controlled air-actuated shutoff valve, and a 28 VDC motor-operated diverter valve (see Figure 6). The shutoff valve is energized by a circuit through a microswitch which is closed and remains closed as the diverter valve moves toward the closed position.

The floor heat diverter valve does most of the work of regulating underfloor heat. It is installed in the bleed air

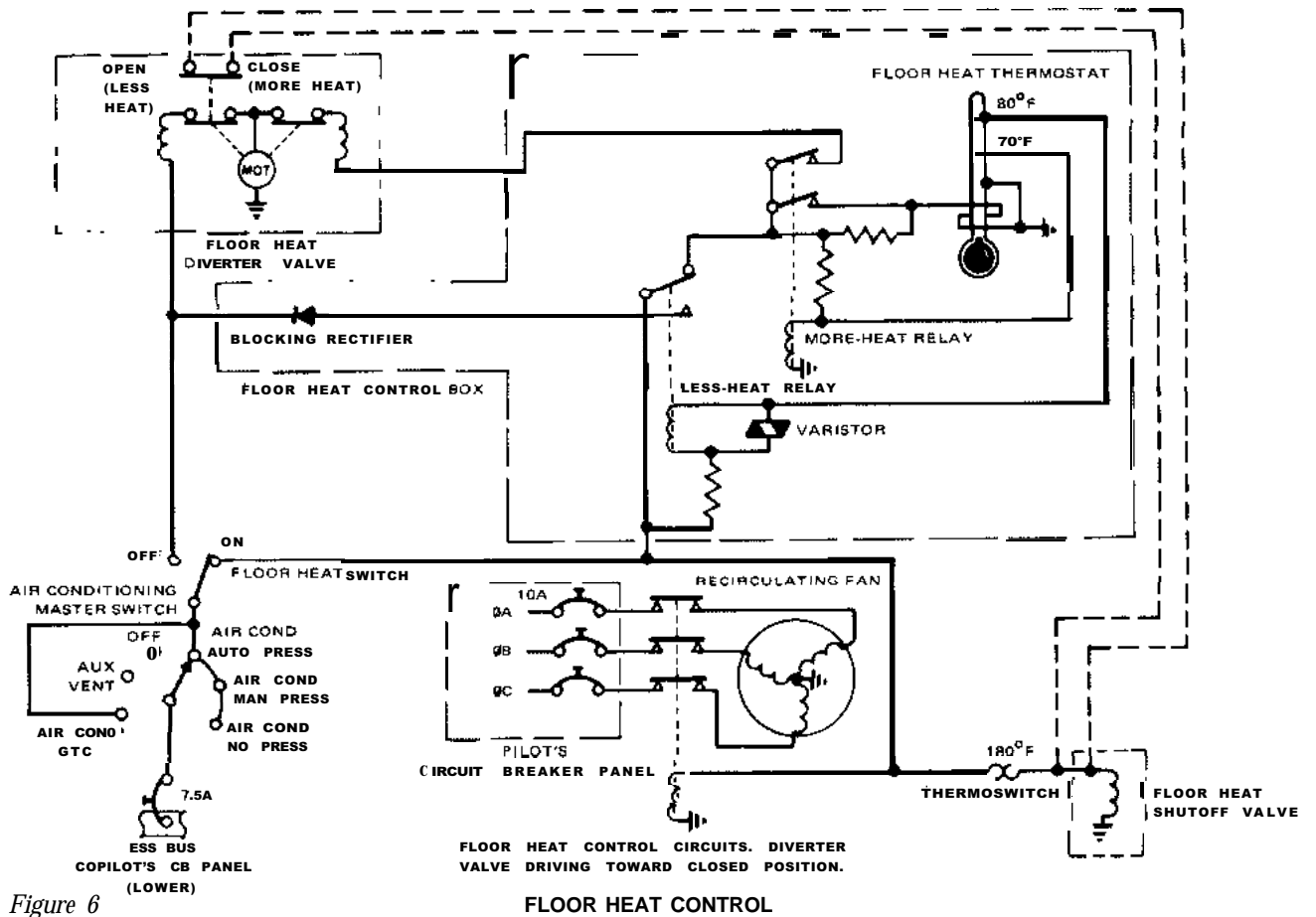


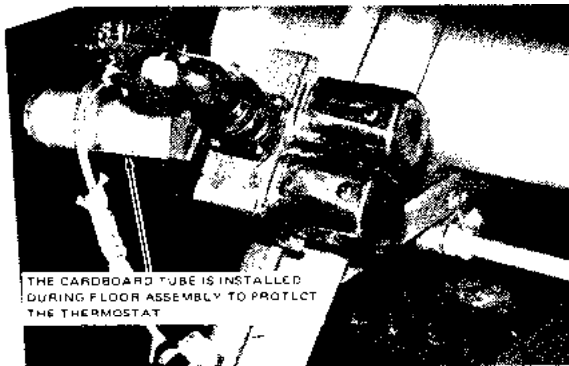
Figure 6

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duct leading to the cargo compartment temperature control valve and cooling turbine. Its purpose is to divert part of the air going to the cargo compartment system into the floor system. The more the valve closes, the more bleed air is directed to the floor system.

However, the valve will never completely shut off all of the bleed air to the cargo compartment system. The valve butterfly is smaller than the valve body. Even with the diverter valve fully closed, the cargo compartment system still receives about 50% of the bleed airflow.

FLOOR HEAT THERMOSTAT & CONTROL BOX



BIMETALLIC THERMOSWITCH

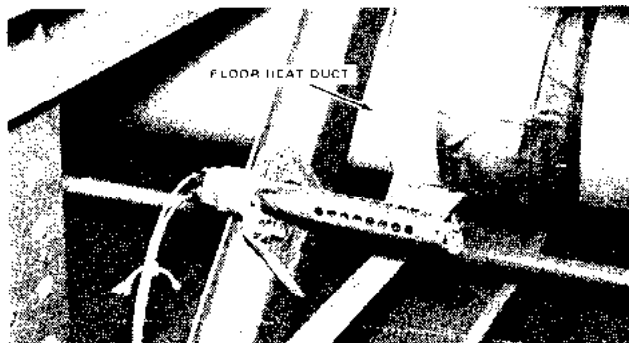


Figure 6 shows the electrical control circuits for the floor system. When the Air Conditioning Master switch is placed in one of the air conditioning positions and the Underfloor Heating switch is placed to ON, the more-heat relay is energized and a circuit completed to the close side of the diverter valve. The diverter valve moves toward the close position. In a similar manner as the duct anticipator thermostat for the cargo compartment system, the floor heat thermostat regulates diverter valve operation by circuits through the more-heat and less-heat relays. If by this time you are not completely circuit happy, you will be able to trace out these circuits for yourself.

It might help though, if we did give you a tip concerning two or three items in the schematic. For example, take the bimetallic thermoswitch. It is installed under the floor just left of the airplane centerline by the wheel well and serves as a protective measure for the system. If the diverter valve control malfunctions or floor system heating is attempted on the ground at 100°F the thermoswitch will open when underfloor temperature exceeds 180°F. The shutoff valve will close to prevent excessive heating of the underfloor area.

Another item shown on the schematic is the recirculating fan that runs anytime the system is turned on. You've probably noticed it overhead in the cargo compartment just forward of the wing box beam.

WC might also say that it operated on some of the early C-130 airplanes even when the floor system was OFF. Notice the blocking rectifier in Figure 6. Without the rectifier in the circuit it is possible for power to feed back through the less-heat relay contacts if the relay is energized when the Underfloor Heating switch is turned OFF. The relay will be held in, and through the relay contacts, power will hold the shutoff valve open and will operate the recirculating fan.

The limit switch for the open side of the flow diverter valve is in series in the floor heat shutoff valve circuit (shown in dotted lines on the schematic). Therefore, **any** time the diverter valve is fully open, the floor heat shutoff valve will be deenergized closed. Thus, a positive means of closing the shutoff valve is provided anytime the diverter valve fully opens.

Transistorized Control Box

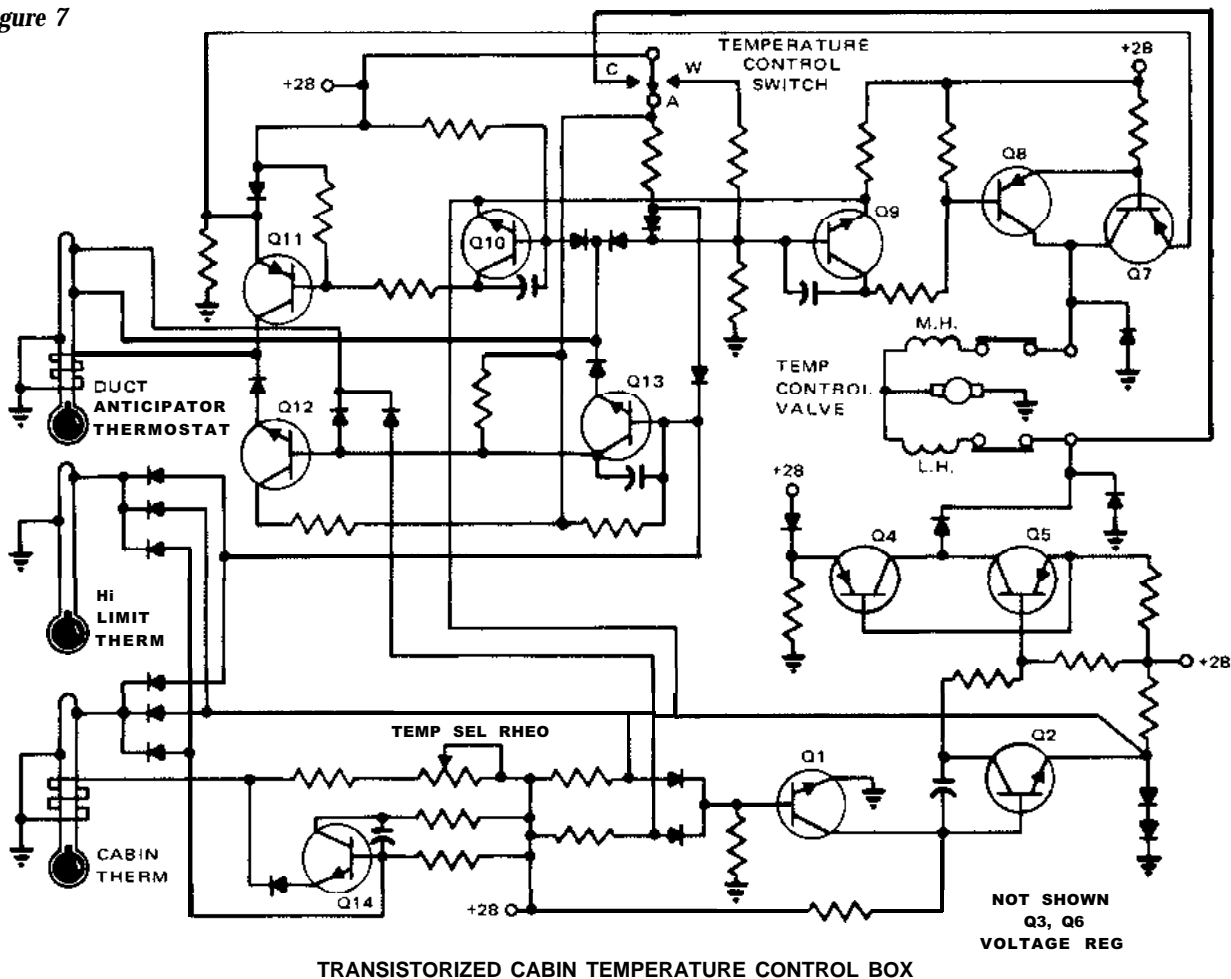
A transistorized (solid state) temperature control box is interchangeable with the earlier relay-type control box

installed on aircraft up through LAC Serial 4.578. Chances are all of the relay boxes are being phased out, but system operation is basically unchanged. Transistors perform the functions of the relay circuit. The transistorized control box is shown in Figure 7.

Manual Operation

The temperature control circuit is energized by placing the Air Conditioning Master switch in any of the four air conditioning positions. The temperature **can** be controlled manually by holding the Temperature Control switch in WARM or COOL. When the switch is held in the COOL position, 28 VDC from the control box is applied to the less-heat winding of the control valve; when the desired temperature is reached, the switch is released, breaking the circuit. With the switch in the WARM position, 28 VDC from the control box is applied to the more-heat winding of the control valve IF the duct thermostat senses a temperature of $390 \pm 10^\circ\text{F}$ or less ($230 \pm 10^\circ\text{F}$ for flight compartment). This circuit is broken when the temperature sensed by the overheat thermostat is greater than $390 \pm 10^\circ\text{F}$ ($230 \pm 10^\circ\text{F}$ for flight compartment), or the switch is released. It takes approximately 35 seconds for the valve to move from the extreme hot to the extreme cold position, and 3-1/3 minutes to move from extreme cold to extreme hot.

Figure 7



Automatic Operation

When the Temperature Control switch is in the AUTO position, the control box automatically controls the more-heat and less-heat actuators of the control valve to maintain the temperature selected by the temperature rheostat. Positioning the rheostat to select a temperature causes a voltage output from the rheostat. This signal is compared with a voltage signal that is proportional to the actual temperature. If the actual cabin temperature is higher than the selected temperature, the control box supplies 28 VDC to the less-heat actuator of the control valve. If the cabin temperature is less than the selected temperature, 28 VDC is applied to the more-heat actuator of the control valve. If the cabin thermostat detects a cabin temperature of 110°F or greater - or if duct temperature exceeds 400°F - 28 VDC is applied to the less-heat actuator of the control valve.

New Temperature Control System

Beginning with LAC Serial 4579 and on, a new temperature control system was introduced that, as a system, is interchangeable with the earlier systems. Sensors, which replaced the mercury thermostats, and solid state amplifiers control the system. Airflow and basic system operation remain the same - the difference lies in the sensing and controlling of the temperature.

The sensors are wire wound types with a positive resistance coefficient - as temperature increases, resistance increases. Automatic temperature selection is through a variable resistance (rheostat) in series with the cabin sensor. Changing the position of the selector (selecting a desired temperature) sets the operating or balance point of the system. An angular (knob) travel of 300 degrees gives a temperature selection range of 60° to 90°F - with the mid-point (12 O'clock position) being equivalent to 75°F.

Automatic Operation

Before getting into the automatic mode of operation, let's list the system components since there are some strange new names among them (reference Figure 8).

- Voltage Regulator
- Differentiating Amplifier
- Overheat and Shorted Sensor Amplifier
- Error Amplifier
- Pulse Generator
- More-Heat and Less-Heat Output Drivers
- Duct Sensor (Anticipator)
- Temperature Selector (Rheostat)
- Compartment Temperature Sensor
- Duct Overheat Sensor

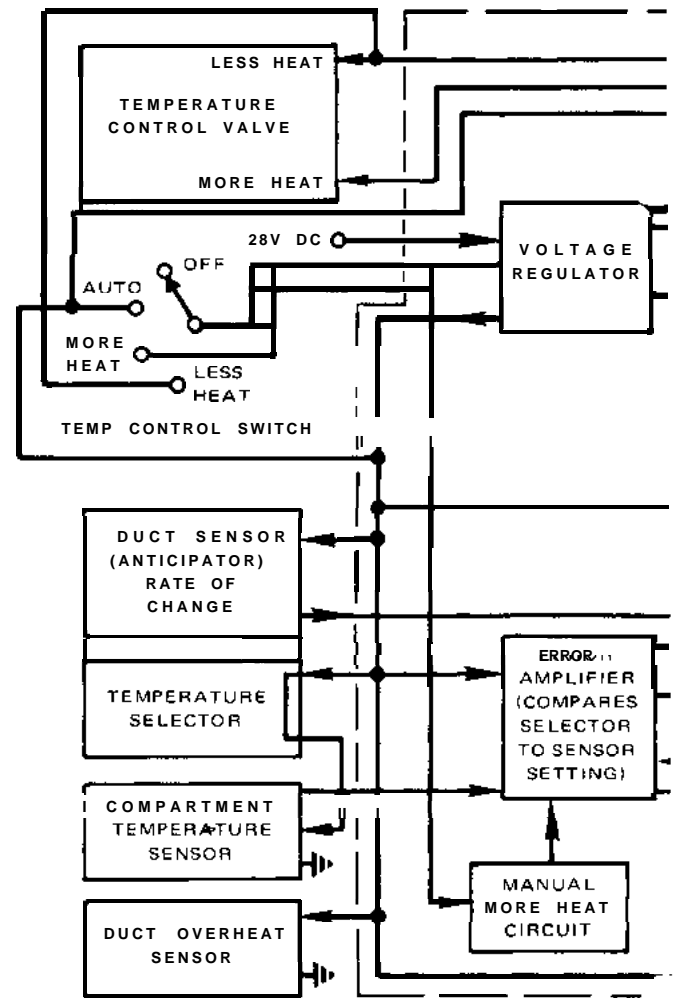
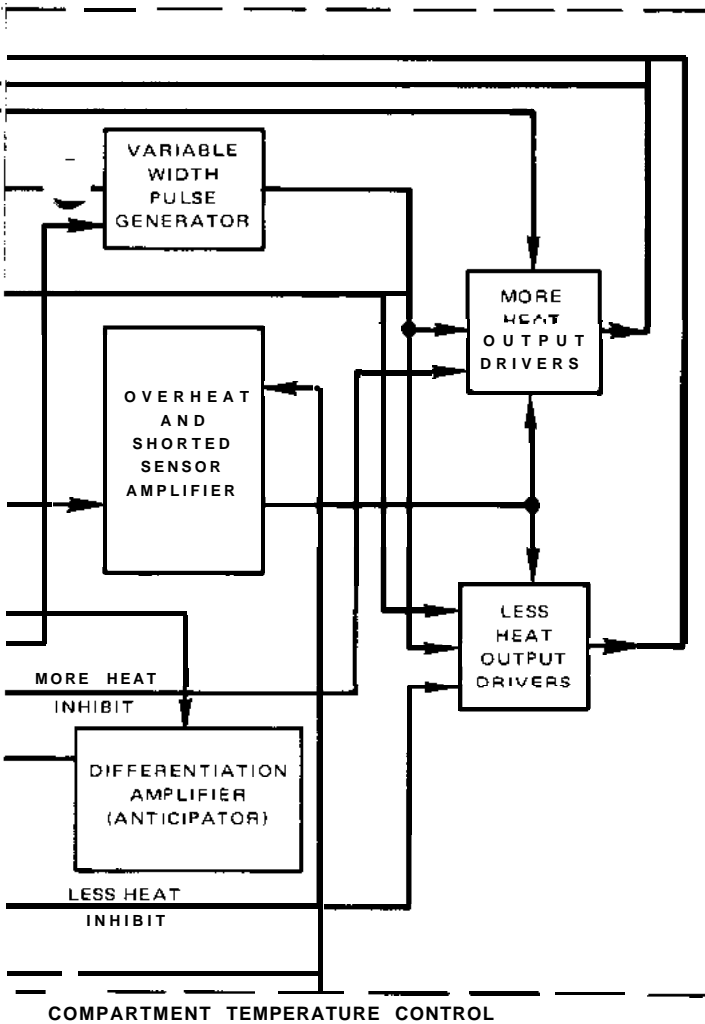


Figure 8

The voltage regulator provides power to the components as required. The automatic controls cycle to operate the temperature control valve intermittently until the cabin temperature reaches the level selected by the temperature selector rheostat.

The error amplifier compares the signal received from the compartment temperature selector (rheostat) with that from the compartment temperature sensor. The error amplifier then emits two signals: One signal to the pulse generator amplifier which controls the length of time that the more-heat and less-heat output drivers are turned on; the other signal is either a more-heat inhibit or a less-heat inhibit signal. With either a more-heat signal or a less-heat signal, both drivers are turned on by the pulse generator; however, the inhibit signal will determine which signal will actually drive the temperature control valve. Any change in temperature selection or a change in cabin temperature will cause the error amplifier to emit signals to correct the error between selected temperature and cabin temperature.

The solid state temperature control system operates on the pulse width modulation principle. The temperature



control valve changes position (opens or closes) at a rate that is decided by the difference between the actual cabin temperature and the selected temperature. If, for instance, it is a cold day and you select a warm temperature on the rheostat - say 30°F outside (and in the cargo compartment) and you select approximately 75°F, the control valve will be moved faster than if the temperature had been, say, 65°F and you selected 75°F. The average speed of the valve is proportional to the error. To provide for stability (prevent overshoots or undershoots), the duct sensor provides a signal to the differentiating amplifier. The duct sensor detects duct temperature and signals the control box to restrict the opening of the valve, preventing surges.

The differentiating amplifier senses the rate-of-change in duct temperature and adjusts the error amplifier to cause the less-heat output to pulse. This pulsing signal tends to prevent temperature overshoots. However, if a temperature selection exceeds existing cabin temperature by more than 15°F, the duct temperature will increase rapidly and the overheat sensor will cause excessive cycling of the temperature for more than 20 minutes. To avoid this condition, an overheat sensor installed in the

supply duct protects the system from overtemperature. If the duct temperature reaches 400°F (210°F for the flight station), a signal is sent to the control box to drive the temperature control valve toward closed. This overheat signal overrides the valve open signals in either automatic or manual operation.

So, the controller (control box) receives signals from three sensors: The cabin sensor (whose signal is compared to the selected temperature); the duct sensor, also called the anticipator; and the overheat sensor. The error amplifier compares actual temperature to selected temperature and supplies a more-heat or less-heat output to the valve actuator. The error amplifier also supplies a signal to the variable-width pulse generator which produces power pulses to the output stages that are proportional to the error signal. The differentiating amplifier calculates the rate of duct temperature change based on a signal from the duct sensor, and adjusts the error amplifier if the rate is too high. This signal from the differentiating amplifier also prevents overshooting while permitting good system response characteristics.

Manual Operation - More Heat

Manual operation for more heat is accomplished by placing the Temperature Control switch in the WAKM position. The system response is basically the same as in AUTO. The manual hot drive signal goes through the controller so the overheat protection circuit will be effective. The manual more heat circuit permits the error amplifier input to be altered and enables the error amplifier to pulse the more-heat output drivers. As the heat increases, the more-heat output pulses become shorter until either the duct high-limit temperature or the desired temperature is reached.

If the duct high-limit temperature is reached either manually or in AUTO, the overheat sensor provides a signal to the controller. This signal causes a slight reduction in supply temperature by driving the valve toward closed far enough to cause a 20° to 30°F drop, and then returns to the original signal condition. Thus, the overheat circuit can result in a cycling action of the valve if the high heat demand persists.

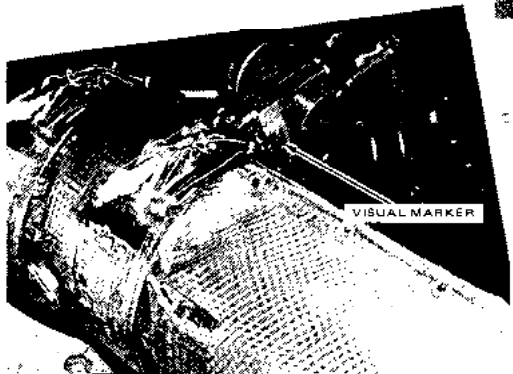
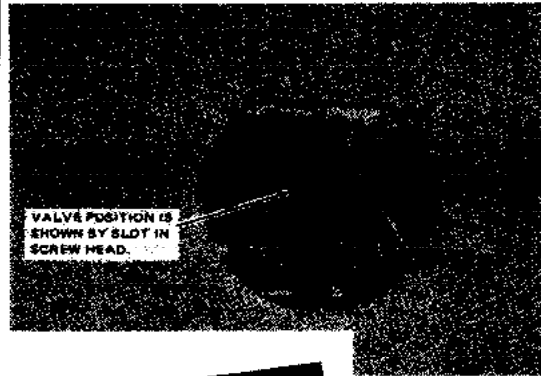
In the event of a shorted overheat sensor, a high temperature condition could not be detected. In such an event, the shorted sensor amplifier sends a signal to the error amplifier resulting in a less-heat signal to drive the temperature control valve toward closed.

Manual Operation - Cool

When the Temperature Control switch is positioned to COOL, power is applied directly to the less-heat actuator of the temperature control valve and the valve drives continuously toward cold.



▲ CARGO COMPARTMENT FLOW CONTROL VALVE



▲ FLIGHT DECK FLOW CONTROL VALVE

▲ FLOOR HEAT DIVERTER VALVE

TROUBLESHOOTING THE SYSTEM

There's probably a different troubleshooting procedure for almost every mechanic that undertakes to correct the squawks on a discrepant air conditioning system. These procedures range anywhere from checking system circuits and operation with a black box to replacing one unit at a time in the system in a process of elimination.

We don't have a new procedure that will solve all air conditioning ills in a few minutes, nor advocate dispensing with your present procedure if it gets the job done in a minimum of time, labor, and equipment. Rather, here are a few ideas which may be helpful in improving your own method.

Squawks written against the cargo compartment air conditioning system usually fall into a general category such as: "The system doesn't keep the compartment warm (or cold)." or, "Cargo compartment temperature can't be regulated - it's either too hot or too cold."

We suggest a plan of troubleshooting which isolates the first component in the system. Then, if it proves satisfactory, keep adding another component to the check

until the entire system is covered. Spelled out in more direct words, this means checking system components in a logical sequence.

If you have a good idea of the cause of the trouble, it won't be necessary to run through the complete check sequence; however, in the event the sequence is not followed, the only sure test that the fault has been corrected is that the system works properly after the suspected component has been replaced.

NOTE

In the following steps, we use the callout "sensor" for both thermostats and sensors.

Start the GTC.

Select the AIR COND GTC position on the Air Conditioning Master switch. (Make sure the Cargo Compartment Shutoff switch and Emergency Depressurization switch are both in NORMAL position.) Place Temperature Control switch in AUTO. There should be enough airflow from the ducts to almost push your hand away.

If flow is weak, or if there is no flow, check the position of the flow control valve. An indicator on the side of the valve tells whether it is open or closed. (The indicator may not hold a steady open position but don't worry about it. The valve merely regulates airflow.)

Next, check the floor-heat diverter valve. With the Underfloor Heating switch OFF, the diverter valve should be fully open. Its position is also shown by an indicator on the valve. You will need a mirror and flash light to check it.

Finally, suspect system leakage at duct joints, or in the heat exchanger and water separator areas. Visual inspection will usually pinpoint this type of trouble.

An inoperative turbine or one with noisy operation and/or smoke will usually be the tip-off to a bad cooling turbine.

Shut down the GTC if you've just completed the airflow check. The control system check is done under static conditions, so no airflow is necessary.

Disconnect the duct anticipator sensor and the hi-limit sensor. If the cargo compartment temperature is above 90°F, remove the cabin sensor and cool it in cold water from a drinking fountain for a couple of minutes. Then, reinstall it.

Place the Air Conditioning Master switch to AIR COND GTC, AIR COND AUTO PRESS, or AIR COND NO PRESS. Turn the Temperature Control switch to AUTO.

The temperature control valve should move (by pulses, and note that it is by pulses) toward warm. One caution here: In any valve operational checks, be alert to the possibility that the valve has moved to the end of its range - either full hot or full cold. If it has, use the manual control (Temperature Control switch to WARM or COOL) to bring the valve back to the middle of its range.

If the valve moves by pulses toward warm, it means the cabin temperature control system is operating as it should. By this one check you have proved that the cabin sensor, control box, and the more-heat side of the control valve are functioning as they should.

If the valve doesn't move in pulses, but moves continuously, it is a good sign that the cabin sensor is at fault. Install a new sensor and recheck valve pulsating operation.

If the valve doesn't move at all, it doesn't prove much of anything. You will have to dig deeper.

Place the Temperature Control switch to WARM. The valve should move toward warm. If it doesn't, either the valve or the control box is at fault.

Turn the Air Conditioning Master switch to OFF. Disconnect the electrical connection on the control valve. Jumper pin A on the circuit connector to pin B on the control valve. (You are furnishing power to the more-heat side of the valve from the cool circuit.) Use a flashlight to be sure your jumper is to the correct pins -- and be careful not to ground the jumper.

Turn the Air Conditioning Master switch back to the previously selected air conditioning position.

Place the Temperature Control switch to COOL.

The temperature control valve should move toward warm, proving the control box is at fault. Replace the control box after turning off the system. If the valve doesn't move, replace the valve.

Turn the Air Conditioning Master switch to OFF and reconnect the control valve electrical connections.

After finishing 3A, repeat check No. 3 in total to prove out the cabin sensor and temperature control box.

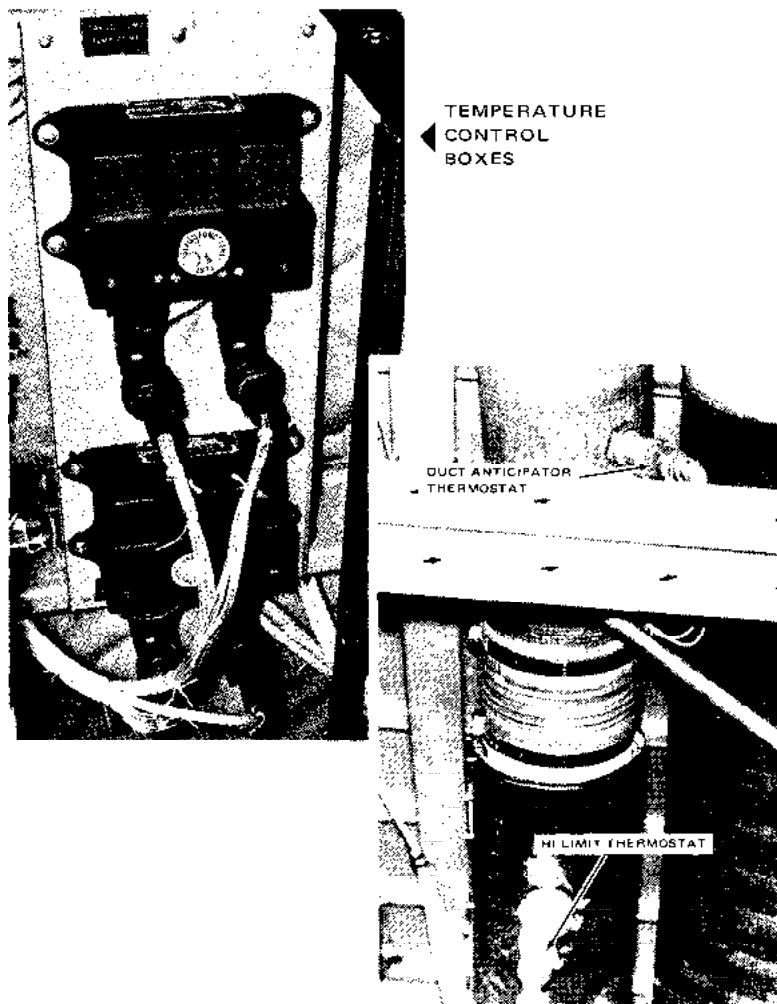
Turn the Air Conditioning Master switch to AIR COND GTC. Place the Temperature Control switch to COOL. The valve should move toward cool. If it doesn't, check the circuitry and valve.

Turn the Air Conditioning Master switch to OFF. Disconnect the cabin sensor electrical plug. (Leave the hi-limit sensor disconnected.) Make sure the duct anticipator sensor is connected to its electrical plug.

Turn the Air Conditioning Master switch to one of the four air conditioning positions. Place the Temperature Control switch in AUTO.

The control valve should move toward WARM. If the valve doesn't move, replace the sensor and repeat check No. 4 from the beginning.

Turn the Air Conditioning Master switch to OFF. Jumper pin A to pin C on the electrical connection for the cabin sensor. This duplicates the action of the duct anticipator sensor.



Turn the Air Conditioning Master switch back to the previously selected position. The control valve should drive toward cool. (If it doesn't, the duct sensor is probably at fault. Replace the sensor and repeat check No. 4 from the jumper step.)

Disconnect the jumper. The valve should stop moving toward warm. Replace the sensor if the valve doesn't move.

Install the hi-limit sensor. The control valve should still move toward warm. (This insures the sensor is not erroneously providing a ground.)

There's One Other Possibility

If all components prove out satisfactorily during your static check, there is still the possibility that the temperature control valve is at fault even though it appears to be acceptable. Some instances are known where the valve motor torque-limit switch has been opening when engine bleed air is used in the system; while under static conditions or with GTC bleed, the valve has operated as it should.

The static check procedure we have just reviewed won't uncover this discrepancy. Therefore, we suggest that if your check fails to uncover any faulty components, consider this possibility.

Engine bleed air is required to check out this item because it places a greater load on the valve during movement from cool to warm than does GTC bleed air or static operation. If the torque limit switch is set too low, the switch will open the circuit and stop valve movement. The control valve should be replaced.

As mentioned at the beginning of the article, we have talked primarily of the cargo system. The flight deck system is similar in operation and troubleshooting. Every possibility for problems and their solutions could not be covered, but we have given you a good start. In a future issue we will discuss the new APU and refrigeration units.



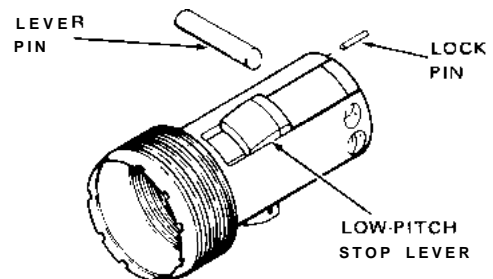
StarTip

CRACKED PROPELLER DOME SHELL

Our Hamilton Standard Resident Representative provided the details of the following incident and asked that it be passed on to you, our readers. While only one of these incidents involved a Hercules, we agree that all concerned should be made aware of this problem.

Inspection for the source of oil running out of a propeller revealed a crack, approximately 4" in length, running fore and aft of the propeller dome shell. This was an extreme case, but not the first - two other similar incidents have occurred. Any crack in the dome shell could be expected to propagate to the point of oil loss, and with a severe leak from the outboard side of the dome, feathering capability could be compromised.

In the above example, propeller teardown revealed that the lock pin for a low-pitch-stop



lever hinge pin had been omitted during propeller assembly following overhaul. This permitted the hinge pin to fall out, become wedged between the propeller piston and dome shell, and crack the dome shell. The obvious answer: care and attention to detail during assembly.

While the flight line mechanic has no control over the foregoing assembly operation, the main point of this message is: Check all propeller oil leaks carefully for source and cause.

Keep Up the Pressure on JetStar Tires

This article first appeared in Lockheed-Georgia's AirLifters service publication in 1969, Volume 3, Number 3. The precautions expressed in it are just as important today. While the coverage here is on high pressure dual tires, you will find that many of the situations apply to all aircraft tires. Not only is the correct tire pressure a necessary safety precaution, it also extends the wear life of the tires. Remember to check your tires every morning when flights are anticipated.

On the JetStar, Type VII high pressure tires cushion taxis, takeoffs and landings. There are good reasons why these small cross-section tires should be inflated to the proper pressure levels in order to give the best service with a maximum of safety.

In the first place, JetStar tires don't hold a lot of air. Hence, even a few pounds air loss cuts the tire's load carrying capacity drastically. And with those heavy sidewalls you just can't guess at how much the tire is deflected, for appearances can be misleading. As little as a quarter-inch change in the rolling radius could mean a 35 PSI drop in pressure. (The foregoing is merely an illustration and not a guide, because the amount of deflection will change with tire age.)

On higher altitude runways the proper tire pressure becomes a matter of real concern, particularly when the JetStar's gross weight is heavy and the takeoff roll is long and fast.

For good tire care, Lockheed recommends that you use an accurate dial-type air gage at least every morning before flight. (See photo on back cover.) Tires should be checked at surrounding temperatures. And it's a good idea to keep a record of tire pressures; then you will learn each tire's characteristics so that any change in its leak rate won't be overlooked.

Air Pressure Gages – A word of caution concerning air pressure gages. Many times, we at Lockheed have found that differences in gage readings are caused, not by changes in air pressure, but by varying accuracies between the different gages being used.

It's not unusual to find an inaccurate tire gage in constant use with a tag on it saying the gage reads a certain number of pounds too high, or too low. Unfortunately, this error will compound itself as different pressures are checked. Example: A gage reading ten pounds high at eighty pounds pressure may well read 25 pounds too high at 150 pounds pressure. Faulty tire gages, therefore, don't belong around an otherwise efficient tire shop. It's wise to take them out of service.

Cold temperatures may affect tire gages and cause pressure readings lower than they actually are. Sometimes, too, you'll come across a gage that a well-meaning person has treated with oil to make it work better. The opposite usually results, for oiling, in itself, will cause incorrect readings and probably render the gage unfit for further service.

You'll find it pays to have tire gages re-calibrated periodically. And it's best to use the same gage for performing an inflation cycle – that is, for checking pressure during the 12- or 24-hour stretch period recommended for new tires. Dial-type gages, of good quality, are a must for all tires regardless of size.

Most people know that high pressure aircraft tires are not designed for continuous running like automobile tires. For one thing, the tread and ply thickness combine to absorb heat; since not enough heat is dissipated, there is a continual temperature rise. Offsetting this tendency somewhat, the higher tire pressures and lower tire deflection work together to slow heat buildup inside the tire. Excessive heat will melt the tire between the tread rubber and the cord plies, causing tread separation or bubbles.

One of the tire manufacturers ran some dynamometer tests to see what would happen to a dual JetStar tire when its adjacent tire blew. The condition simulated was where the airplane is at VR (rotation speed for takeoff) and one tire blows.

The dynamometer accelerated to 140 knots with maximum airplane load. Then the load was doubled to simulate a blowout of the adjacent tire. No failures occurred with the tires at recommended pressure. On successive runs thereafter the tire pressure was reduced until the tire failed when the overload was applied.

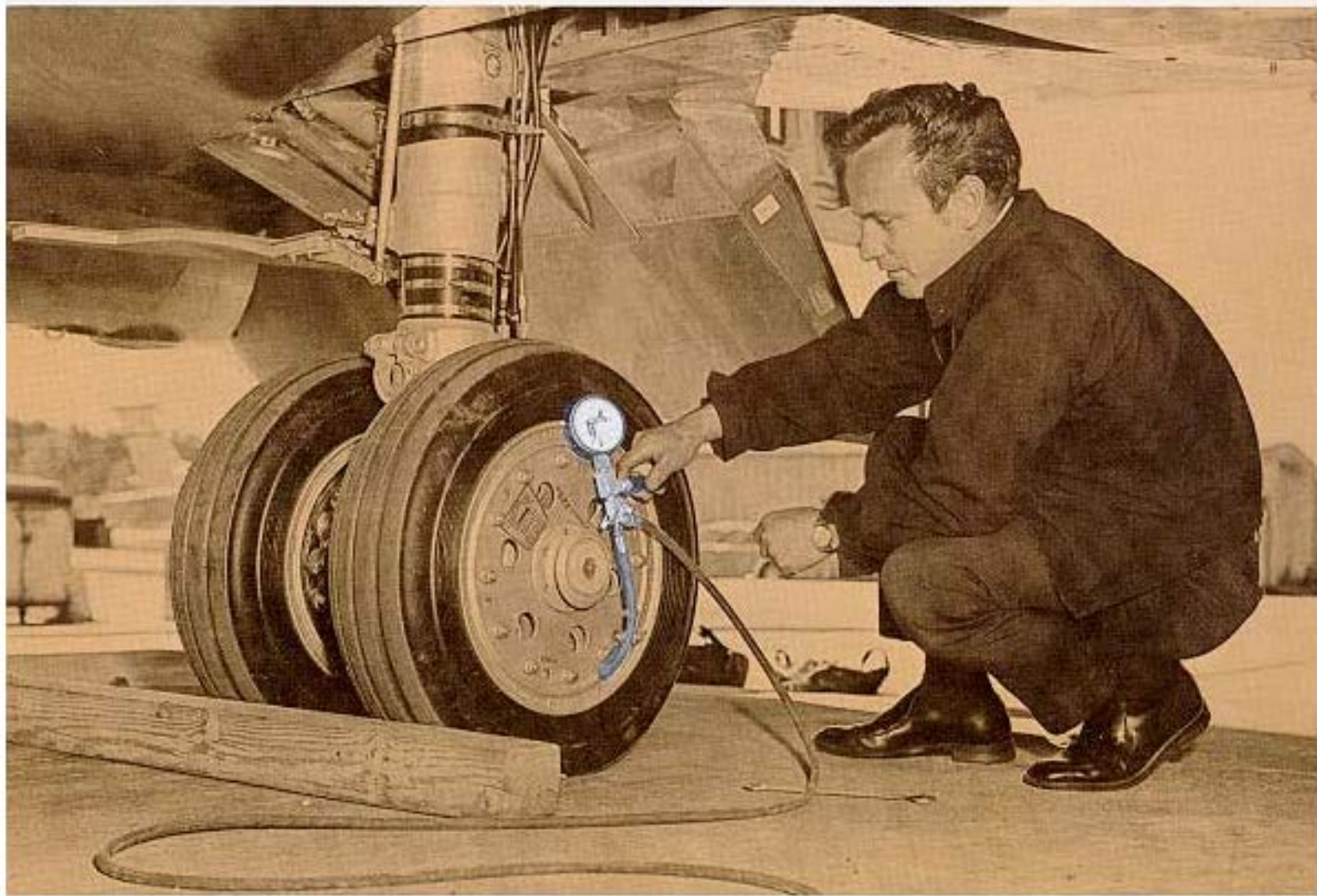
The tire blew at the sidewall. Heat in this dynamometer run was not the primary cause.

To better explain what happened, suppose we bent a thin sheet of aluminum to a small radius. Nothing would happen. If, however, we bent a thicker sheet over the same radius the metal would split on the outside skin of the bend. This, simply, was what took place in the tire. Deflection was so great that the wheel rim and runway failed the tire sidewall by pinching, and the fracture spread around the tire while the wheel rotated. Finally, the tire broke up and threw big pieces of tread around, leaving some of the sidewall to roll to a stop.

With your JetStar tires comes an extremely important safety bonus: These high pressure tires are far less likely to hydroplane on wet runways (JetStar thrust reversers help, too). On the other hand, too-low pressures can significantly shorten tire life, cause a blowout if the adjacent tire fails, and extend an open invitation to dangerous hydroplaning.

All the facts say maintain the recommended pressure so you may expect a long life and the utmost in safety from your Jet Star tires.

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