SERVICE BULLETIN

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SUBJECT:

ELECTRONIC CONTROL TROUBLESHOOTING GUIDE

PURPOSE:

The purpose of this bulletin is to transmit the attached 19C Electronic Control Trouble-shooting Guide.

EQUIPMENT AFFECTED:

19C Hermetic Centrifugal

DESCRIPTION:

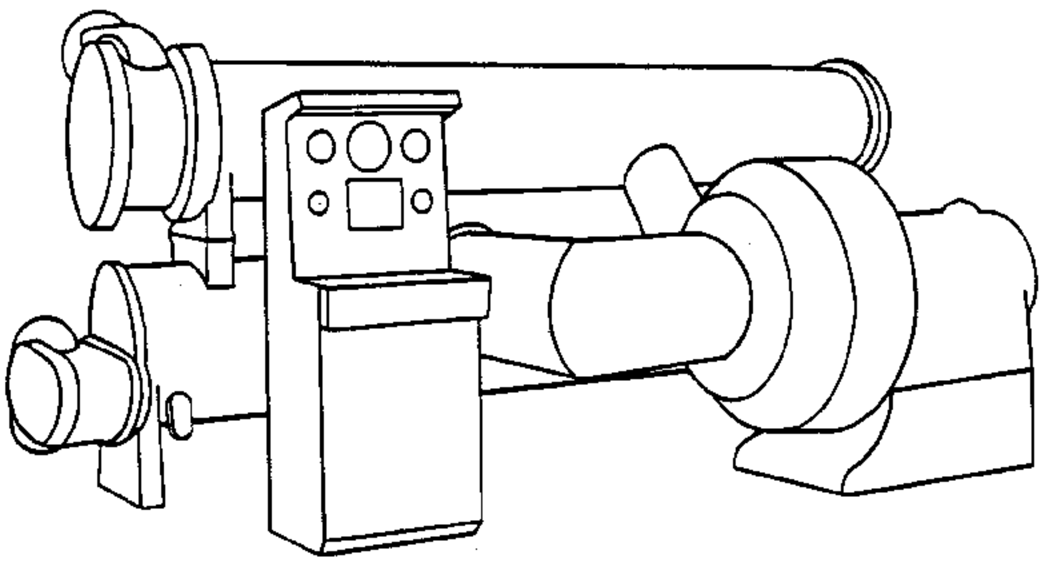
This attachment is divided into two parts. Part I, pages 2 through 12 contains a trouble shooting guide to facilitate servicing the electronic controls. The purpose of this guide is to provide external checks which can be made before the electronic module is replaced if proper control cannot be attained.

Part II, pages 13 through 30 contains a detailed description of the electronic control system and the bridge circuit. This information is intended as general background information and does not imply that servicemen must be electronic technicians. A thorough understanding of Part I is all that is required to trouble shoot the 19C controls.

Carrier

19C

HERMETIC CENTRIFUGAL REFRIGERATION MACHINE



ELECTRONIC CONTROL TROUBLE-SHOOTING GUIDE

19C-5Z

PART I

ELECTRONIC CONTROL - TROUBLE SHOOTING GUIDE

GENERAL TROUBLES

There are several basic steps which must be taken when trouble shooting the 19C electronic controls. They are as follows:

1. All electrical connections must be checked for tightness.
2. All electronic tubes must be checked. Be sure all tubes are in designated tube sockets.
3. Be sure plug connectors are installed properly. Check plug pins to be sure none have been bent.
4. On the chilled water control, the relays must act with the water temperature or all other efforts to stabilize the system will be unsuccessful. Therefore, observe that water temperature changes do actuate the relays.
5. The motor overload control cannot be calibrated unless the signal from the starter is between .45 and .55 volts. This is the first item to check when trouble is experienced with the motor overload controller.
6. Always observe the operation of the relays as they may be a clue to the problem that exists.

The following summation of possible troubles with the 19C electronic control parallels the Set-Up procedure as outlined in the Initial Startup Instructions. After the trouble has been corrected, recalibrate the modules by following the procedure as outlined in the Initial Startup Instructions.

It is intended that this outline be used to differentiate between external and internal module troubles. If trouble is determined to be in the electronic components they should be replaced.

TROUBLE	MINNEAPOLIS HONEYWELL	BARBER COLMAN
1. Zero and Span Adjustment **a. Zero adjusting screw will not adjust capacity meter to zero.**	a. The vanes may be in the open instead of closed position. Terminal 21 and 22 should be de-energized. Check the vane close switch with a volt ohmeter. The vane switch should be closed. Check the oil circuit piping. Check the wiring of the vane potentiometer which controls the vane indicator, terminals 31, 32 and 33. With the vanes closed, the resistance between 31 and 32 should be approximately 50 ohms and between 32 and 33, 350 ohms (these values are only approximate and may vary as much as 20 ohms). Open the vanes while having an ohmeter installed between terminals 31 and 33. The resistance should increase from 50 to approximately 350 ohms. Check for open or ground on all positions of the vane potentiometer. If this check is done at the terminal module and indicates a bad vane potentiometer, repeat the above at the terminal block at the potentiometer. Do not replace the potentiometer until it is removed and checked separately. If grounded or shorted by itself, replace.	a. The vanes may be in the open instead of closed position. Terminal 21 and 22 should be de-energized. Check the vane close switch with a volt ohmeter. The vane switch should be closed. Check the oil circuit piping. Check the wiring of the vane potentiometer which controls the vane indicator, terminals 31, 32 and 33. With the vanes closed, the resistance value between 31 and 32 should be approximately 50 ohms and between 32 and 33, 350 ohms (these values are only approximate and may vary as much as 20 ohms). Open the vanes while having an ohmeter installed between terminals 31 and 33. Resistance value should increase from 50 to approximately 350 ohms. Check for open or ground on all positions of the vane potentiometer. If this check is done at the terminal module and indicates a bad vane potentiometer, repeat the above at the terminal block at the potentiometer. Do not replace the potentiometer until it is removed and checked separately. If grounded or shorted by itself, replace.

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TROUBLE	MINNEAPOLIS-HONEYWELL
a. Zero adjusting screw will not adjust capacity meter to zero. (continued)	If the above checks show a good potentiometer, then the capacity indicator should be replaced. Replace the terminal module. If this does not produce the desired results, the console panel should then be replaced.
b. Span adjustment screw will not adjust meter.	b. Same procedure as outlined in 1a. above.
c. Capacity indicator erratic	c. Same procedure as outlined in 1a. above.
d. Meter operates backwards.	d. Check vane potentiometer as outlined in 1a. above. Change polarity by changing leads on the back of the meter. If this does not correct trouble, replace the meter or console panel.
2. Motor overload control (assume capacity control switch in manual position and current demand knob in 100% position)	
a. Relays cannot be adjusted to hold vanes at 100% full load amperage.	a. Check the voltage between terminals J23 and J24. This voltage must be between .45 and .55 volts at full load amps or ~~module~~ ~~cannot~~ be calibrated.
b. The full load signal to J23 and J24 is not within .45 to .55 volt range.	The value of the resistor in the current transformer circuit in the starter is not correct. If the voltage is below .45 the resistance must be increased. If the voltage is above .55 the resistance must be decreased.

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BARBER-COLMAN

If the above checks show a good potentiometer, then the capacity indicator should be replaced.

Replace the control module.

If this does not produce the desired results, the console panel should then be replaced.

b. Same procedure as outlined in 1a. above.

c. Same procedure as outlined in 1a. above.

d. Check vane potentiometer as outlined in 1a. above.

Change polarity by changing leads on the back of the meter.

If this does not correct trouble, replace the meter or console panel.

a. Check the voltage between terminals J23 and J24. This voltage must be between .45 and .55 volts at full load amps or module cannot be calibrated.

b. The value of the resistor in the current transformer circuit in the starter is not correct. If the voltage is below .45 the resistance must be increased. If the voltage is above .55 the resistance must be decreased.

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TROUBLE	MINNEAPOLIS-HONEYWELL
b. The full load signal to J23 and J24 is not within .45 to .55 volt range. (Continued)	Resize if a fixed resistor, change as required if a variable resistor. The value of the resistor in the current transformer circuit is normally on the order of .10 ohms to .20 ohms. Warning: Do not attempt to make any adjustments on the current transformer circuit while the machine is operating. The secondary coil of an energized current transformer should never be open.
c. Relays open preventing vanes from moving toward the open position.	c. Electrical demand control knob set at less than 100% position. J24 grounded in the starter instead of J23. Note: Early machines without the electrical demand control knob will not operate with a ground on the current transformer. Signal above .55 volts Check for loose connections and faulty tubes. Replace external diode. (1N34 located approximately in the center of the module). Replace motor overload module. If this does not correct trouble, replace terminal module.
d. Relays closed and cannot be calibrated to open.	d. Voltage at J23 and J24 is below .45 volts. (See item 2b) Check for loose connections. Check for faulty tubes and replace if necessary. Replace motor overload module.

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Resize if a fixed resistor, change as required if a variable resistor. The value of the resistor in the current transformer circuit is normally on the order of .10 ohms to .20 ohms.

Warning: Do not attempt to make any adjustments on the current transformer circuit while the machine is operating. The secondary coil of an energized current transformer should never be open.

c. Electrical demand control knob set at less than 100% position.

J24 grounded in the starter instead of J23.

Faulty overload micropositioner or overload relay. Replace.

Signal above .55 volts.

Check for loose connections and faulty tubes.

Replace controller.

d. Voltage at J23 and J24 below .45 volts. (See item 2b)

Check for loose connections.

Check for faulty tubes, overload micro positioner and overload relay.

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TROUBLE	MINNEAPOLIS HONEYWELL
e. Relays close and vanes will not open.	e. Check terminal J18 to ground for 115 volts. If zero volts, then trouble is with auxiliary contact in starter or loose wire. With the thermostatic switch in manual position, terminal 21 to ground should read 115 volts. Depress "higher" push button and check voltage between terminal 22 to ground. Voltage should be 115 volts. If either voltage is zero volts then trouble is in high or low push button switches or internal wiring. Replace faulty pushbutton. Check for dirty CR1 and CR2 relay contacts. Check wiring to solenoid valves.
f. 100% relay opens. 105% relay will not open.	f. Check tubes and replace if faulty. Check for loose connections. Replace module if the relay still will not open at 110%. To check 105% relay (CR1) hold 100% relay (CR2) closed. If 105% relay does not open before machine starter overload relay stops machine, replace motor overload module.

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e. Check terminal J18 to ground for 115 volts. If zero volts, then trouble is with auxiliary contact in starter or loose wire.

With the thermostatic switch in manual position, terminal 21 to ground should read 115 volts. Depress "higher" push button and check voltage between terminal 22 to ground. Voltage should be 115 volts. If either voltage is zero volts then trouble is in high or low push button switches or internal wiring. Replace faulty pushbutton.

Interchange overload relay with either CRC or CRO relay to check operation of overload relay. Replace if faulty.

Check wiring to solenoid valves.

f. Check tubes and replace if faulty.

Check for loose connections.

Place thermostatic switch in "manual" position. Operate "lower" pushbutton and observe if relay CRC operates.

Replace overload micro positioner.

To check 105% relay, wire across terminals J18 to J22. Vanes will continue to open. At 105% of full load amps observe operation of CRC relay.

Replace control if relay still will not open at 110%.

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TROUBLE	MINNEAPOLIS HONEYWELL
g. 105% relay opens before 100% relay.	g. Remove the ground on the current transformer in the starter. Isolate motor overload module from its hold down bracket. Check for incorrect control wiring. Replace motor overload module.
3. Chilled Water Control a. Relays CRC and CRO on chilled water module will not operate properly.	a. Check shielding on wires J25, J26, J27, J29 and J30 to be grounded only to terminal J28 in the console. Braided shielded wire to be 20 or 22 gauge Beldon wire 8735-22-3 or equal. Check voltage between terminals J29 and J30. Voltage should be between 6 and 8 volts. Zero volts indicates a short circuit in the resistance element. Approximately 15 volts indicates a grounded circuit. Replace resistance element and/or shielded wiring. Remove wires from terminals J26, J25 and J27. With the vanes closed the resistance value between terminals J25 and J26 should be approximately 350 ohms, between J26 and J27, approximately 50 ohms. Connect ohmmeter between terminals J25 and J26 at the potentiometer (with vanes closed) and rotate potentiometer through full travel. Resistance (ohms) should slowly decrease from approximately 350 ohms to 50 ohms. Next connect ohmmeter between terminals J26 and J27 and repeat potentiometer rotation. Resistance value should increase from 50 ohms to 350 ohms. If readings indicate a broken wire or ground, replace potentiometer. Trace wiring to insure correct terminals are connected

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g. Replace overload micro-positioner.

Check for incorrect control wiring.

Replace control module.

Check shielding on wires J25, J26, J27, J29 and J30 to be grounded only to terminal J28 in the console. Braided shielded wire to be 20 or 22 gauge Beldon wire 8735-22-3 or equal.

Check voltage between terminals J29 and J30. Voltage should be approximately 6 volts. Zero volts indicates a short circuit in the resistance element. Approximately 12 volts indicates a grounded circuit. Replace resistance element and/or shielded wiring.

Remove wires from terminals J26,J25 and J27. With the vanes closed the resistance value between terminals J25 and J26 should be approximately 350 ohms; between J26 and J27 approximately 50 ohms.

Connect ohmmeter between terminals J25 and J26 at the potentiometer (with vanes closed)and rotate potentiometer through full travel. Resistance (ohms) should slowly decrease from approximately 350 ohms to 50 ohms. Next connect ohmmeter between terminals J26 and J27 and repeat potentiometer rotation. Resistance value should increase from 50 ohms to 350 ohms. If readings indicate a broken wire or ground, replace potentiometer.

Trace wiring to insure correct terminals are connected.

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TROUBLE	MINNEAPOLIS-HONEYWELL
a. Relays CRC and CRO on chilled water module will not operate properly. (Continued)	Check for faulty tubes. Replace if necessary. Control wiring should not be run in same conduit with higher voltage wiring. Replace chilled water module.
b. Capacity balance voltage above 2 or 3 volts. (If satisfactory operation of chilled water module cannot be attained).	b. Use 50 to 60 volt scale on volt ohmeter as lower range may load the amplifier and give a false reading. Retain the minimum voltage possible and calibrate the chilled water module. If satisfactory control is not obtained check for faulty tubes and loose connections. Check shielded wire to the resistance element. Replace chilled water module only if satisfactory operation cannot be attained.
c. Chilled water temperature hunting excessively.	c. Observe the operation of the chilled water relays with the changing water temperature. The relays must quickly ~~sense a temperature~~ change or any efforts to correct the hunting condition will not be successful. Use dielectric grease between the resistance element and the element well. Check for condensation at resistance element terminals. Use dielectric grease on the terminals. Check for air in the chilled water circuit

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Check for faulty tubes. Replace if necessary.

Control wiring should not be run in same conduit with higher voltage wiring.

Replace chilled water micro-positioner on controller.

Replace relays CRC and CRO

Replace controller.

b. Not applicable.

c. Observe the operation of the chilled water relays with the changing water temperature. The relays must quickly sense a temperature change or any efforts to correct the hunting condition will not be successful.

Use dielectric grease between the resistance element and the element well.

Check for condensation at resistance element terminals. Use dielectric grease on the terminals.

Check for air in the chilled water circuit.

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TROUBLE	MINNEAPOLIS-HONEYWELL
c. Chilled water temperature hunting excessively. (Continued)	Check for proper immersion of resistance element in leaving chilled water. Check for external effects on the water circuit such as changing GPM and quick acting bypass valves, etc. Throttle range may not be stabilizing the chilled water controller. Reset the throttling range adjusting screw. With throttle range added, the machine controls at a lower chilled water temperature as the vanes close. This is normal. If machine controls at a higher chilled water temperature, reverse terminals J25 and J27 as the throttle range adjustment may be backwards. Check the vane follow-up potentiometer J25 to J26 for approximately 350 ohms with the vanes closed; J26 to J27 for approximately 50 ohms with the vanes closed. In addition, check for open or grounded potentiometer (see item 3-a). Change the vane speed and differential adjustment between relays as necessary. Check the control point adjustment potentiometer on the console panel for open or ground. Check for faulty tubes and loose connections. Replace chilled water module.

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Check for proper immersion of resistance element in leaving chilled water.

Check for external effects on the water circuit such as changing GPM and quick acting bypass valves, etc.

Throttle range may not be stabilizing the chilled water controller. Reset the throttling range adjusting screw.

With throttle range added, the machine controls at a lower chilled water temperature as the vanes close. This is normal. If machine controls at a higher chilled water temperature, reverse terminals J25 and J27 as the throttle range adjustment may be backwards.

Check the vane follow-up potentiometer J25 to J26 for approximately 350 ohms with the vanes closed, J26 to J27 for approximately 50 ohms with the vanes closed. In addition, check for open or grounded potentiometer (see item 3-a).

Change vane speed and differential between CRC and CRO relays. On machines shipped before April 1st, 1960, the differential was controlled by a resistor between "GR" and "Grid". On machines shipped after April 1, 1960, the external resistor was eliminated. If an increase in differential is desired, a 3900 ohm resistor between "Grid" and "GR" will increase the differential to $1\frac{1}{4}$ F. (Refer to bulletin 19SB-60-7).

Check the control point adjustment potentiometer on the console panel for open or ground.

Replace chilled water micro-positioner and relays CRC and CRO.

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TROUBLE	MINNEAPOLIS-HONEYWELL
c. Chilled water temperature hunting excessively. (Continued)	
4. Chilled water module needs replacing, none immediately available.	4. Can operate machine by switching capacity control switch to manual and operating higher and lower push buttons manually. Watch leaving chilled water temperature.
5. Motor overload module needs replacing, none immediately available.	5. Place capacity control on manual with ammeter installed in main motor circuit. Block in overload relays CR1, CR2 and operate manual push buttons. Do not exceed full load amps and watch leaving design chilled water temperature.
6. Miscellaneous	6. Check 5 amp fuse in control circuit if control cannot be energized. Diode can be installed backwards. There should be a white dot to align diode with socket. Tubes in module can be switched to check tube failures. Check voltage of power source. Should be 115 volts.
NOTES:	NOTES:

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Replace controller.

4. Can operate machine by switching capacity control switch to manual and operating higher and lower push buttons manually. Watch leaving chilled water temperature.

5. Place a jumper between J18 or J3 to J22 to open the vanes. To hold the vanes, remove the jumper. Push "lower" button on console panel to close vanes (with jumper removed). Do not exceed full load amps. Watch leaving chilled water temperature.

The 3 relays are identical. They can be interchanged to check their operation.

The micro-positioners cannot be interchanged.

Check voltage of power source. Should be 115 volts.

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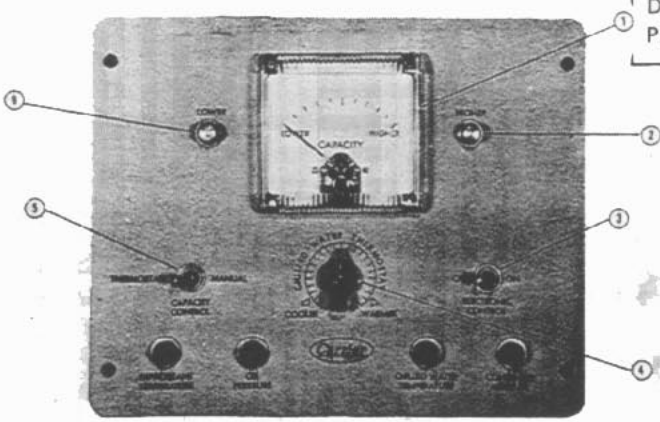
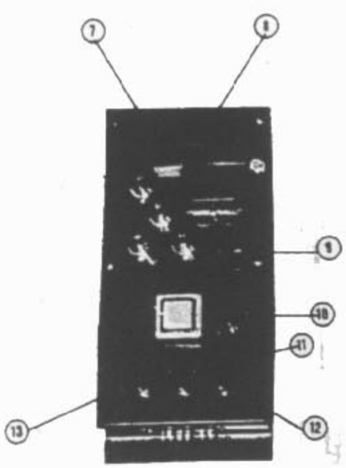
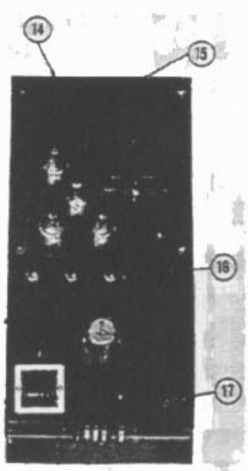


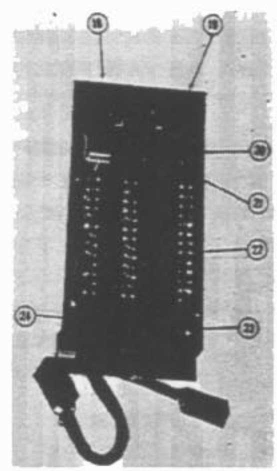
CONSOLE PANEL



CHILLED WATER MODULE



MOTOR OVERLOAD MODULE



JUNCTION MODULE

FIGURE 1
MINNEAPOLIS-HONEYWELL ELECTRONIC CONTROLS

1. Capacity indicator
2. Push Button - higher capacity
3. Electronic Control On-Off Switch
4. Chilled Water Thermostat
5. Capacity Control Thermostatic - Manual Switch
6. Push Button - lower capacity
7. Relay CRC
8. Relay CRO
9. Test Jack
10. Throttle Range Adj. Screw
11. Capacity Balance Adj. Screw
12. Differential Adj. Screw
13. Calibration Adj. Screw
14. Relay CR1
15. Relay CR2
16. Electrical Demand Control Knob
17. Calibration Adj. Screw
18. Relay (Con. High Pressure Cutout)
19. Relay (Refrig. Low Temperature Cutout)
20. Span Adj. Screw
21. Zero Adj. Screw
22. Terminal Strip
23. Reset (Refrig. Low Temperature Cutout)
24. Control Circuit Fuse

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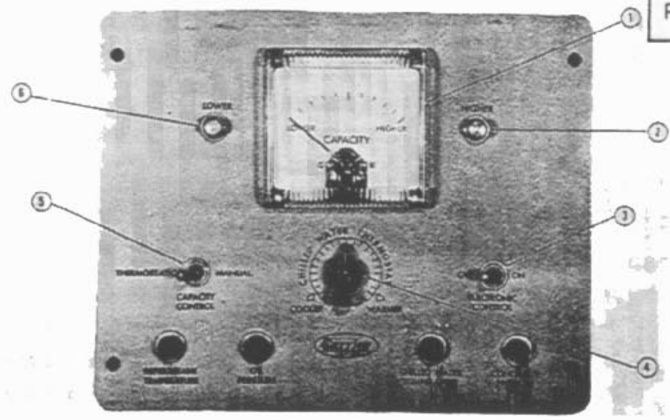

CONSOLE PANEL

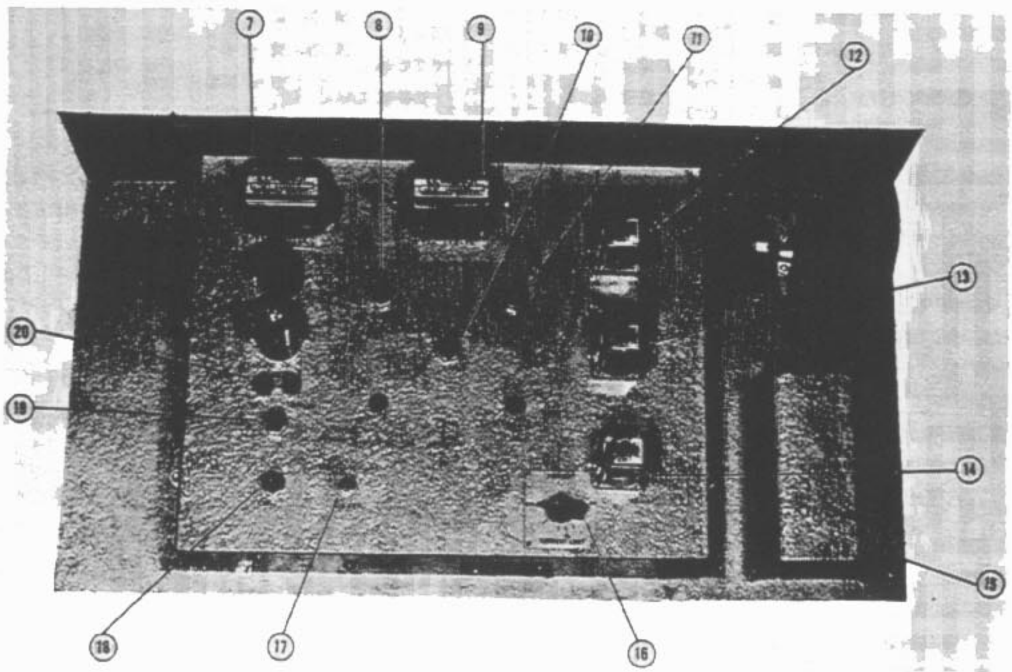

FIGURE 2
BARBER-COLMAN ELECTRONIC CONTROL

1. Capacity Indicator
2. Push Button - Higher Capacity
3. Electronic Control On-Off Switch
4. Chilled Water Thermostat
5. Capacity Control Thermostatic - Manual Switch
6. Push Button - Lower Capacity
7. Chilled Water Micro - Positioner
8. Zero Adjustment Screw
9. Overload Micro-Positioner
10. Calibration Adjustment Screw (Motor Overload)
11. Span Adjustment Screw
12. Overload Relay
13. Relay CRO
14. Relay CRC
15. Refrigerant and Condenser Relays
16. Electrical Demand Control Knob
17. Reset Button, Refrig. Low Temp. Cutout
18. Calibration Adj. Screw (Chilled Water)
19. Throttle Range Adjustment Screw
20. Fixed Resistor (Differential Factory Set)

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PART II

ELECTRONIC CONTROL SYSTEM

1. General Description

The electronic control system consists of two circuits; one for chilled water temperature and the other for motor overload which position the prewhirl vanes through a hydraulic motor. Under normal conditions, the water temperature leaving the cooler is controlled by the chilled water module. A resistance element immersed in the chilled water is sensitive to temperature changes of leaving water from the cooler. The element is part of a bridge circuit* from which signals are strengthened by an electronic amplifier which in turn activates relays. The relays open and close solenoid valves which feed or bleed oil to and from the hydraulic prewhirl vane motor. When the temperature of the water leaving the cooler increases, the vanes will move toward the open position. A decrease in temperature results in a movement toward the closed position.

Motor overload is detected by a current transformer and resistor in the starter. An increase in current flow causes a change in voltage drop across the resistor. This voltage is amplified sufficiently to activate relays. The relays are located in the circuit to over-ride the chilled water control relays.

The console panel includes push button switches for manual operation of the prewhirl vanes, a remote prewhirl vane position indicator, and safety control lights which indicate the cause of a shutdown. A vane close switch together with an interlocking circuit insures the prewhirl vanes being closed before the compressor motor will start. An auxiliary contact in the starter prevents the prewhirl vanes from opening until the motor attains full speed.

The solenoid valves controlling the hydraulic motor are so arranged that when de-energized they will provide oil pressure to one side of the piston and bleed the other side closing the vanes.

2. Chilled Water Temperature Control Operation

a.) General

The chilled water temperature is controlled by a sensing resistance element in the leaving water line. A rise in temperature sends a signal through the chilled water amplifier to position the prewhirl vanes toward open. The inverse also occurs. The chilled water resistance element is part of a bridge circuit and any unbalance in the bridge caused by resistance change due to temperature change is detected by the amplifier.

* For description of the electronic bridge circuit, see page 16.

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b.) Barber-Colman

Referring to Figure 3, if the water temperature is at the control point and the bridge circuit is in balance, then the chilled water micro-positioner will be in the "hold" position and both relay coils CRC, normally closed, and CRO, normally open, will be de-energized.

Under this condition with solenoid valve "F" energized and solenoid valve "G" de-energized, both sides of the hydraulic piston are subject to oil pressure which keeps the piston in a fixed position.

If the water temperature rises above the set point, the micro-positioner goes to the "open" position and relay coil CRO is energized. This energizes solenoid valve "G" permitting oil to bleed from one side of the piston (Port B) while pressure on the lower side (Port A) forces the piston open until a new temperature equilibrium position is reached.

The micro-positioner will then go to the "hold" position and relay coil CRO will be de-energized causing the vanes to stop in whatever position they happen to be in.

A similar action takes place if the water temperature drops below the set point. The micro-positioner goes to the "close" position energizing relay coil CRC which will de-energize solenoid valve "F" and bleed oil from the hydraulic motor. This allows the oil pressure from solenoid valve "G" to slowly close the prewhirl vanes until a new temperature equilibrium position is reached.

c.) Minneapolis-Honeywell

Referring to Figure 4, if the water temperature is at the control point and the bridge circuit is in balance, the chilled water module will be in the hold position and the left relay (CRO) will be open and the right relay (CRC) closed. Under this condition with solenoid valve "F" energized and "G" de-energized, both sides of the hydraulic piston are subject to oil pressure which keeps the piston in a fixed position.

If the water temperature rises above the set point, the chilled water module goes to the "open" position and relays CRC and CRO are closed. This energizes solenoid valves "G" and "F" permitting oil to bleed from the upper side of the piston (Port B) while pressure on the lower side (Port A) forces the piston open until a new temperature equilibrium position is reached. The chilled water module will then go to a "hold" position and the left relay (CRO) will be open and the right relay CRC remain closed causing the vanes to stop in whatever position they happen to be in.

A similar action takes place if the water temperature drops below the set point. The chilled water module goes to the closed position, with relay CRC and CRO open which will de-energize solenoid valve "F" and "G" and bleed oil from the hydraulic motor. This allows the oil pressure from solenoid valve "G" to slowly close the prewhirl vanes until a new temperature equilibrium position is reached.

3. MOTOR OVERLOAD CONTROLS

a). General

Motor overload is detected by a current transformer and resistor circuit in the starter. An increase in current flow causes a change in voltage across the fixed resistor. The voltage drop across the resistor is compared to a "reference" voltage supplied in the motor overload module circuit, the value of which is set to correspond to the rated current of the compressor motor. The motor overload relays are activated by the voltage difference (between "reference" voltage and actual voltage drop across the resistor) and are located in the circuit to over-ride the chilled water control relays.

The voltage signal between terminals J23 and J24 should be between .45 to .55 volts when the motor reaches full load amperage.

b). Barber-Colman

Referring to figure 3, during normal operation the overload micro-positioner is in the "under 100%" position. If the motor current flow reaches 100% of full load amps, the micro-positioner goes to the "100% to 105%" position, de-energizing relay coil "R" and contact "R", de-energizing relay CRO and solenoid valve "G" causing the vanes to hold.

If the motor current continues to increase to 105% of full load amps, the micro-positioner moves to the "over 105%" position, energizing relay coil CRC, opening contact CRC and de-energizing solenoid "F" causing the vanes to close until the current decreases to approximately 103%. The micro-positioner will then go to its 100% position, relay coil CRC will be de-energized causing the vanes to stop closing.

When the current drops below 97%, the micro-positioner will go to the "under 100%" position, relay coil "R" will energize and the chilled water control will control the position of the prewhirl vanes.

c.) Minneapolis-Honeywell

Referring to figure 4, if the current flow reaches 100% of full motor rating, the right relay (CR2) will open which will de-energize solenoid valve "G" and prevent the vanes from opening further.

If the current continues to increase and reaches approximately 105% of full motor rating, the left relay (CR1) will open which de-energizes solenoid valve "F" causing the vanes to close and reducing the load until the current is down to approximately 103%. The left relay CR1) will then close causing the vanes to stop moving.

When the current drops below approximately 97%, relay CR2 will close and the chilled water control will take over, controlling the prewhirl vanes by activating relays CRC and CRO.

4. ELECTRONIC CONTROL BRIDGE CIRCUIT

The 19C electronic control is essentially a Wheatstone bridge circuit as illustrated in Figure 5. (A Wheatstone Bridge is a device used to determine the value of an unknown resistance). Voltage is applied to the bridge circuit and when the total resistance on each side of the bridge is equal, the bridge circuit will be in balance and the electronic amplifier to ground will read zero volts. Under these conditions the vanes will be in the hold position.

When the chilled water temperature changes, the resistance value of the resistance element will change and thus the resistance side (A) of the bridge will be different than side (B). This will produce a voltage drop between the electronic amplifier and ground or across the bridge circuit, and the control relays will be activated. An increase in chilled water temperature increases resistance and correspondingly a decrease in chilled water temperature decreases resistance.

This same reasoning applies to the control point adjustment and the calibration knob. Changing either one of these variable potentiometers during the adjustment of the 19C control will change the resistance of one side of the bridge and thus shift the point at which the bridge is in balance to a different chilled water temperature.

Figure 5 shows how the throttle range feature is incorporated. If the throttle range adjustment is turned to its counterclockwise stop, it has the effect of removing the vane potentiometer from the bridge circuit. However, if the throttle range adjustment is set for a portion of its travel, the operation of the vanes and potentiometer will remove more resistance from side A than is really required, causing the vanes to stop <u>before</u> the chilled water temperature reaches the set point. This prevents "hunting" of the chilled water temperature.

5. PROPORTIONING AND FLOATING CONTROL

(a) General

Proportional and floating control are incorporated in the 19C electronic control system. Proportional control is generally used on comfort air conditioning applications. At partial loads it provides a lower leaving chilled water temperature and therefore a lower relative humidity in the condition spaces.

Floating control provides a constant leaving chilled water temperature. However, it is strictly an on-off control and considerable hunting of chilled water temperature may result when floating control is used on a changing load condition.

(b) Proportional Control

Proportional Control permits the leaving water temperature to drop in proportion to the load as shown in Figure 6 by adding throttling range. A throttling range is used to prevent hunting. The added throttle range resistance to side A of the bridge (Figure 5) causes the amplifier to sense that the chilled water is hotter than it actually is, thus will cool to below the set point by the amount of throttle range added. For example, assume proportional control is set to regulate to 45°F at full load. With a 3°F throttle range, the machine controls the leaving water at 42°F when the vanes are in the closed position.

In most instances only a minimum amount of throttle range is desirable for good control and system performance. The throttling range is adjustable from 0 to 10° on Minneapolis-Honeywell and from 0 to 30° on Barber-Colman controls. (A recent Barber-Colman revision changed the throttle range from 0 to 20 degrees.)

The limits govern the vane position when the temperature is changing. The upper limit as shown in Figure 6 shows vane positions when the temperature is increasing and the lower limit shows vane positions when the temperature is decreasing. The area between the limits is called the "dead zone". As long as the leaving water temperature remains in this zone, the vanes will be stationary.

The addition of throttling range will cause a shift in the chilled water control point. The electronic controls should be adjusted to obtain design chilled water temperature at full load conditions.

(c) Floating Control

Floating control does not incorporate the throttling range adjustment and regulates the leaving chilled water within the differential setting of the design temperature under steady operating loads. Under fluctuating load conditions, floating control has a tendency to over-position the capacity prewhirl vanes which may result in a hunting chilled water temperature. See Figure 7.

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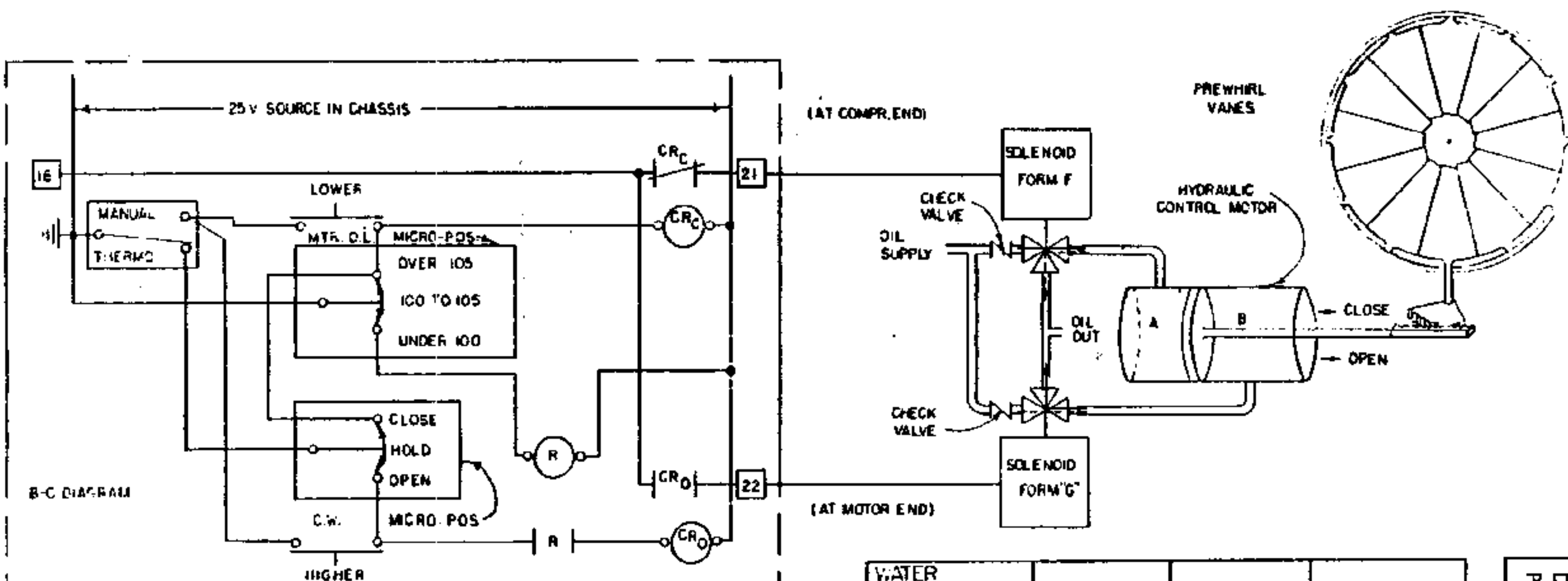

FIGURE 3

BARBER-COLMAN CONTROL DIAGRAM

WATER TEMPERATURE	SOLENOID F	SOLENOID G	VANE MOTION
HIGH	ENERGIZED	ENERGIZED	OPEN
AT SET POINT	ENERGIZED	DEENERGIZED	STATIONARY
LOW	DEENERGIZED	DEENERGIZED	CLOSE

ENERGIZED = ————→
DEENERGIZED = – – – –→

(REVISED 9-28-'60)

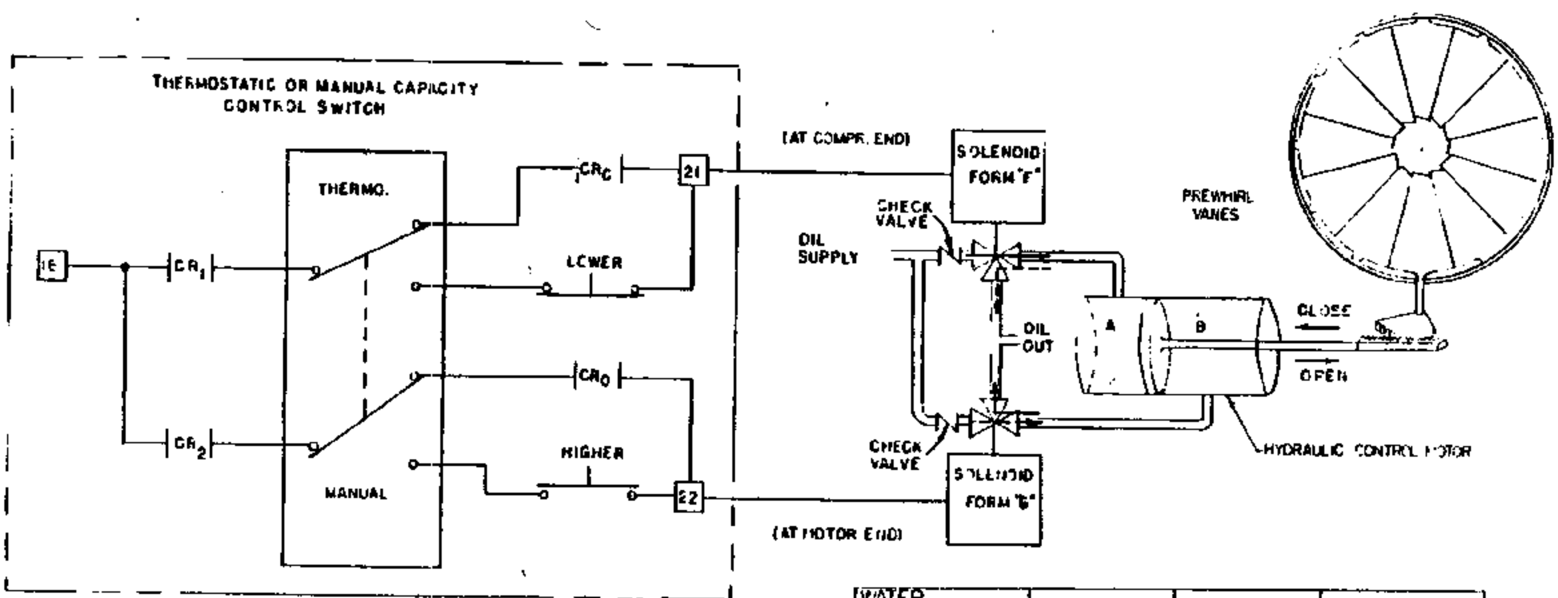

FIGURE 4

MINNEAPOLIS-HONEYWELL CONTROL DIAGRAM

WATER TEMPERATURE	SOLENOID F	SOLENOID G	VANE MOTION
HIGH	ENERGIZED	ENERGIZED	OPEN
AT SET POINT	ENERGIZED	DEENERGIZED	STATIONARY
LOW	DEENERGIZED	DEENERGIZED	CLOSE

ENERGIZED = ————
DEENERGIZED = - - - - -

(REVISED 9-28-60)

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SERVICE BULLETIN

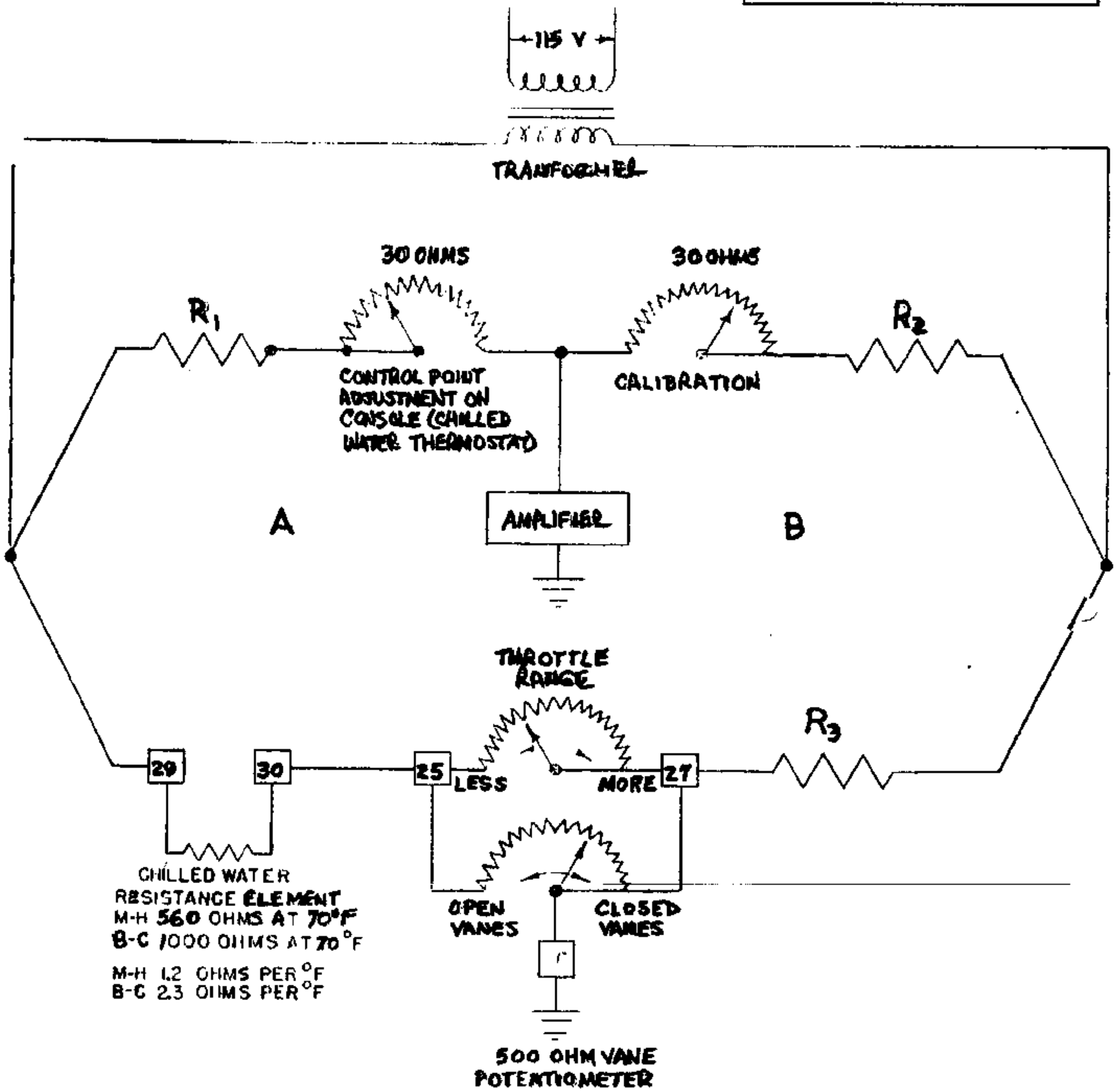

FIGURE 5

BRIDGE CIRCUIT - ELECTRONIC CONTROL

SERVICE BULLETIN

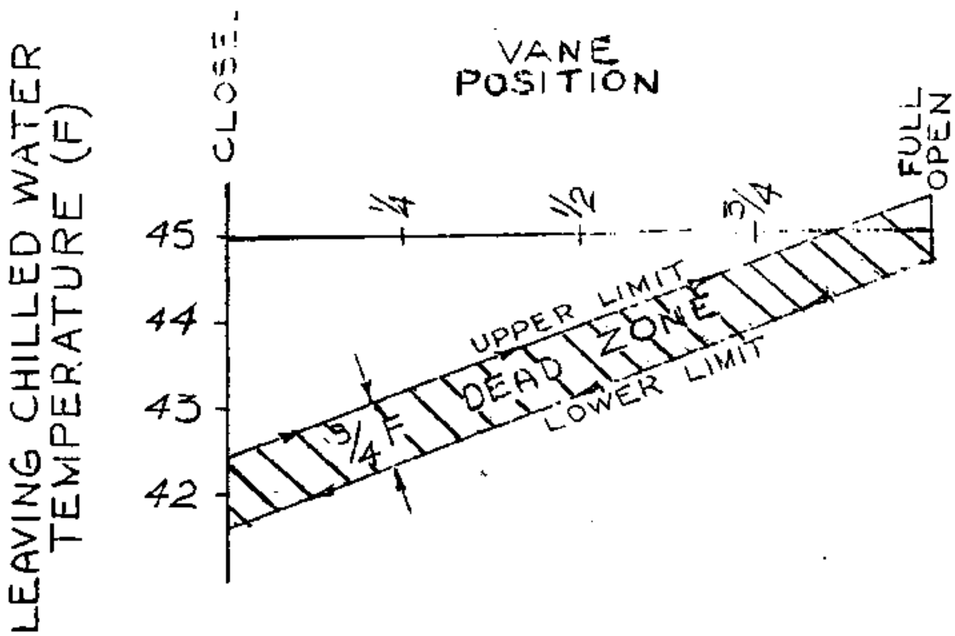

FIGURE 6

PROPORTIONING CONTROL

WITH 3 F THROTTLING RANGE

SERVICE BULLETIN

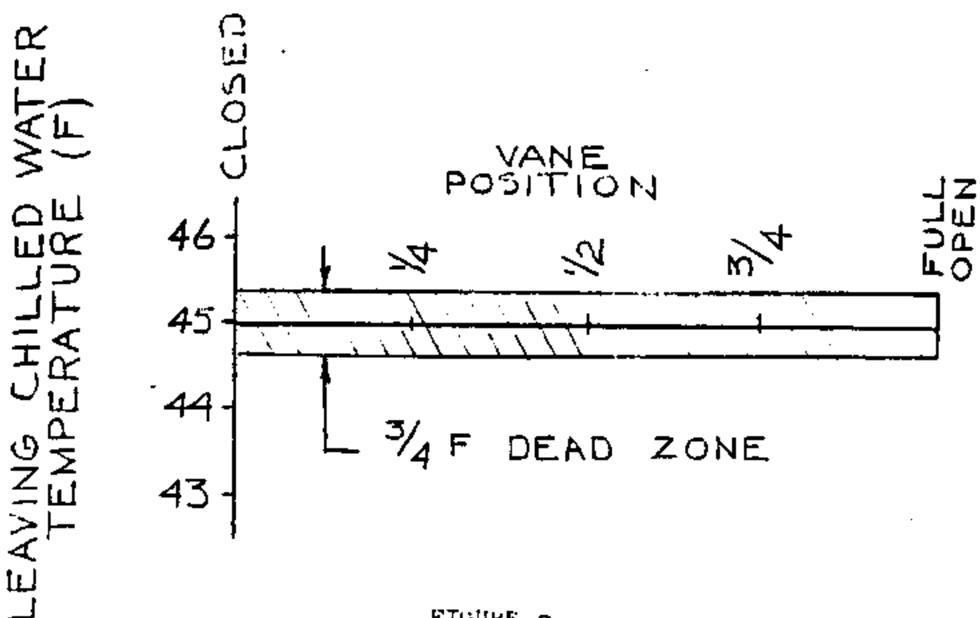

FIGURE 7

FLOATING CONTROL