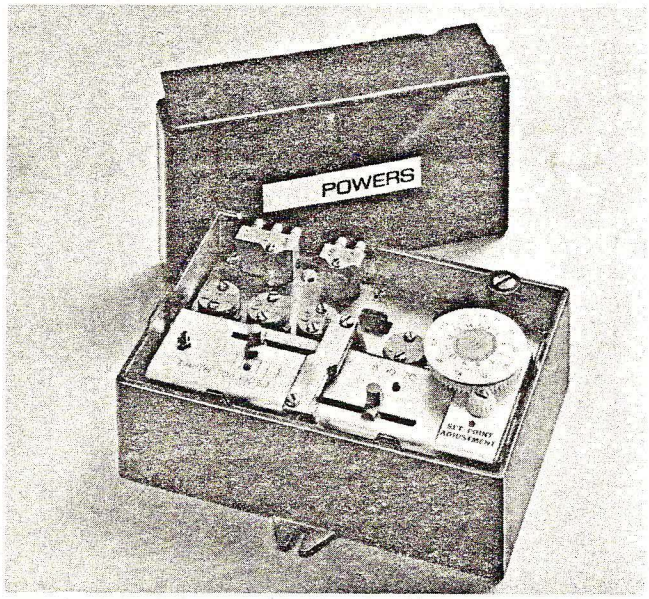
MCC POWERS

RC 195 RECEIVER-CONTROLLER SYSTEM

Application Eng. Form
AE-19
October, 1979



INTRODUCTION

In the RC 195 Receiver-Controller System, the transmitter sensing temperature, humidity, pressure or other values transmits a signal that is proportional to the medium being sensed. This signal is transmitted to a summing and amplifying point where it is converted to a control signal. This control signal leads to a controlled device and, in turn, corrects the controlled medium.

CONTENTS

PURPOSE

The RC 195 Receiver-Controller System consists of an adjustable pneumatic amplifier with a sensor (transmitter) piloting the control output. Transmitters may sense temperature, humidity, pressure or other values.

To facilitate maximum flexibility in planning the controls location, the RC 195 Receiver-Controller has the capability of placing the sensor and controller in different locations.

What kind of instrument is the receiver-controller?

What can it do?

The RC 195 Receiver-Controller is used with a transmitter for remote control (and adjustment) of various industrial or air conditioning processes. In addition, indication of the controlled variable can also be achieved.

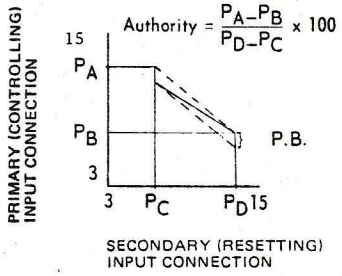
The receiver-controller has adjustable sensitivity and manual reset. Moreover, since a transmitter is used as a sensor, the controller is unaffected by ambient conditions or elevation effects. The RC 195 also has the ability to add or subtract pneumatic inputs. Furthermore, through the use of the authority adjustment, multiplication is also possible.

Because the sensing device is a transmitter, indication is readily achieved either locally at the instruments or at a remote location.

AUTHORITY ADJUSTMENT

The authority setting determines the effect that the secondary input (resetting) has on the primary input (controlling). (Refer to figure 1) Authority setting is determined by $\frac{P_A - P_B}{P_D - P_C} \times 100$. When calculating authority, use transmitter output pressure rather than values of temperature, humidity, static pressure or differential pressure because the transmitter spans may be over different ranges and give a false authority.

Figure 1



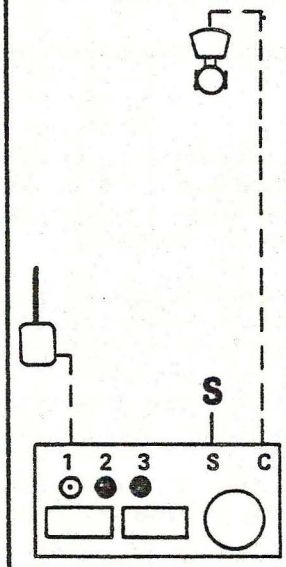
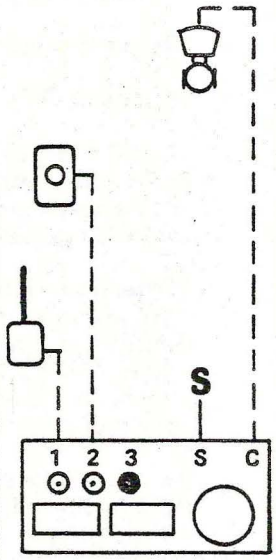
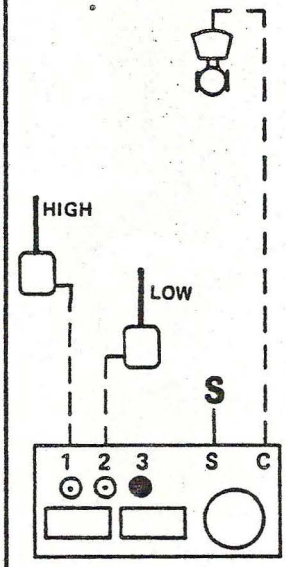
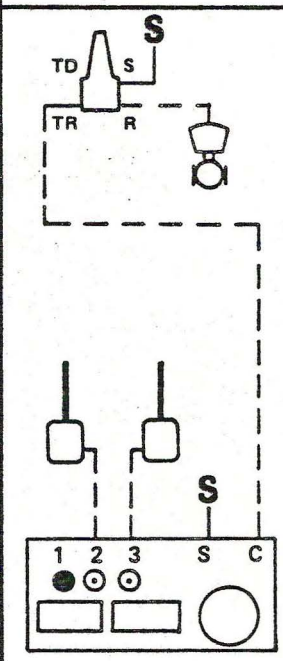
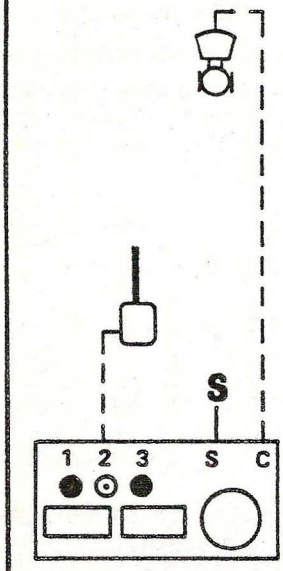
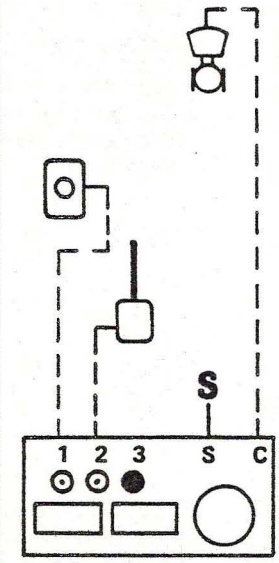
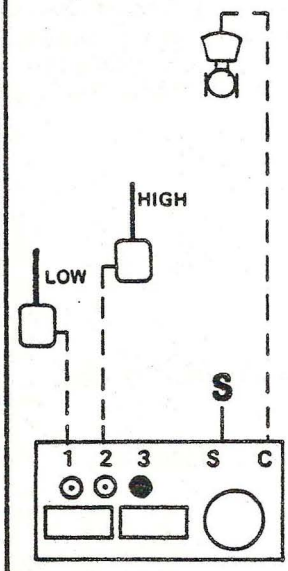
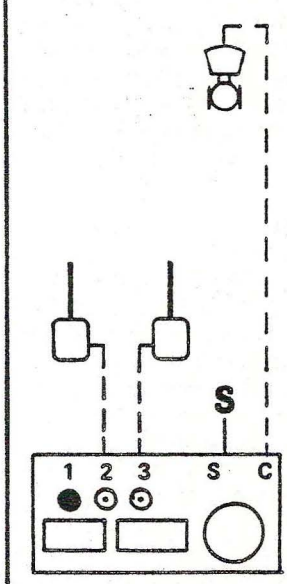
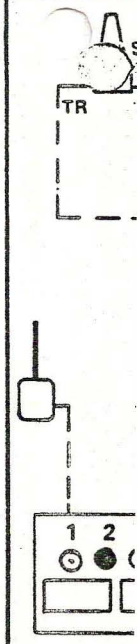
Input connections one (1) and two (2) have fixed authorities equal to 100%. Input connection three (3) has an adjustable authority which, by means of the authority adjustment slide, may be varied from 20 to 200%.

Authorities over 200%

Occasionally you will have an application similar to that shown in figure 2A where the computed authority exceeds 200%.

By changing the pneumatic connections between the transmitters and the primary and secondary input connections as shown in figure 2B, it is possible to increase the authority to greater than 200%.

TYPICAL RC 195 RECEIVER-CONTROLLER APPLICATIONS

CON-TROLLING INPUT PIPED FOR	NO RESETTING INPUTS	ONE RESETTING INPUT			
		MANUAL	DIFFERENTIAL	TRANSMIT	
				DIRECT RESET	RE R
DIRECT ACTION					
REVERSE ACTION					

ALL TRANSMITTERS ARE D.A. BUT CAN HAVE A R.A. EFFECT ON CONTROLLER BY PIPING TO # 2 INPUT CONNECTION

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S = SUPPLY AIR 22 psig
C = CONTROL AIR
1 = DIRECT ACTING INPUT CONNECTION
2 = REVERSE ACTING INPUT CONNECTION } **100% AUTHORITY (FIXED)**
3 = DIRECT ACTING INPUT CONNECTION **20 TO 200% AUTHORITY (ADJUSTABLE)**

ONE-PIPE 3 PSI SPAN POSITIONING SWITCH FOR REMOTE CPA

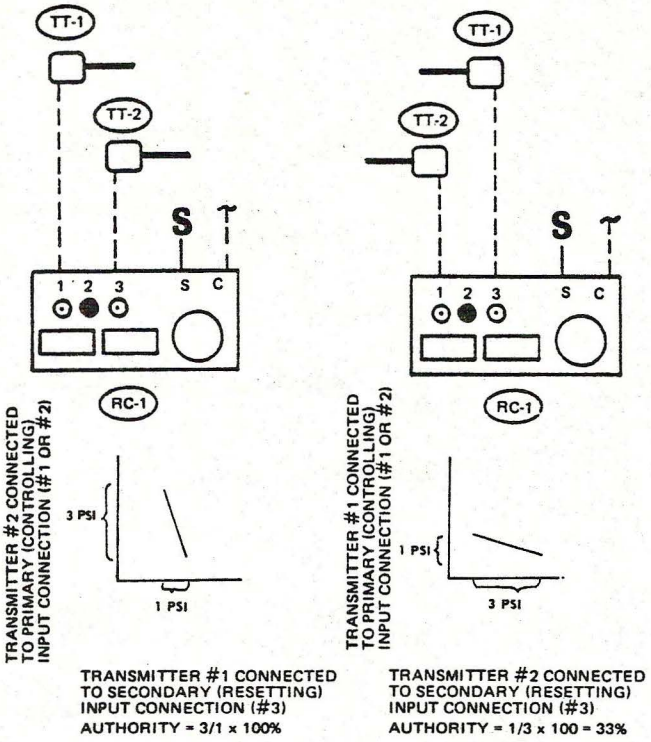


Figure 2A Figure 2B

PROPORTIONAL BAND ADJUSTMENT (Sensitivity)

The proportional band setting on the receiver-controller is adjustable from 2 to 20% of the primary input scale based on a control pressure change of 5 psi. For a 100°F primary transmitter span the minimum setting of 2% P.B. gives a throttling range of 2°F. (.02 x 100°F). A 2°F change at the transmitter will proportionally vary the RC 195 control pressure 5 psi. A maximum % proportional band setting of 20% provides a throttling range of 20°F (.20 x 100°F = 20°F) for a 5 psi output change.

The actual proportional band setting selected depends on the characteristics of the system under control. The proportional band adjustment is normally set for a value which will result in satisfactory control without overshooting, undershooting, or hunting—in other words, to satisfactorily maintain the control point. The % P.B. adjustment can be set to give the desired proportional band.

AIR SUPPLY

The RC 195 requires a clean, dry, oil free supply of compressed air.

We recommend that an AF 908 In-Line Air Filter be located in the supply line to the RC 195. A maximum of two RC 195 Receiver-Controllers can be supplied by a single AF 908 in-line air filter.

RECOMMENDATIONS WHEN USING THE RC 195 SYSTEM WITH A TWO-PRESSURE AIR SUPPLY

Whenever possible the RC 195 equipment should be used with a constant air supply. The RC 195 Receiver-Controller and transmitters are calibrated at the factory with a 22 psig air supply. If a constant air supply is not available use a remote restrictor and separate air supply to transmitters.

Effects on RC 195 Receiver-Controller System

Changing the supply pressure to the RC 195 Receiver-Controller system from 22 psig to either 18 or 25 psig can shift the control point by as much as 2% of scale.

AVERAGE AIR CONSUMPTION

RC 195 with no inputting devices	60 scim
Each transmitter	35 scim
Positioning Switch (one pipe)	35 scim

RESTRICTORS USED WITH MCC POWERS TRANSMITTERS

A 40 scim restrictor should be used with every MCC Powers transmitter. The RC 195 Receiver-Controller comes with a 40 scim restrictor for each of its three input connections. When using a remote restrictor be sure that it has a rating of 40 scim. Never provide more than one restricted air supply to an MCC Powers transmitter. Never connect a device which consumes air to an MCC Powers transmitter.

TRANSMISSIONS OF HIGH TEMPERATURES

When an application requires transmission of temperatures 75°F or more above ambient temperatures, take precautions to insure accuracy at these higher temperatures.

When using a rigid bulb transmitter, the transmitter chassis will tend to reduce the temperature of the rod and tube close to the transmitter body. Consequently, the temperature of the rod and tube element varies along its length and will transmit a pneumatic signal equal to the average temperature of the rigid sensing element. To minimize this error, use the insulating cover. (Refer to figure 3). This cover tends to reduce the heat loss from the transmitter body which, in turn, allows the transmitter body to approach the temperature of the sensing element. This reduces the amount of heat conducted from the rod and tube element, thus giving a more uniform temperature along the length of the rod and tube element.

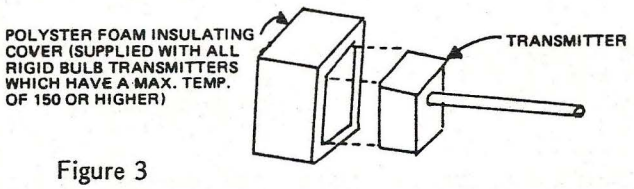


Figure 3

MULTIPLE USE OF TRANSMITTERS

Figure 4 shows an MCC Powers transmitter conected to a variety of pneumatic devices. Generally, the output pressure from an MCC Powers transmitter can be used with any device, as long as that device does not consume air (is dead-ended). The number of devices that can be so connected is limited only by the total volume in the pipe and bellows. As this volume increases, the response decreases. Note that in figure 4 only one RC 195 Receiver-Controller (RC-1) is supplying air to the transmitter. On the second receiver-controller (RC-2) the input to which the transmitter is connected has its restrictor in the "OUT" position. Never provide a transmitter with more than one restricted air supply.

TRANSMITTERS PILOTING ELECTRIC AND PNEUMATIC SWITCHES

MCC Powers transmitters can be used to pilot pneumatic switching relays and pressure to electric switches; however, you must consider the resulting differential. Table 1 shows

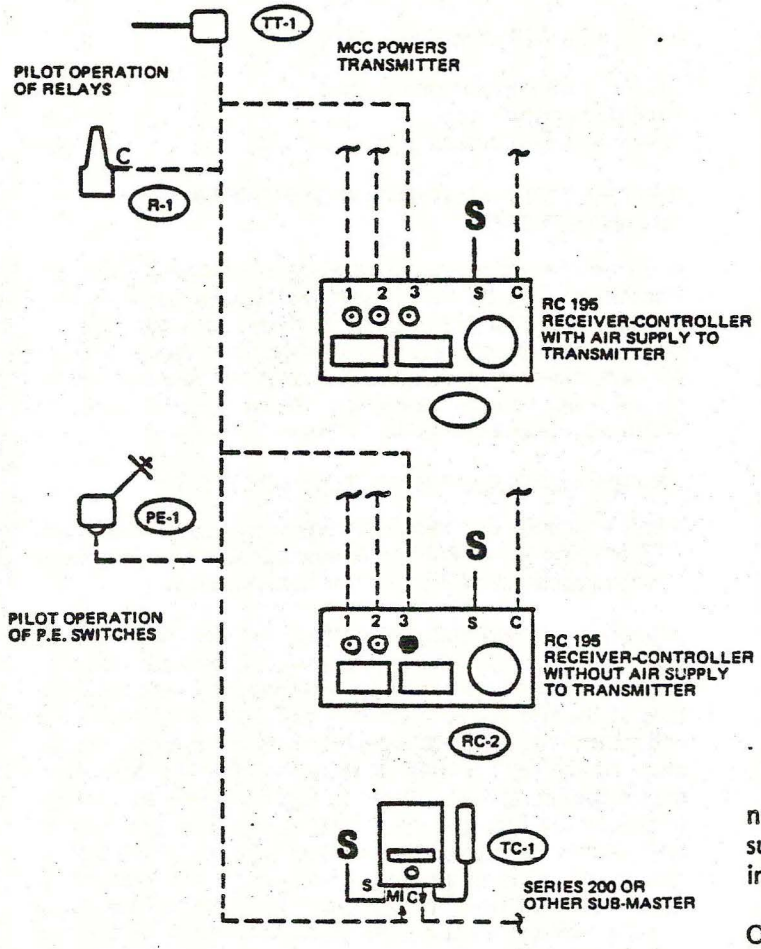


Figure 4

the sensitivity of transmitters with various spans. Figures 5A and 5B show two examples of how to determine the resulting differential in terms of the sensed medium.

CONNECTING OTHER PNEUMATIC DEVICES TO THE RC 195 RECEIVER-CONTROLLER

Figure 6 shows two examples of how other pneumatic devices can be used with the RC 195 Receiver-Controller. If the pneumatic device connected to one of the input connections of the RC 195 Receiver-Controller has its own air supply, the restrictor for that input connection should be in the "OUT" position.

SPAN	SENSITIVITY (PSI/UNIT)
50°F	.24 psi/ °F
75°F	.16 psi/ °F
100°F	.12 psi/ °F
160°F	.075 psi/ °F
.5 "H_2O	2.4 psi/ 0.1"H_2O
3 "H_2O	.4 psi/ 0.1"H_2O
15 "H_2O	.08 psi/ 0.1"H_2O
60 % R.H.	.2 psi/ % R.H.

Table 1

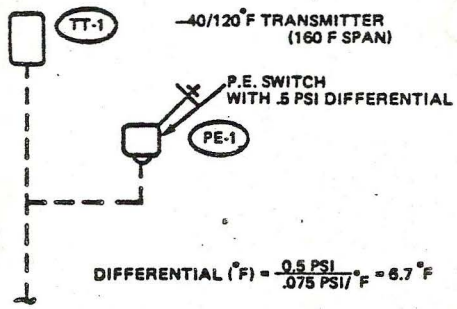


Figure 5A

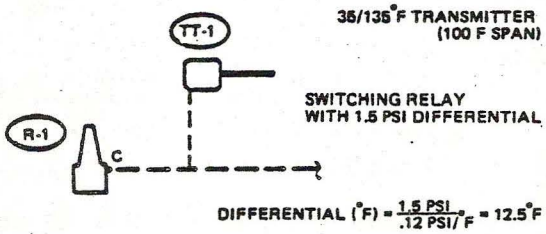


Figure 5B

Other pneumatic devices which incorporate pneumatic feedback, such as positioning switches, Limitem thermostats, D thermostats, etc., can be used with the RC 195 Receiver-Controller as "bleed" devices. If they are used in this way, be sure to plug the supply port as shown.

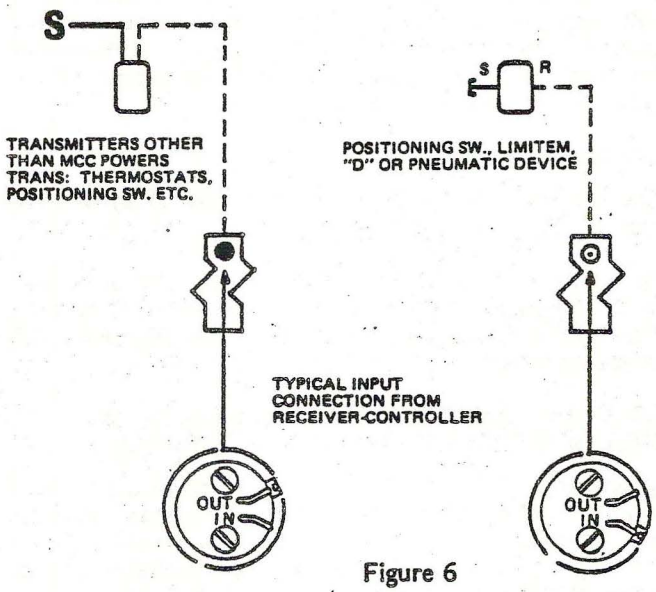


Figure 6

USE OF CONTROL POINT ADJUSTMENT (CPA) WITH RC 195

Many applications require remote control point adjustment. This remote adjustment provides a means of remotely changing the system set point.

Because of the variety of input connections and adjustments available on the RC 195 Receiver-Controller, a great deal of flexibility is possible in the application of remote adjustments, the application, using a CPA, is similar to a master-submaster application. The CPA would be comparable to the master transmitter.

On most applications where remote control point adjustment is required, it is not necessary nor desirable to have the capablity at the CPA to adjust the system set point an amount greater than 25% of the controlling (primary) transmitter span. To accomplish this a one-pipe positioning switch is available which will change its output a total of 3 psi for a 300° rotation of the knob. This positioning switch is factory calibrated, with an output pressure of 9 psig when the knob is centered. By rotating the knob counter-clockwise to a mechanical stop, the output pressure will be reduced to 7.5 psig. Rotating the knob clockwise to the mechanical stop will increase the output pressure to 10.5 psig.

In general when employing remote control point adjustment, adjust the receiver-controller with a CPA pressure = 9 psig at the set point. This will permit an equal amount of adjustment (12.5% of the controlling transmitter span) above and below the initial set point.

Table 2 lists the various MCC Powers transmitter spans and the respective latitude of adjustment (± °F, "H_2O, % R.H.) possible in each case.

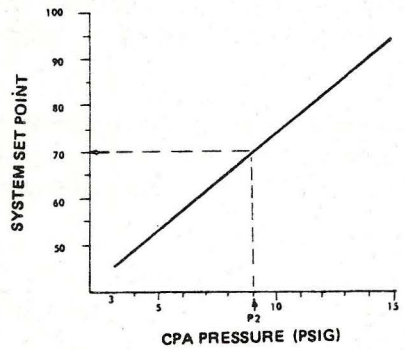
Figure 7A shows a typical application using a room transmitter for control and the one-pipe positioning switch, for remote control point adjustment. Assuming that this system is calibrated with the receiver-controller set at 70°F and CPA pressure of 9 psig, the system set point would be 70°F as long as the CPA pressure remained at 9 psig.

If the CPA pressure were increased to 10.5 psig, as shown in figure 7B, the system set point would be increased to approximately 76°F.

CONTROLLING (PRIMARY) TRANSMITTER CHARACTERISTICS			APPROXIMATE LATITUDE OF ADJUSTMENT FROM INITIAL SET POINT IN TERMS OF *	
TYPE	RANGE	SPAN	UNITS OF MEASUREMENT OF SENSED VARIABLE	PERCENTAGE OF CONTROLLING TRANSMITTER SPAN
DRY BULB TEMP.	50 to 100F	50F	± 6.2F	± 12.5%
	−10 to +65F	75F	± 9.4F	
	0 to 100F 35 to 135F	100F	± 12.5F	
	−40 to +120F 80 to 240F	160F	± 20.0F	
STATIC OR DIFFERENTIAL PRESSURE	0 to 0.5 "H_2O	.5 "H_2O	± .06 "H_2O	
	0 to 3.0 "H_2O	3.0 "H_2O	± .4 "H_2O	
	0 to 15.0 "H_2O	15.0 "H_2O	± 1.9 "H_2O	
RELATIVE HUMIDITY	20 to 80 % RH	80 % RH	± 7.5% RH	

* NOTE: Above table is based on the following assumptions
1. The system is calibrated with a CPA pressure of 9 psig at the initial set point and ± 1.5 psi.
2. The CPA device is connected to input connection No. 1 or No. 2.
3. If CPA device connected to input connection No. 3 the authority adjustment is set at 100%.

Table 2



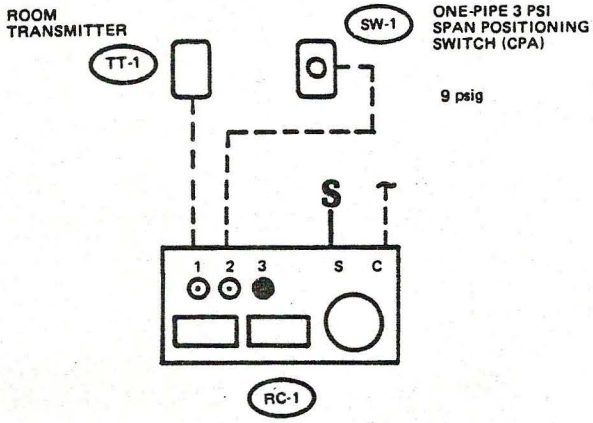
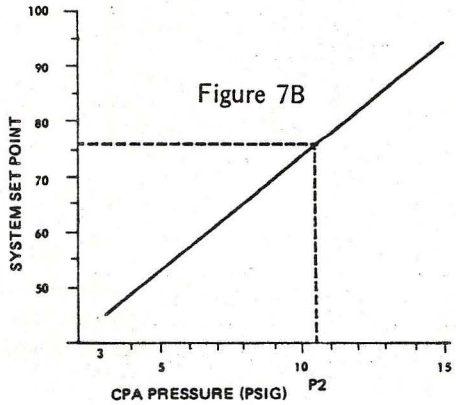
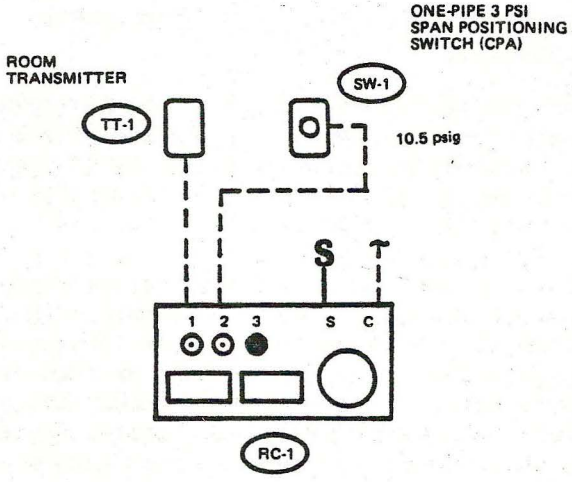


Figure 7A

Figure 7B

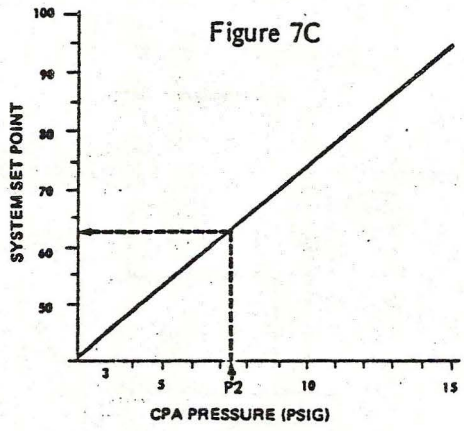


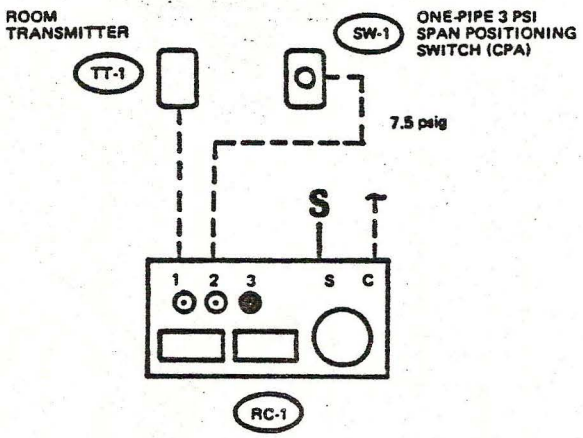


If the CPA pressure were reduced to 7.5 psig, as shown in figure 7C, the system set point would be reduced to approximately 63.5°F.

Note that in the above examples a change in the CPA pressure from 10.5 psig to 7.5 changes the set point 12.5°F (76°F–63.5°F = 12.5°F). When using a CPA connected to

Figure 7C





either input connection 1 or 2 of the receiver-controller, it will have 100% authority, it has the capability of changing the system set point an amount equal to 25% of the span of the controlling transmitter. (See figure 8)

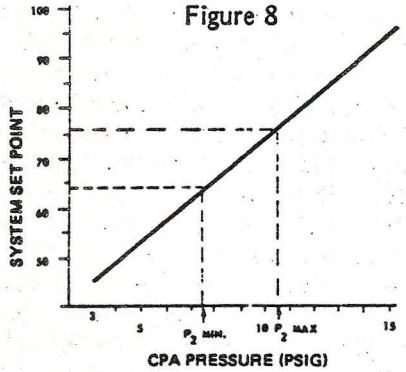
REMOTE INDICATION OF SET POINT WHEN USING CPA

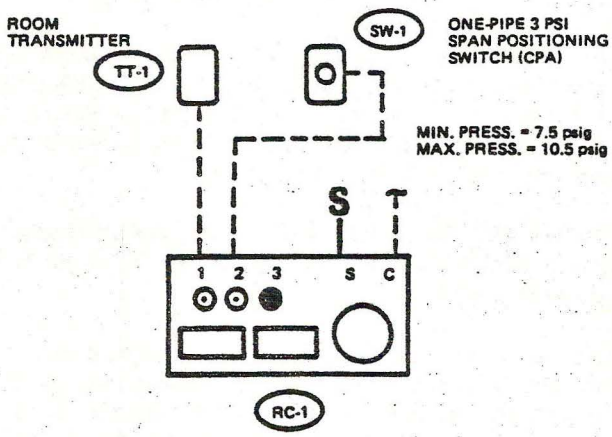
For any application where the transmitter sensing the medium being controlled and the CPA have 100% authority, the sensitivity (psi per unit) is the same for the transmitters, CPA, and set point scale. This matching of sensitivities provides a great deal of flexibility.

One way in which you can use this feature is to indicate the set point at a remote control point adjustment, is shown in figures 9A and 9B. An increase in the CPA pressure will always increase the set point provided the respective input connections to which the controlling transmitter and CPA device are connected have opposing actions. This allows us to use the same gauge for either a direct acting or a reverse acting application.

It is not practical to use a remote indication of set point when a CPA is utilized with a master-submaster. Since the set point of the receiver-contoller is continuously reset by the master transmitter, it is impossible to indicate set point at the CPA. For this application use the increase, decrease markings on the CPA switch plate.

Figure 8





To adjust a standard receiver gauge for "set point indication" at a remote CPA, proceed as follows:

1. Adjust the CPA to 9.0 psig.
2. Establish the set point of the receiver-controller. This set point is the value you wish to maintain with 9 psig from the CPA. If this set point is changed, it is necessary to change the calibration of the remote gauge.
3. Adjust the "set point indication" gauge to read the same value as set point. After this adustment has been made, ignore the psi scale on the receiver gauge. If the calibration screw on the receiver gauge does not allow you to properly position the indicator, it may be necessary to pull the indicator from the shaft and reposition.

Note that a 3 to 15 psi gauge is used in the CPA line at the receiver-controller. This is required for set up and calibration.

PNEUMATIC INDICATION

To obtain indication, place an air pressure gauge in the line, since the transmitter's air pressure output is directly proportional to a change in temperature, humidity or pressure. The gauge used should agree with the type and range of transmitter. When using the transmitter for indication only, it is best to place the restriction at the transmitter rather than at the gauge. This is because the transmitter uses air and there will be a pressure drop in the connecting tubing.

SW-1 = ONE-PIPE 3 PSI SPAN POSITIONING SWITCH (CPA)
G-1 = RECEIVER GAUGE WITH SAME RANGE AS TRANSMITTER (FOR SET POINT INDICATION)
G-3 = PRESSURE GAUGE (3-15 psig) RANGE
TT-1 = TRANSMITTER
G-2 = PRESSURE GAUGE (3-15 psig) RANGE

Figure 9A

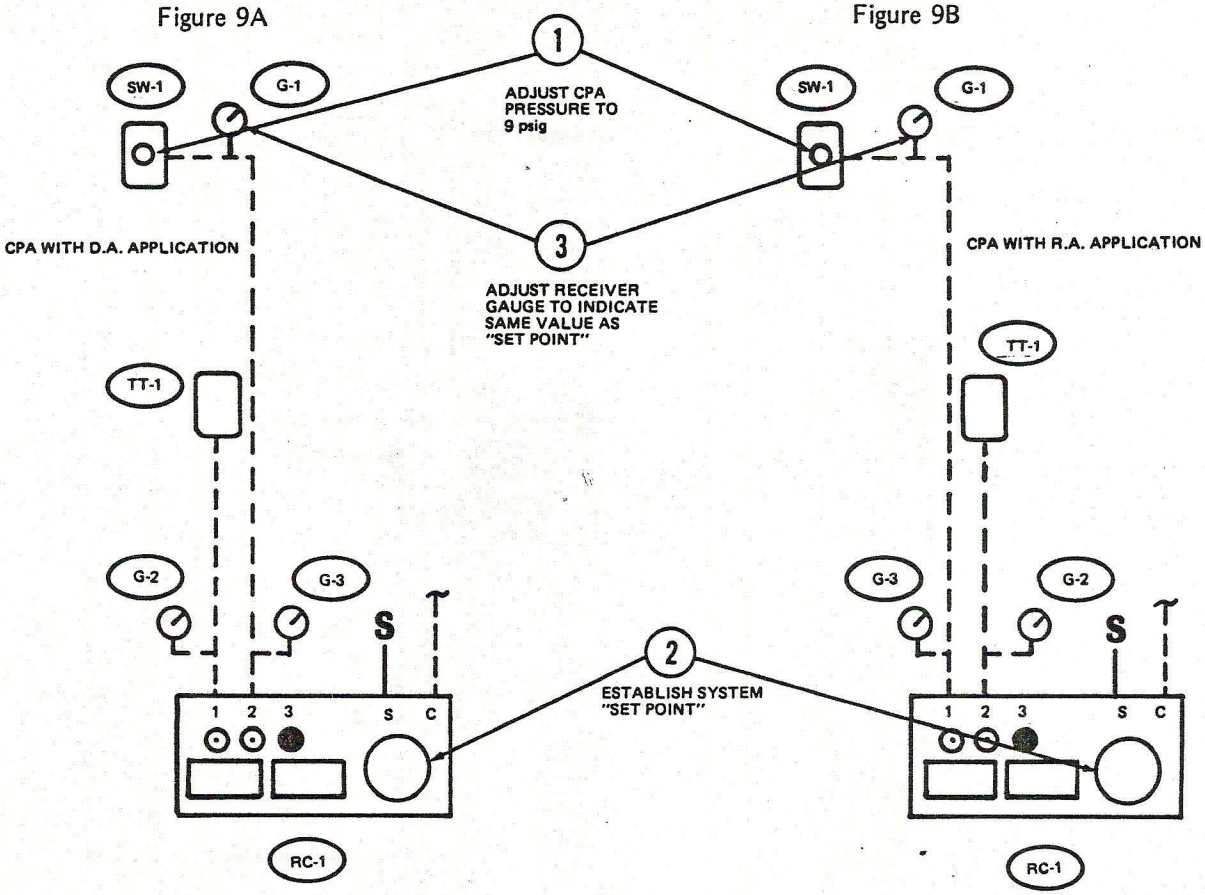


Figure 9B

The response time for pneumatic transmission is very rapid, provided the following is maintained:

1. The pneumatic tubing is standard ¼" O.D. plastic or copper.
2. The length of the tubing between the transmitter and restrictor does not exceed 300 feet. Referring to figure 10, A<300 feet.

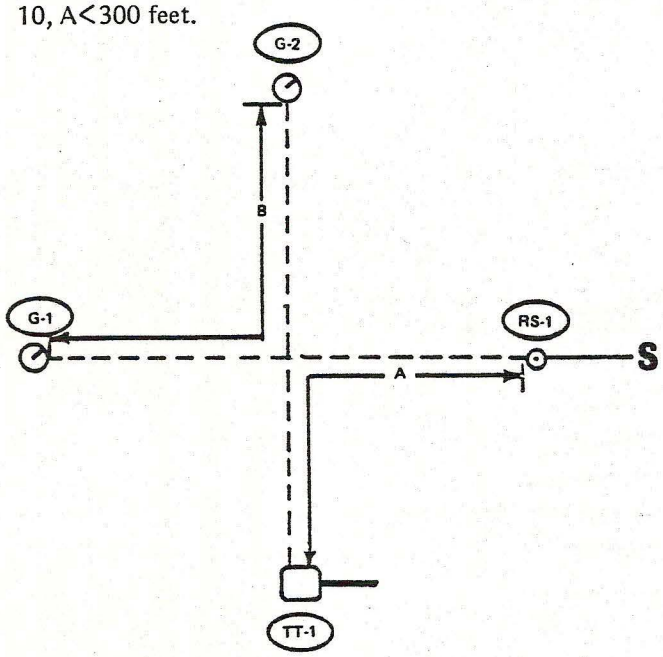


Figure 10

3. The total length of tubing from restrictor to gauges and transmitter does not exceed 1000 feet. Referring to figure 10, A + B<1000 feet.

TRANSMITTED DISTANCE

Because the transmitter is a bleed type instrument and there is air flow from the restrictor in the receiver-controller, there can be a pressure drop in the connecting tubing. The size of the pressure drop can be considered a function of the transmitter line pressure and the transmitter line length.

If the distance between the receiver-controller (RC-1) with restrictor and transmitter (TT-1) does not exceed 300 feet, the pressure loss is negligible, provided ¼" O.D. plastic or copper tubing is used. Also, the total length of tubing to connect to a gauge should not exceed 1000 feet. (See figures 11 and 12).

When the transmitter (TT-2) is more than 300 feet from the receiver-controller, an external restrictor is required. Also the restrictor for the No. 1 input connection on RC-2 should be in the "OUT" position. The restrictor cannot be more than 300 feet from the transmitter but TT-2 may be a maximum of 1000 feet from RC-2. Gauges may be placed anywhere in the transmission line provided tubing length is not more than 1000 feet; however, the line from TT-2 to RC-2 is a dead end volume.

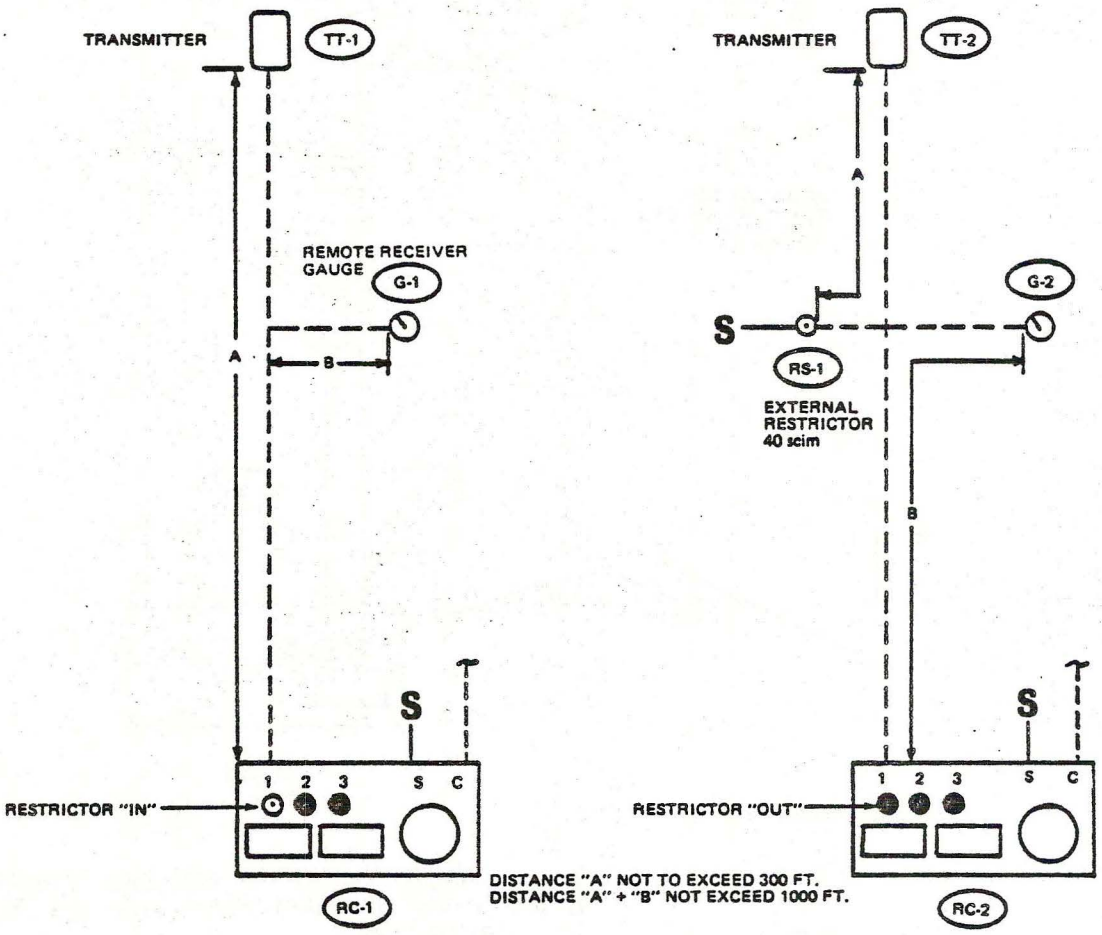


Figure 11

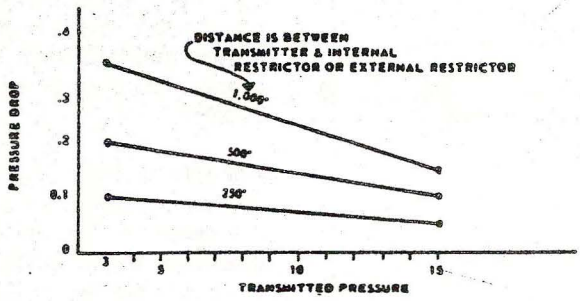


Figure 12

MCC POWERS

RECEIVER-CONTROLER SYSTEM TYPICAL APPLICATION

Application Engineering
AE-19
Supplement 1
October, 1979

INTRODUCTION

When it is desirable to have controls in an accessible and/or central location a transmitter/receiver-controller system is used.

These systems are particularly suited for panel installation to facilitate system or unit function control. Functions include start, stop, program, adjust and/or calibrate one or several units or systems.

A panel also provides a location for indication of unit or system performance, i.e. indicating lights and gauges.

MCC Powers transmitters are one-pipe instruments requiring a separate restrictor located adjacent to the transmitter or in the receiver-controller. However, any pneumatic device can be used to "input" the receiver-controller, providing it is used within the application and pressure constraints of the receiver-controller.

SINGLE INPUT PROPORTIONAL CONTROL

In this application the RC 195 Receiver-Controller may be piped to provide either direct or reverse action with or without remote set point adjustment (CPA).

Both the set point and the percent proportional band are adjustable at the receiver-controller. These adjustments, as well as the selection, sizing and location of other control and heat transfer devices, determine the accuracy and stability of the control system.

It is extremely important that the transmitter signal be adequate for proper control in terms of level and span. Figure 1 illustrates how the RC 195 Receiver-Controller, utilizing a single primary transmitter input, may be used to control the discharge air temperature of a VAV system. Note that SW-1 is a one-pipe 3 psi span positioning switch allowing a maximum of 25° F (25% of transmitter span) set point adjustment.

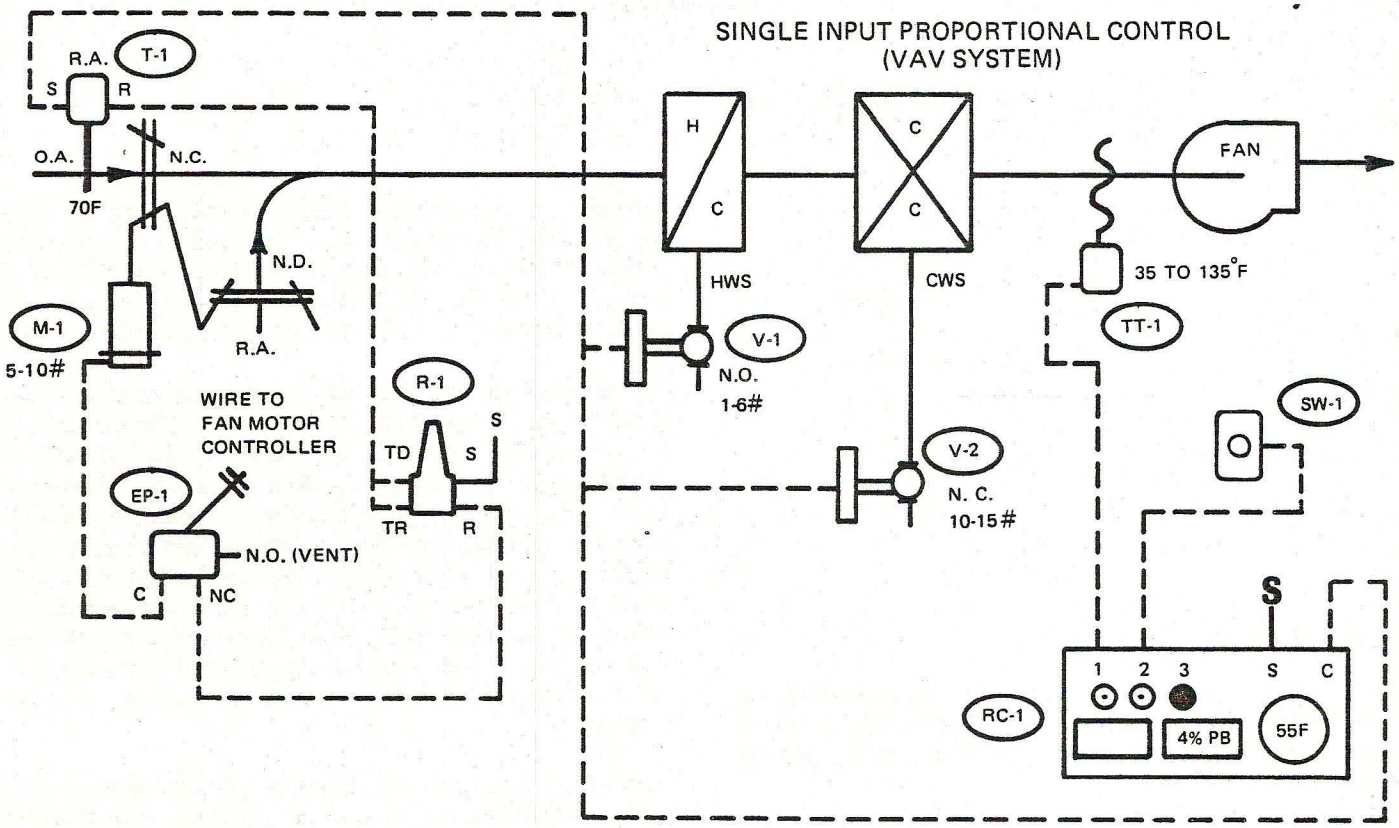
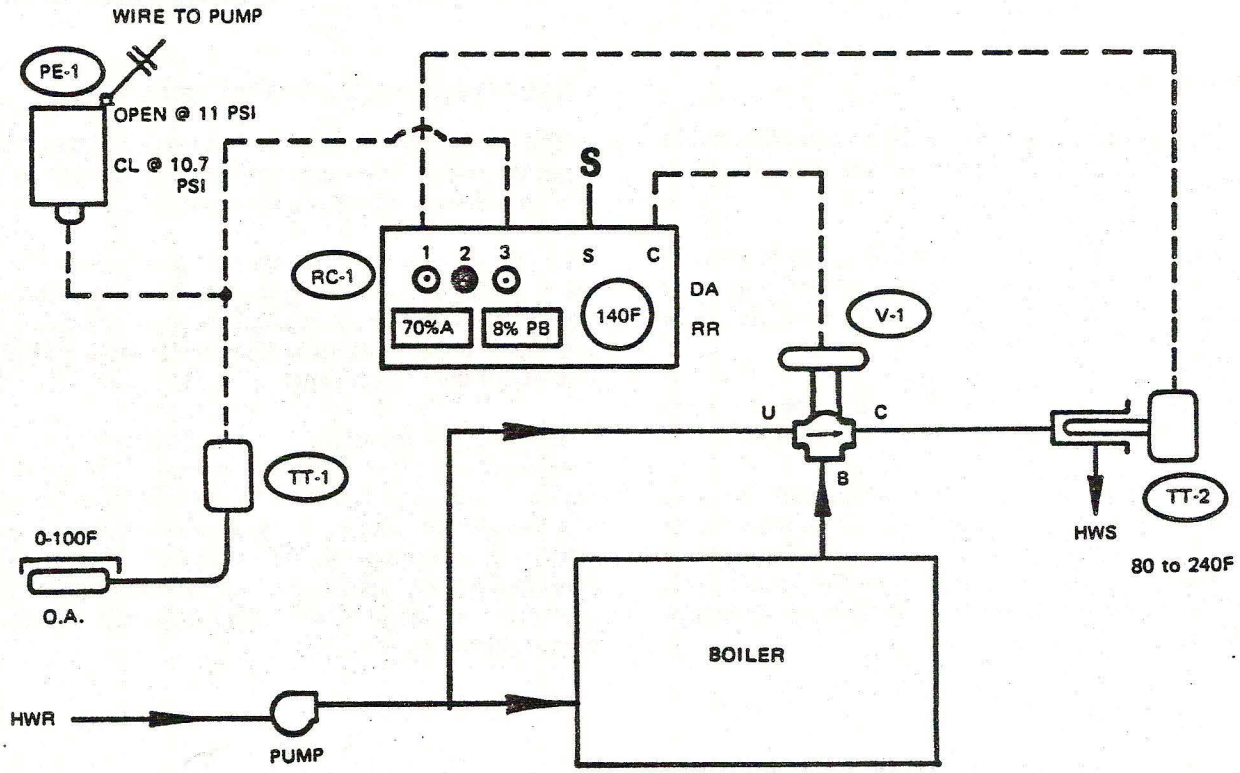


Figure 1

HOT WATER RESET (CASCADE) CONTROL



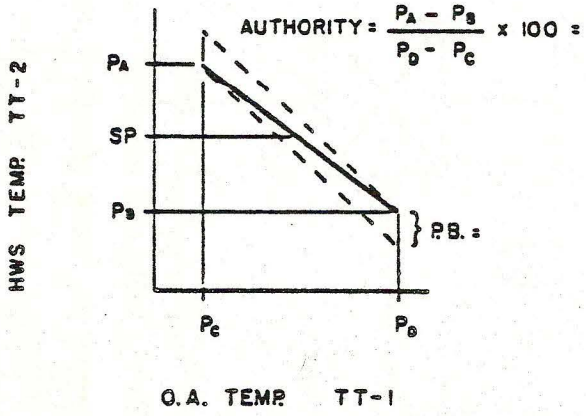


Figure 2

RESET (CASCADE) CONTROL

Reset control provides a means for compensating for system time (transportation) lags, and/or matching system capacity to system load. Stable control and energy savings are the primary benefits.

In reset control, the set point of the receiver-controller is reset as a function of a selected variable. This is similar to a CPA application, but a transmitter replaces an operator in resetting the receiver-controller set point. Direct or reverse reset is available with direct or reverse action per AE-19.

Selection of the control action is dependent on the controlled device and the medium it controls, i.e. is the controlled device normally open or normally closed? Does it increase or decrease the controlled variable (temperature, pressure, humidity, etc.) at controlling transmitter?

The selection of the reset action (direct or reverse) is dependent on the application requirement. Should the receiver-controller set point be raised or lowered with a second input? For example, when a humidity trasmitter and a RC 195 Receiver-Controller are used for relative humidity control, lowering (resetting) the receiver-controller set point when outdoor air temperature falls to a point where condensation forms on cold window sufaces. This requires direct reset action. Conversely if one wished to lower the hot deck temperature on a dual duct system as zone temperature increased, reverse reset action would be required.

Note: That the authority adjustment on the receiver-controller determines the amount of set point change for a given change in secondary input.

In Figure 2 the set point of RC-1 is lowered when the temperature at TT-1 increases, therefore RC-1 has a reverse reset action.

LOW LIMIT CONTROL DISCHARGE AIR

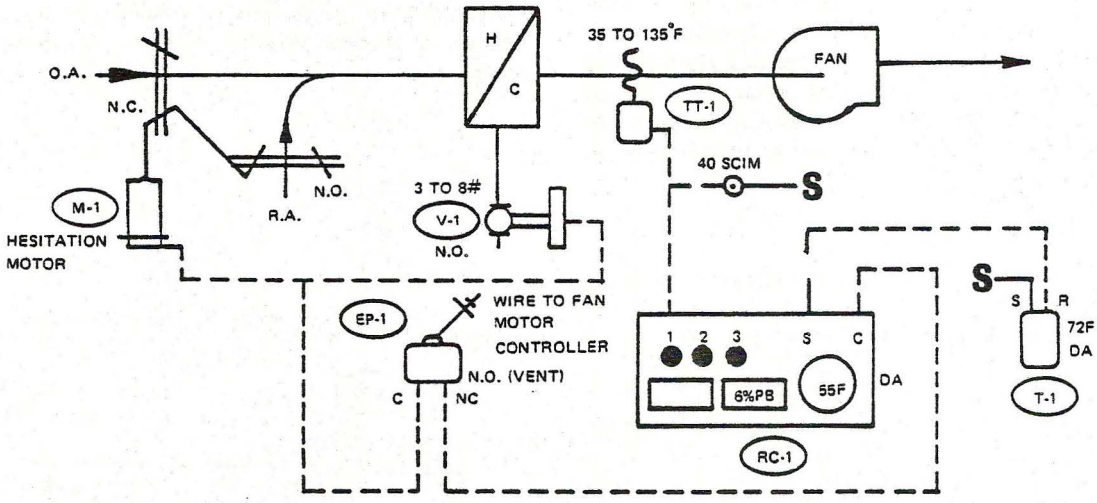


Figure 3

HIGH LIMIT CONTROL - CHILLER

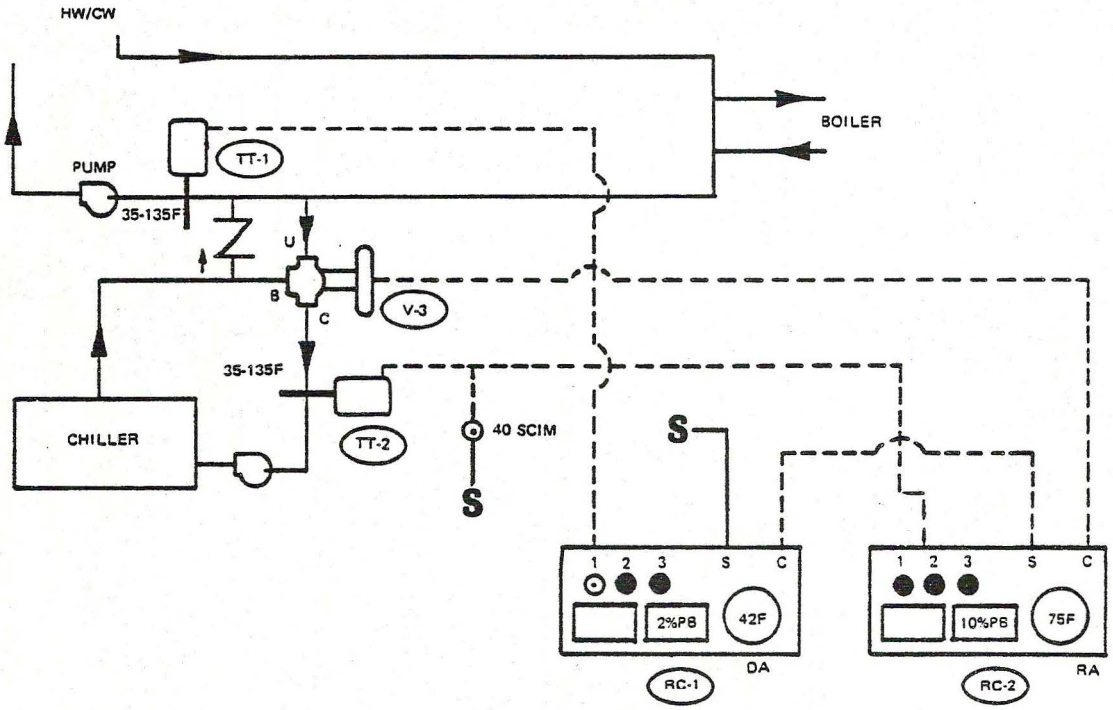


Figure 4

LIMIT CONTROL

The RC 195 Receiver-Controller utilizing one transmitter input can also be used for limit applications by connecting the control pressure output of the primary controller (T-1) to the "supply" port of the limit controller (RC-1).

LOW LIMIT CONTROL

This form of control is applied to limit a condition (temperature, relative humidity, pressure) to a minimum value. An example of this would be when a thermostat limits the discharge air temperature to a value no lower than 55°F so that the occurance of objectionable drafts in a space are minimized. (See figure 3) It is also used as a protective device against "freeze-up".

HIGH LIMIT CONTROL

This form of control is applied to limit a condition (temperature, relative humidity, pressure) to a maximum value. This form of control is applied to protect against excessive energy or temperature. For example, a high limit thermostat applied to a radiant floor control system to protect both the floor and the occupants; a high limit thermostat applied to an electric heater to protect against high temperature; a static pressure; high limit control to reduce or relieve excessive static pressures; etc. Figure 4 illustrates high limit temperature control via (RC-2) for a chiller.

REHEAT SYSTEM CONTROL WITH HIGH RESET SIGNAL LIMIT

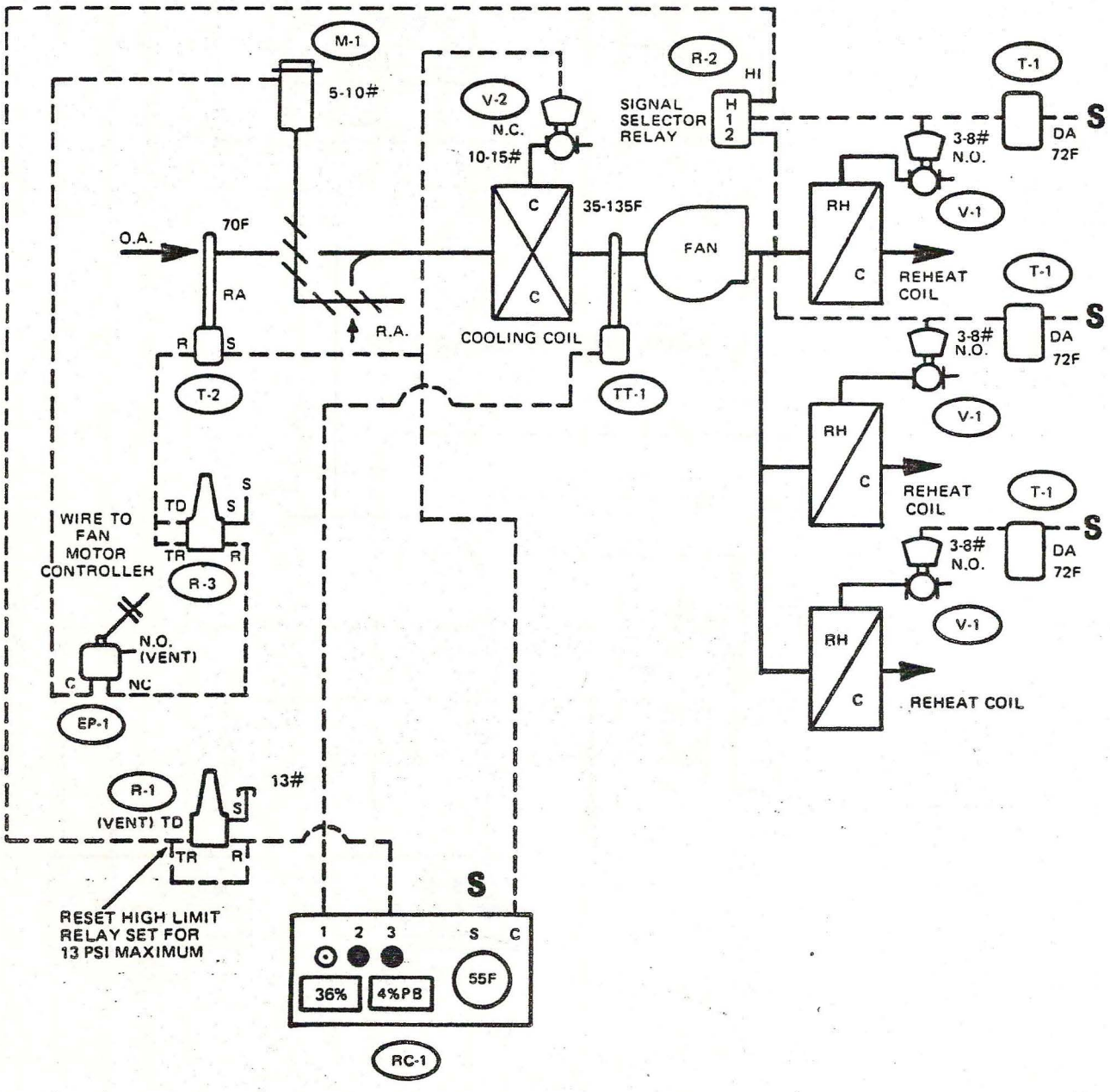


Figure 5

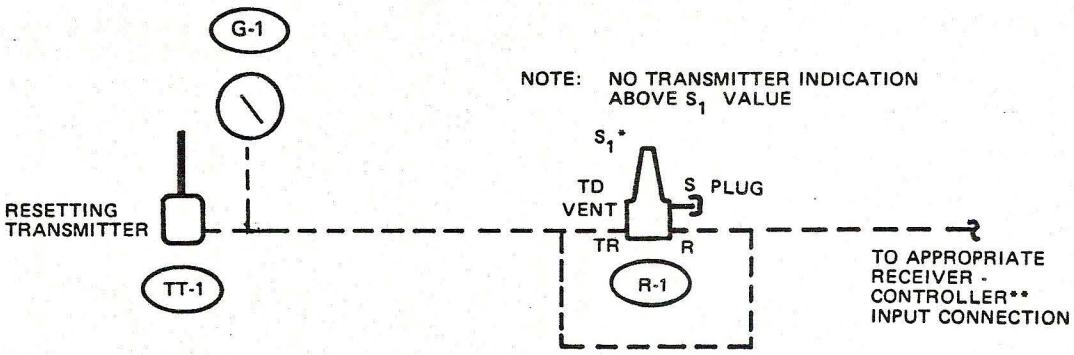
RESET LIMIT CONTROL

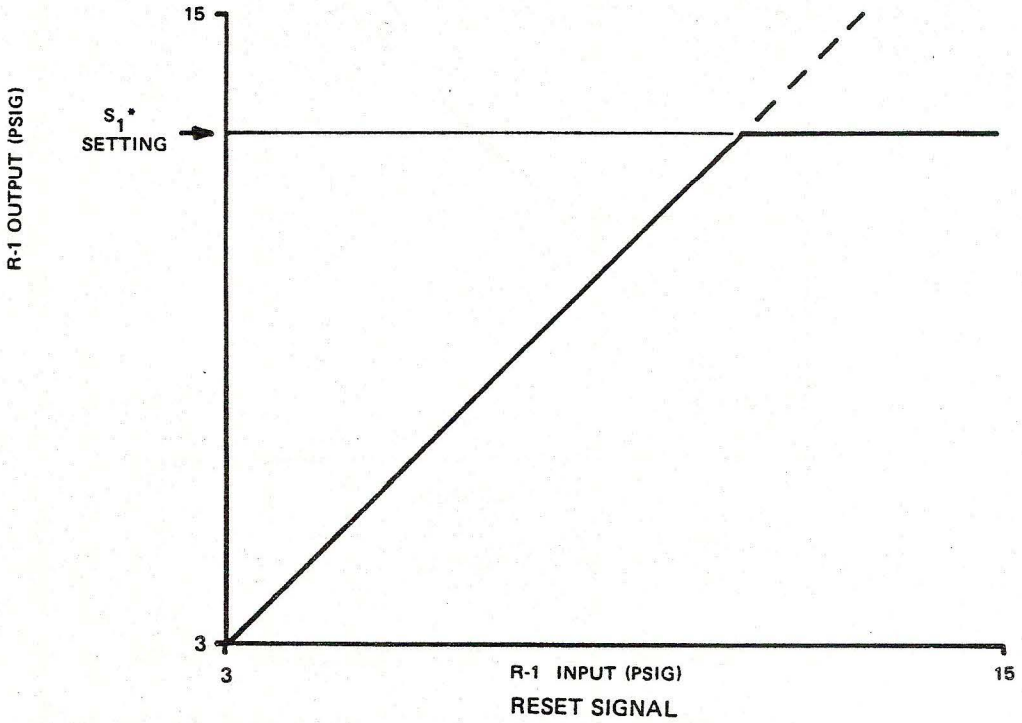
If is often desirable to limit the resetting signal to the receiver-controller. For example, Figure 5 incorporates a high limit control of the resetting signal (warmest room reset temperature) to limit mixed air temperature set point to a minimum value (typically 55°F) to minimize objectionable drafts from supply air diffusers.

Figures 6, 7 and 8 illustrate proper hook-up of the RL 243 MP relay for high, low and both a high and low reset signal limit applications.

Note: The reset high limit control also limits the signal to the receiver gauge. Therefore, indication is only available to that high limit setting.

HIGH RESET SIGNAL LIMIT





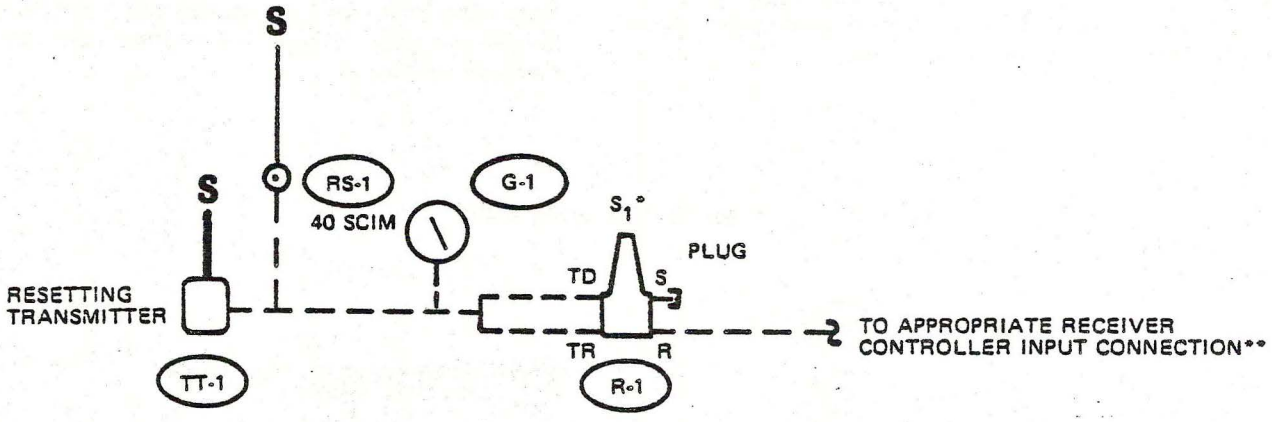
RESET SIGNAL

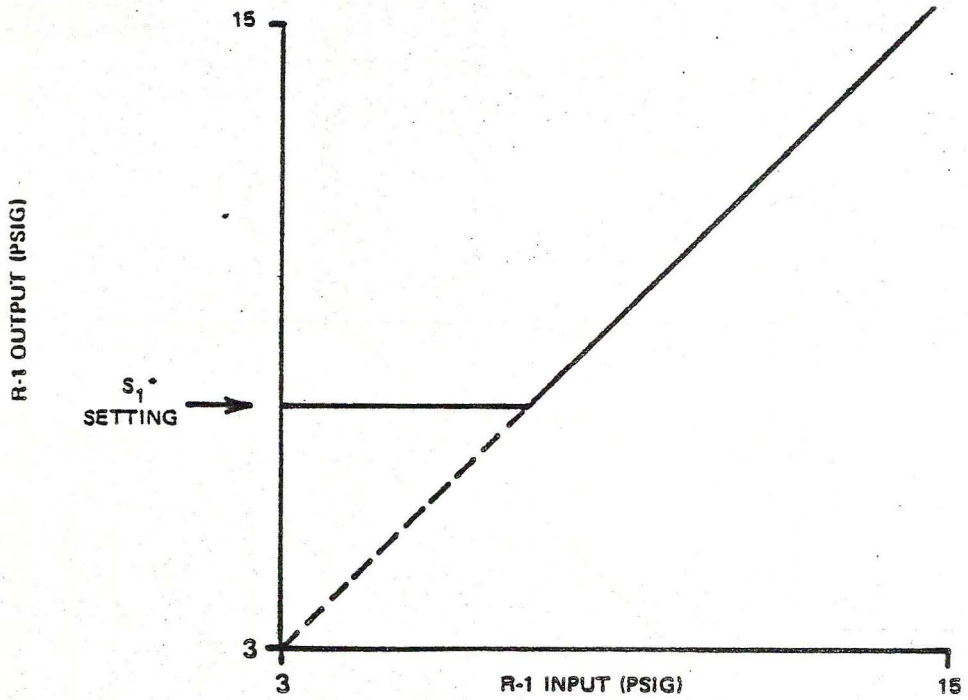
NOTES: *S_1 = SETTING OF RELAY ADJUSTMENT SPRING

**A RESTRICTED AIR SUPPLY IS REQUIRED EITHER FROM A REMOTE RESTRICTED SUPPLY OR FROM INTERNAL RESTRICTOR ON THE RECEIVER CONTROLLER.

Figure 6

LOW RESET LIMIT CONTROL





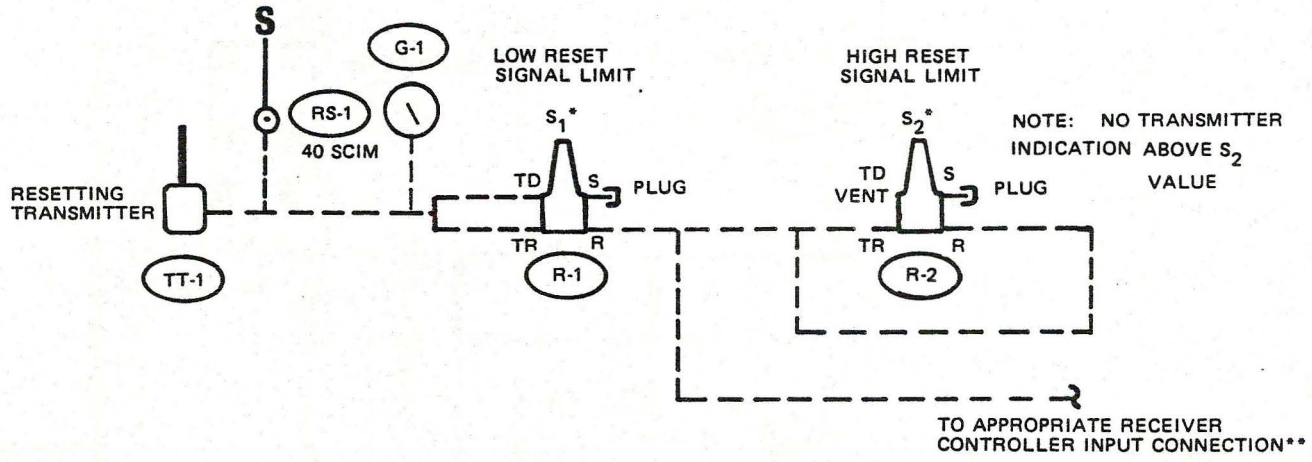
RESET SIGNAL

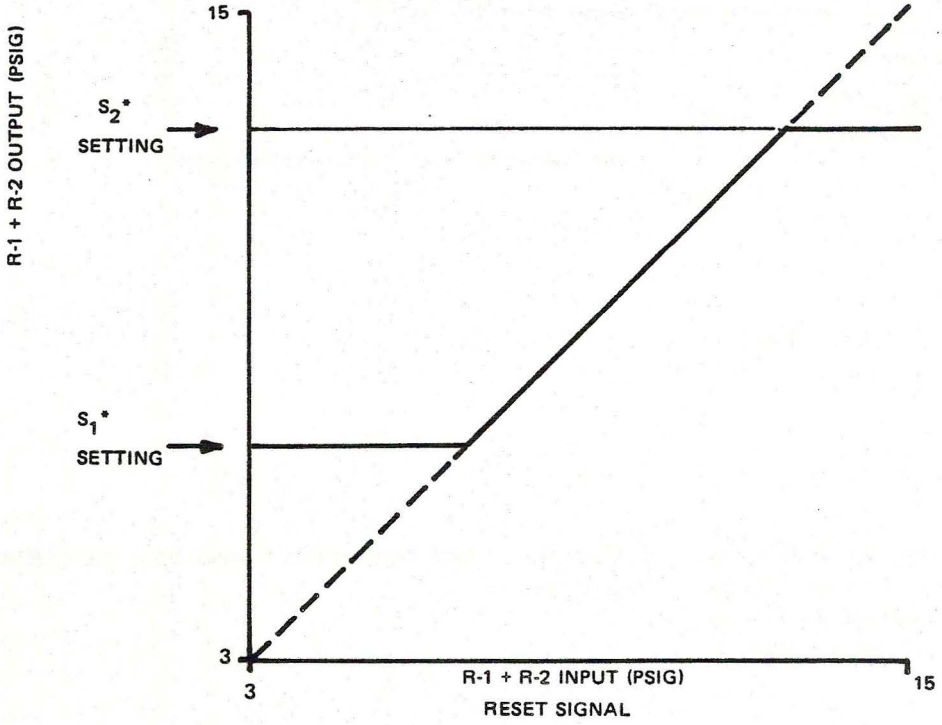
NOTES: * S_1 = SETTING OF RELAY ADJUSTMENT SPRING

** IN ADDITION TO RS-1 A SECOND RESTRICTED AIR SUPPLY IS REQUIRED EITHER FROM A REMOTE RESTRICTED SUPPLY OR FROM INTERNAL RESTRICTOR ON THE RECEIVER CONTROLLER.

Figure 7

HIGH AND LOW RESET SIGNAL LIMIT





NOTES: *S_1 = SETTING OF RELAY R-1 ADJUSTMENT SPRING

S_2 = SETTING OF RELAY R-2 ADJUSTMENT SPRING

**IN ADDITION TO RS-1 A SECOND RESTRICTED AIR SUPPLY IS REQUIRED EITHER FROM A REMOTE RESTRICTED SUPPLY OR FROM INTERNAL RESTRICTOR ON THE RECEIVER CONTROLLER.

Figure 8

DIFFERENTIAL PRESSURE CONTROL

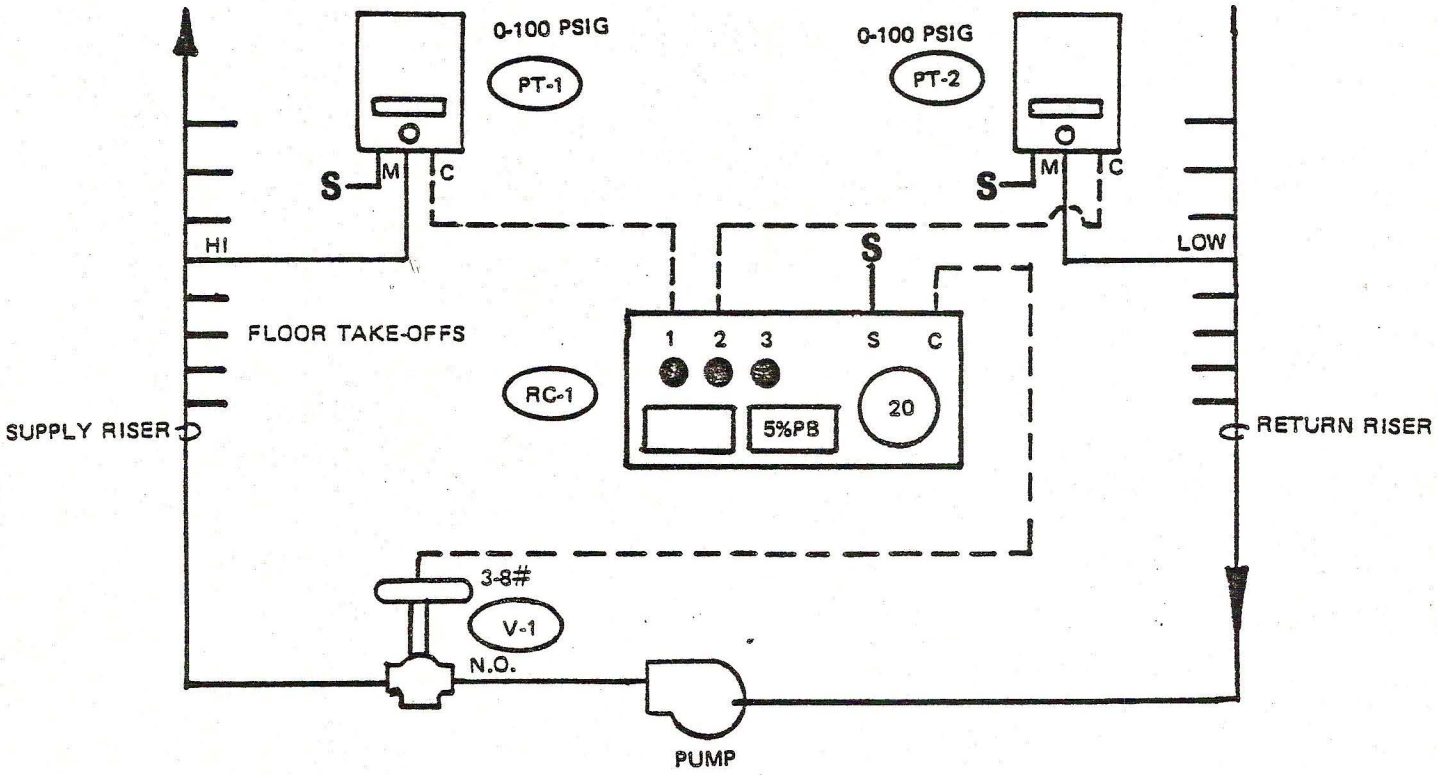


Figure 9

DIFFERENTIAL CONTROL

The receiver-controller may also be used for differential (proportional) control applications where it is desirable to maintain or limit a given differential temperature or pressure. Figure 9 is an example of differential water pressure control.

Differential control applications require both transmitters be identical.

Control devices are combined to make a system. Each control device is mechanical in nature and all mechanical components must be regularly serviced to optimize their operation. All MCC Powers branch offices offer service contracts that will insure your continuous, trouble-free system performance.

For Further Information Contact Your Nearest MCC Powers Representative