MANUAL

for

8 lb Coffee Roaster

Installation

&

Operations

CONTENTS

SIVETZ COFFEE, Inc.
COFFEE BEAN ROASTING MACHINES
ENGINEERING & CONSULTING
349 S.W. 4th STREET
CORVALLIS, OREGON 97333 — U.S.A.
(503) 753-9713

(4)

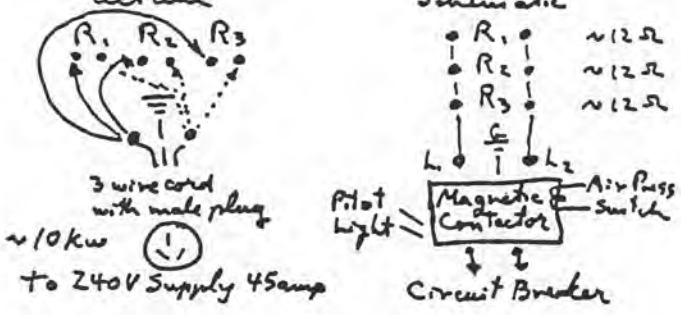
B-'86
Z-'91

Heater Wiring Diagram. 8 lb - 240V - 45 to 50 Amp line
- 60 amp breaker.

SIVETZ COFFEE INC.

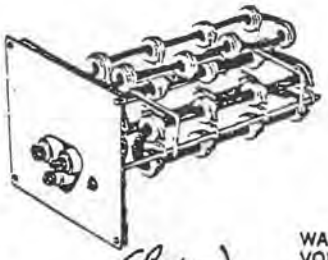
349 SW 4th Street
CORVALLIS, OREGON 97333

8 lb ROASTER - ELECTRIC WIRING



LABEL on ROASTER PANEL- ELECTRICAL WIRING DIAGRAM & COMPONENTS.

Q39585



Westinghouse (Rayco)

WATTS 4600
VOLTS 230

Q39585C RESTRING KIT

2 Coils, 3 Screws, 3 Nuts, 10 Washers.

four for #130 ~~
UPS prepaid
Rev. 892
2-'91

SUGGESTION TO PURCHASER OF COFFEE BEAN ROASTING MACHINE :

EACH USER SHOULD HAVE ON HAND AS SPARE PARTS AT LEAST two spare heaters.

Know how to replace heaters, or have electrician/appliance repair shop that can.

NOTE:- CUSTOMERS HAVE REPEATEDLY GONE INTO A PANIC WHEN THEY FIND THEY HAVE BURNED OUT A HEATER, AND HAVE NOT KEPT SPARES ON HAND. Normally one spare heater is furnished with original equipment. However, the life of these resistance heaters is a function of many variables, some of which are: voltage used, heater rating (12 or 14 ohm), frequency of roasting, amounts of stones, foreign matter falling into perforations, etc.

INTRODUCTORY REMARKS

SIVETZ COFFEE, Inc.
COFFEE BEAN ROASTING MACHINES
Extraction, Engineering & Consulting
349 S.W. 4th ST.
CORVALLIS, OREGON 97333—U.S.A.
Phone 503-753-9713
FAX 503-757-7644

You now own a modern fluid bed coffee bean roasting machine.
It's characteristics are such that the once thru air flow that spouts heats and mixes the beans, gives very uniform and fast heat transfer. The result is a very uniformly roasted coffee bean batch, free of tars smokey deposits, free of harsh bitey tastes, producing a well developed bean physically as well as maximizing flavor and aroma.
These positive features can only be appreciated when one compares the "baked" taste harshness and bite from cy linder roasted beans.

A very important feature of a fluid bed roaster, is our ability to measure accurately the bean temperature with an inserted thermometer. This allows for accurate degrees of roasting as well as reproducability which cylinder roasters can not do.
All bean contact surfaces are stainless steel, and after some use the dark patina acquired in the roast chamber need not be removed.
The 10.6 Kw ~~50~~ 45 amp 240V unit will run for many years when properly used.
Batch sizes should not be less than ~~4~~ 7 lbs nor more than 8 lbs.
When roasting manually, that is, watching bean temperature to shut off heat at desired end point, note that human mental wanderings often allow the bean temperature to go above that point desired, and that is why on other models we furnish automatic heat cutoff bean temp. controllers.
It is very important that the air flow adjustments by the voltage regulator be made so that the beans spout to the top level of chamber, and **MUST NEVER STOP**, otherwise beans can burn. In such an event one must have an emergency procedure to stop heating, lay chamber on metal or concrete floor, and hoe out smoking hot beans to allow to cool and to apply a hand water spray.

One can roast w/o a 1/4" mesh screen to allow chaff and dust to freely fly out, w/o losing any beans from chamber, hence the fine air blower adjustment. Great care must be taken when using the screen cover, that at near 390°F when much chaff is released, that all that chaff does not blind the screen and choke off air flow and hence cause bean movement to stop. If one chooses to use the screen at that time, the blinding chaff can be released by snapping off one corner of the screen and also blowing by mouth, during this 60 second period. A half blinded screen is OK, but a full blinded screen is not safe. Read this manual carefully before use of the roaster and before installation of wiring.

Rev. 8'92

GENERAL DESCRIPTION

12'86
Rev 8'92

8 lb Coffee Roaster

Sivetz Coffee, Inc.
349 SW 4th Street
Corvallis, OR 97333

U. S. PATENT 3,964,175 - see illustrations -

The 8 lb green coffee bean roaster system consists of a roast chamber, a voltage regulator to control blower speed and air flow (so as to control bean levitation (spouting) during the drying and pyrolysis cycles), a safety air pressure switch, that will not allow heat to come on until blower is operating, option - an overhead vent fan drawing air away from about the mouth of the roast chamber, and passing it through the chaff collection cyclone, and then blowing the "particle-free" air outside the building.

The roast chamber heaters are composed of 3 elements each generating 3.5 Kw. They are operated on 240 volts and each element draws 15 amperes. A reset button closes electrical contactor with red-light "on" signals "heat is on."

It is up to the operator to keep sufficient air flow through the spouting beans to assure continual movement, of about 6" " above bean bed. Less movement may cause beans to stop, in which case localized beans at base of cone will burn. Too much spouting wastes hot air and takes longer time to roast.

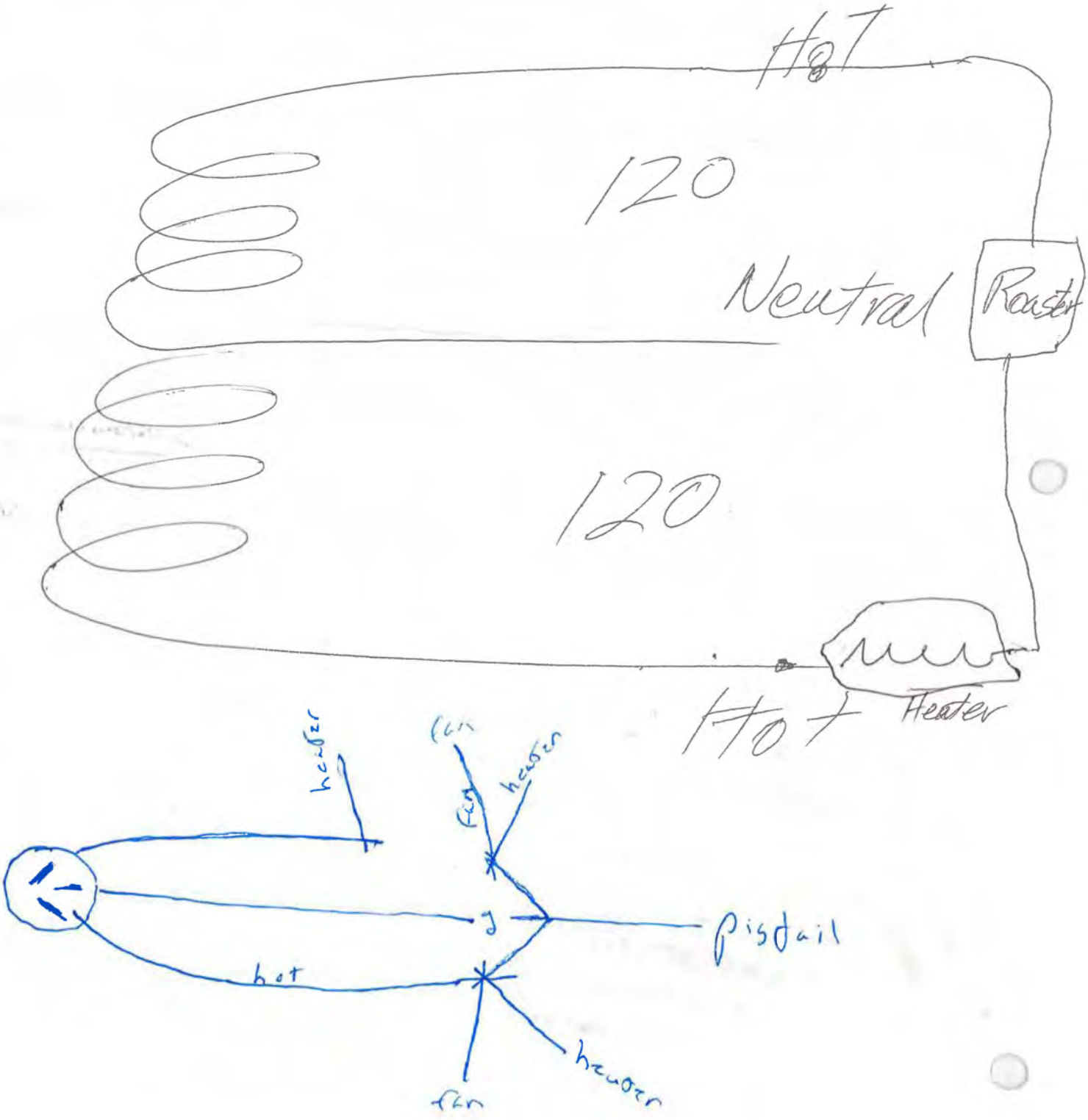
The degree of roast is controlled by continual monitoring the ~~dial thermometer~~ Watlow bean temp. in the beans (3" insertion exactly into bean chamber). When the desired degree of roast is attained (as judged by dial thermometer reading), e.g. 450°F, the Watlow controller causes the contactor to open, which stops heating. There may be a 3°F to 6°F override depending on beans, degree of roast, etc., but 10 to 20 sec. of water spray from nozzles, after heat is cut off, will minimize over-ride of bean temperature, and show a positive decline in bean temperature. Continuing air flow will cool the "just" roasted beans to near room temperature.

The spouting air flow can be stopped, and the roasted beans can be scooped out of the roast chamber or be sucked out by a shop vacuum (option -not included).

To preserve "just roast" aroma & flavor freshness, the "just roasted beans" must be placed in tightly sealed jars (gallon holds 3 lbs), in a freezer.

Depending on number of roasts, line voltage, abuse of equipment, etc. a heater element may fail, and this can be confirmed exactly from "panel" ammeter. The chamber will then have to be disconected from its power supplies, be dismantled, and the "failed" heating element replaced. (TIME to do about 1 hour).

The operator must remain at the roaster at all times to assure of proper bean spouting. Initially green beans lose weight and a lower voltage to blowers is required to maintain 6' "spout movement; over 400°F when beans swell to almost twice their initial volume, less air flow is required. Roast/cool time is 10/4 min.


HOT
120
Neutral
Roaster
120
HOT
Heater
heater
fan
fan
heater
J
pigtail
hot
heater
fan

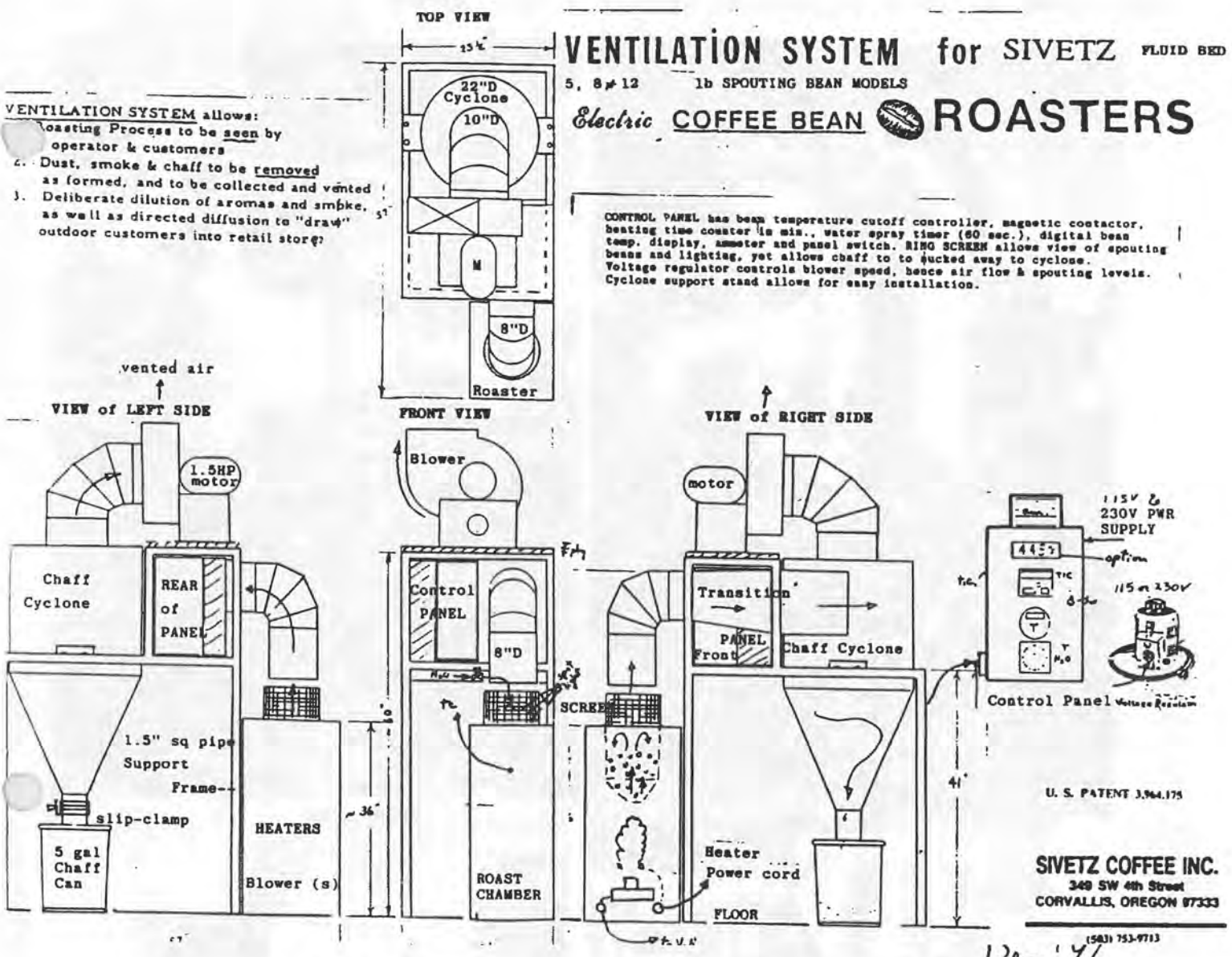
VENTILATION SYSTEM for SIVETZ FLUID BED

5, 8 & 12 lb SPOUTING BEAN MODELS

Electric COFFEE BEAN ROASTERS

VENTILATION SYSTEM allows:
1. Roasting Process to be seen by operator & customers
2. Dust, smoke & chaff to be removed as formed, and to be collected and vented
3. Deliberate dilution of aromas and smoke, as well as directed diffusion to "draw" outdoor customers into retail store?

CONTROL PANEL has bean temperature cutoff controller, magnetic contactor, heating time counter in min., water spray timer (60 sec.), digital bean temp. display, ammeter and panel switch. RING SCREEN allows view of spouting beans and lighting, yet allows chaff to to sucked away to cyclone. Voltage regulator controls blower speed, hence air flow & spouting levels. Cyclone support stand allows for easy installation.



U. S. PATENT 3,964,175

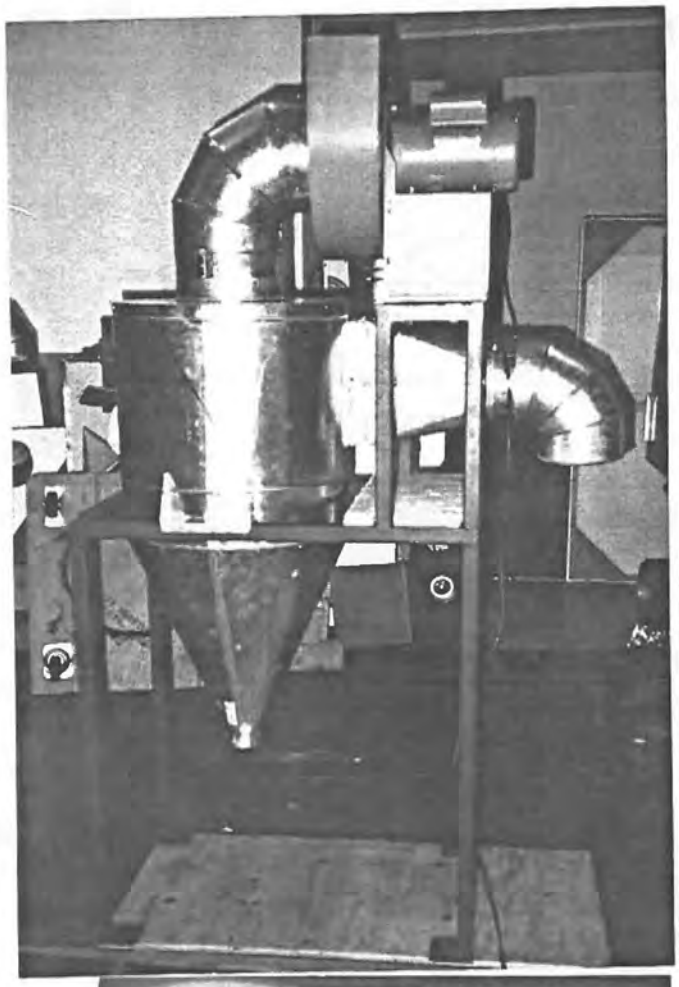
SIVETZ COFFEE INC.
349 SW 4th Street
CORVALLIS, OREGON 97333
(503) 753-9713

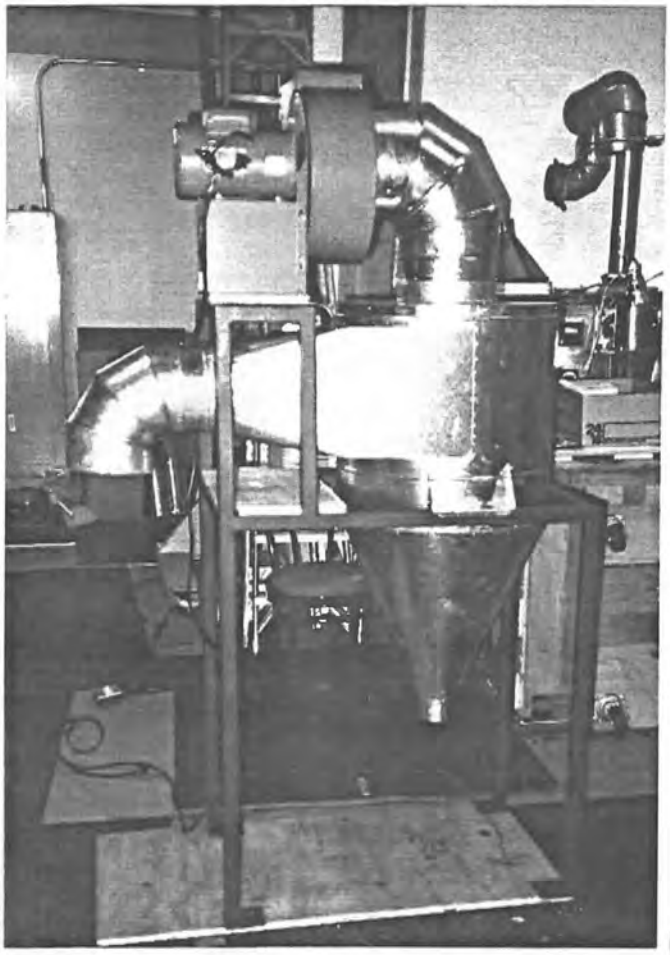
12 Dec '77

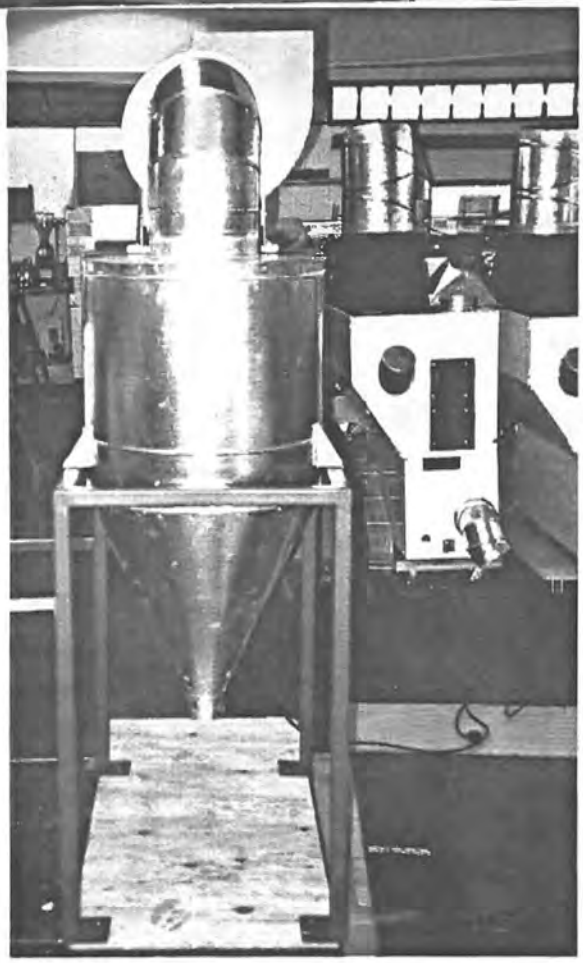
COST BREAKDOWN ON ELECTRIC ROASTERS 9 min reasts

5 lb	8 lb	11 lb
$ 1280 pp	$ 1850 FOB	$ 2,550 FOB
Add $ 1200 for blower & cyclone		
$ 2480	3,050	3,950 FOB
Add $ 1,200 for frame & assembly on frame		
$ 3,680	$ 4,250	5,150
Add $ 2,000 for control panel, water spray, & ammeter		
$ 5,680	$6,250	7,150 FOB

PRE ASSEMBLED Chaff Collection Cyclone & Vent Blower on Frame for use with Electric Roasters







SIVETZ COFFEE INC.
349 SW 4th Street
CORVALLIS, OREGON 97333

Simple LOW COST starting Model

8 lbs Green Beans 10.5 Kw 240V

Coffee Roasting Machine ELECTRIC

3 Fixed resistance heaters..

9.125 stainless steel tube with cone.

13" x 13" x 36" high metal cabinet.(2" thick insulation).

Roasting time: **10** minutes

Bean temperature monitoring & end cutoff control MANUAL
by looking at dial thermometer-3" insertion.

ROAST BEAN UNLOADING by means of shop vacuum or plastic cup.

Voltage regulator controls blower speed hence air flow and inlet air temperatures into conic bean chamber.

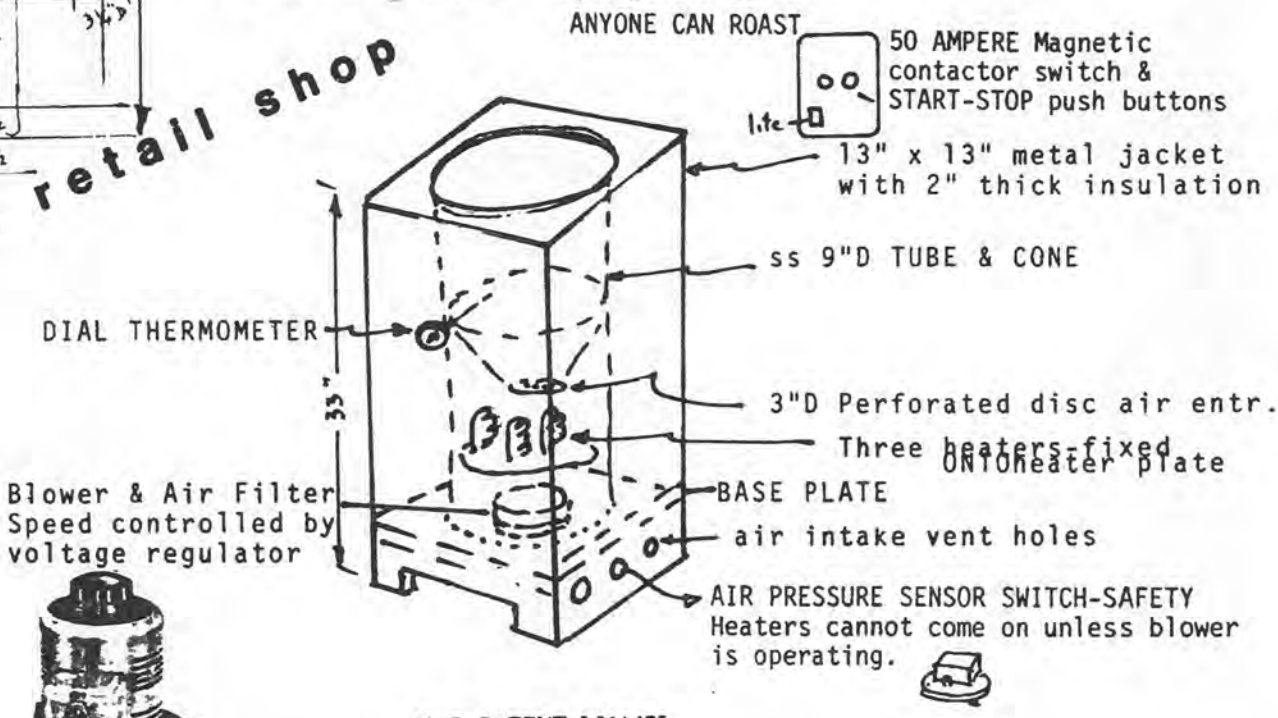
BEANS MUST ALWAYS BE KEPT MOVING.

HEATER PLATE 8-7/8" diameter. 16 Ga Galv.

BASE PLATE 13" x 13" with 1" lips on opposite side(2 up , 2dwn).

ATTENDED ROASTER

for retail shop



U. S. PATENT 3,964,175

SIVETZ **COFFEE**, Inc.
COFFEE BEAN ROASTING MACHINES
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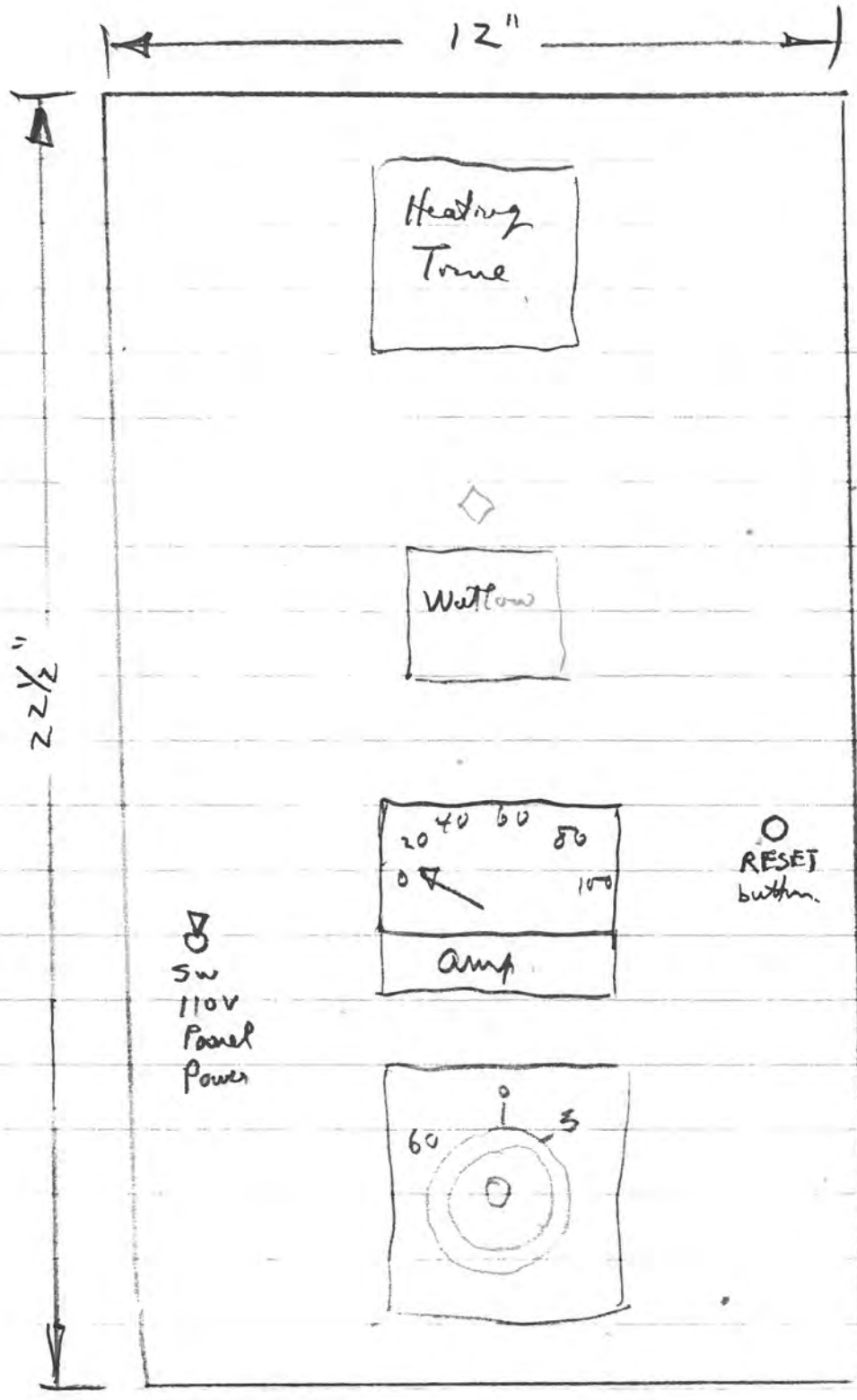
CORVALLIS, OREGON 97333 — U.S.A.

(503) 753 9713

1/83
Rev 3 '86



Control Panel
86 Roadster

8'92

General Arrangement & External Wiring

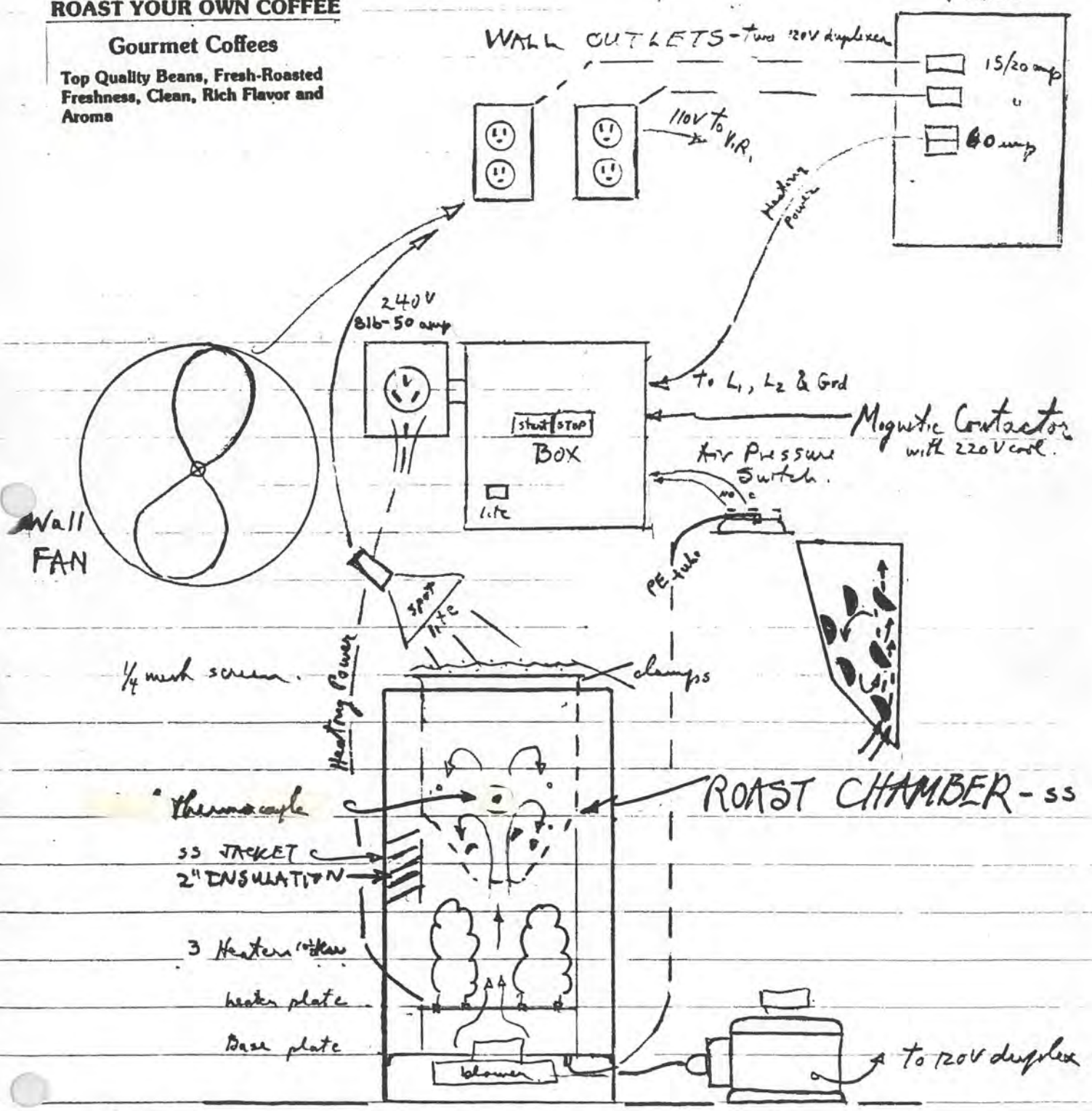
for 8 lb (10½ Kw)

COFFEE BEAN ROASTING MACHINES

ANYONE CAN ROAST BEANS
ROAST YOUR OWN COFFEE

Gourmet Coffees

Top Quality Beans, Fresh-Roasted Freshness, Clean, Rich Flavor and Aroma



U. S. PATENT 3,964,175
Sivetz Coffee, Inc.
349 SW 4th Street
Corvallis, OR 97333

M. Sivetz
Rev Feb. 9 '91
11-12-87
Rev A-'89 & 8'9

ECONOMICAL & SIMPLE
Installation & Use
of 3 and 8 lb
ELECTRIC COFFEE BEAN ROASTING MACHINES

SERVICES REQUIRED:

a) WALL FAN for room ventilation & spot light.

b) Two 120 V duplex wall outlets each on 15 or 20 ampere circuit breakers.

c) One 240 V 60 ampere circuit breakers from building panel.

STEP 1 ELECTRICIAN connects 240 V power supply to contactor L_1 & L_2 & Ground from building breaker panel. Then connect...

a) 1/4" O.D. Poly tube to air pressure switch from base of roast chamber.

b) "PLUG IN" 240V heater cord from roast chamber to panel mounted receptacle wired to Contactor Box.

c) "Plug-in" 120 V blower cord from voltage regulator into wall outlet.

d) INSERT PR SW 2 wire to coil 220V power supply for Mag. Cont. (See Wiring DWG)

e) Set spot light to shine into bean chamber - connect 120 V.

STEP 2 YOU ARE NOW READY TO ROAST ...about 9 minutes

a) Weigh exactly 8.0 lbs green coffee beans. Pour beans into roast chamber. Start Room Vent FAN.

b) Set in . thermo couple in front wall of roast chamber (2" inside chamber).

c) Place screen (1/4 mesh) over top opening of roast chamber with clamps.

d) Turn up blower voltage until beans are spouting just below top of chamber.

e) Push "RESET" button for heating. Red pilot light comes "ON".

f) Dial down VR to reduce blower speed to keep spouting beans below top (as they dry)

NOTE:

g) When beans reach 450°F, via "Watlow" control, Heating ends & cooling starts. Red light goes out. Water spray cooling may or may not be required.

h) The roasted beans will cool down to 120°F in about 4 minutes.

i) Remove top screen after shutting off blower power.

j) Remove thermo couple

k) Scoop out w plastic cup roasted cooled beans.

l) Pour roasted beans into gallon jar, seal and place in Freezer to PRESERVE FRESHNESS & AROMA

SIVETZ **COFFEE,** Inc.
COFFEE BEAN ROASTING MACHINES
ENGINEERING & CONSULTING
349 S.W. 4th STREET
CORVALLIS, OREGON 97333 - U.S.A.

WARNING

When beans reach near 380°F til about 410°F, much chaff will release. This can **BLIND** the 1/4" mesh flat screen, so it must be "flicked" to release chaff, yet not allow beans to be blown out. Failure to keep screen clear impairs seeing moving beans and can cause beans to stop movin

Feb. 1985
Rev 5 '90
- 8 '92

LIST of PARTS to 8 lb coffee bean roasting machine

1. ROAST CHAMBER

a) Dimensions: 13" x 13" x 36" high, with 9.1"D ss in top with cone.

b) ELECTRICAL CONNECTIONS:

- 240 Volt 3 prong 50 amp. cord for 45 amp.(HTRS)
- 120 " " " 10 " " for blower

CONTROL PANEL

Contains magnetic contactor for heating power & receptacle. Air press. switch, ammeter, heater pilot light, reset buttoi to start heating, and Watlow bean temperature high limit controller with relay, and heating time counter, panel switcl

2. VOLTAGE REGULATOR

Controls speed of blower, hence air flow and pressure so that coffee beans can be levitated to peak out near top flange level. Superior Elec. Model 3PN116B rated 120V in, 140V out, 1.2 KVA with 10 amp fuse & switch.

3. MISCL. PARTS

a) Dial thermometer, range 50 to 500°F. Insert only 3" into chamber.

b) 1/4" mesh screen to set on top to keep beans from flying out.

c) Two clamps to hold screen down.

d) Red pilot light on FURNAS to show HEAT IS "ON".

e) Water spray system optional

f) Intake air filter optional inspect periodically, and clean & change as required. A dirty air filter will reduce air flow limiting amount of beans that can be levitated, and can cause excess heating of intake air.

g) One spare heater Q 39585

4. AUX. PARTS

a) CHAFF COLLECTION CYCLONE: 22"D x 4'H with intake transition & elbow.

Inlet duct 10"D , and outlet stack 10"D (accomodates to blower intake).

b) 5 Gallon chaff can with hoop, with 4"D inlet at top cover.

c) Two elbows: One 10" for turn from top of roaster, and other 8"D from Cyclone stack to blower intake.

See drawing of duct-vent arrangement.

d) SUCTION BLOWER

Model CG1 from N.Y. Blower with ~2HP motor 230V 1φ frame, 3000 rpm, belt dr 120/230V, single phase. Capacity:->1,000 CFM at 6" w.c.

12"D wheel (steel).

e) AUTOMATIC BEAN TEMPERATURE SENSOR (thermocouple) tied to high limit bean temp. controller (digital) which shows bean temp. and set temperature, automatic water spray, ammeter & heating time counter.

5. INSTRUCTION MANUAL

SIVETZ COFFEE CO.
349 S.W. 4th Street
Corvallis, OR 97333
(503) 753-9713

AMETEK

we have model # 115826

LAMB® VACUUM MOTORS, BLOWERS

MODEL 115750

technic bulletin

2-VT572-5750

Issued: 11/15/76

Supersedes: 11/15/73

Spares from Sunset Vacuum Supply 916-453-1711 1.800.282.2348

DESCRIPTION

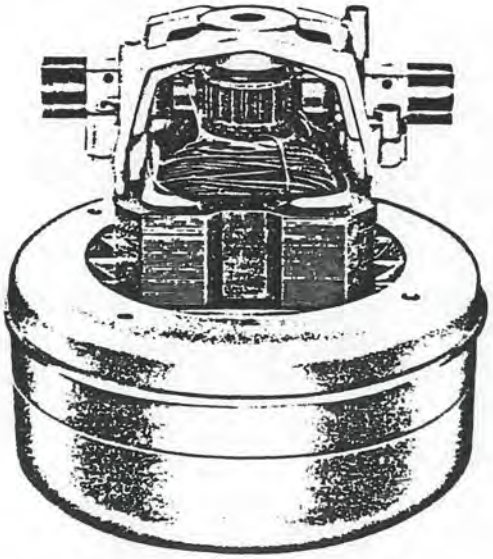
TYPE: Two Stage Single Speed, Thru-Flow, 120 Volt.

DESIGN APPLICATION: Canister-type vacuum cleaners. Equipment not requiring separation of working air from motor ventilating air. Designed to handle clean, dry, filtered air only. For additional application information write for Bulletin 2-VT570-000.

SPECIAL FEATURES:

- Component recognized by Underwriters Laboratories Inc. and Canadian Standards Association (CSA).
- Open frame construction.
- Provision for grounding.
- Double ball bearings.

All 5.7" diameter thru-flow motors feature face mounting interchangeability. The Lamb vacuum motor line offers a wide range of performance levels to meet design needs.



TYPICAL CHARACTERISTICS*

(Not to be used for setting specifications)

@ 120 VOLTS—60 HERTZ Standard Conditions: 29.92 Inches Hg, 68°F		MODEL NUMBER 115750
Sealed	Vacuum (Inches H_2O)	92.0
	Volume (CFM)	0
	Power (Watts)	550
	Current (Amps)	4.7
	Speed (RPM)	23,500
7/8" Orifice	Vacuum (Inches H_2O)	36.0
	Volume (CFM)	61.0
	Power (Watts)	900
	Current (Amps)	7.7
	Speed (RPM)	18,500
1¼" Orifice	Vacuum (Inches H_2O)	17.0
	Volume (CFM)	86.0
	Power (Watts)	930
	Current (Amps)	8.0
	Speed (RPM)	18,200
2" Orifice	Vacuum (Inches H_2O)	3.4
	Volume (CFM)	99.0
	Power (Watts)	970
	Current (Amps)	7.8
	Speed (RPM)	18,500

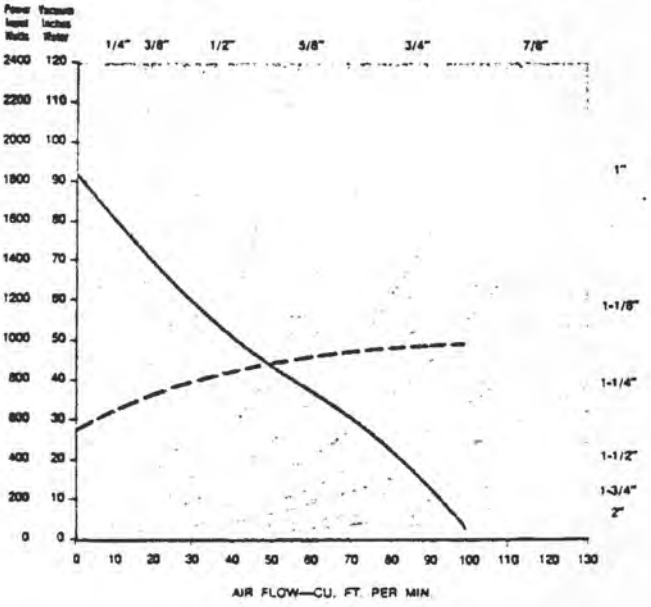
MOTOR PERFORMANCE*

Average test data corrected to standard barometer of 29.92 in. Hg. and 68°F.

LEGEND

Watts - - - - - - - - -

Vacuum ————

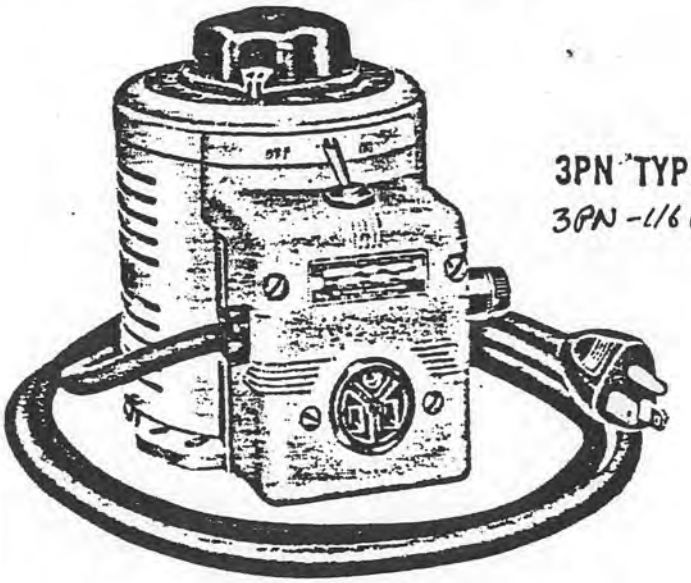


Note: Curves marked with fractional inch designations indicate air flow and vacuum through sharp-edged thin plate test orifices of diameter indicated.

**The performance data specified represents a typical or average motor. If data is required to establish acceptance specifications, contact the factory.*

VOLTAGE REGULATOR for blower

120 V TO 140 V 10 amp



3PN TYPES

3PN-116C

SIVETZ COFFEE INC.

349 SW 4th Street

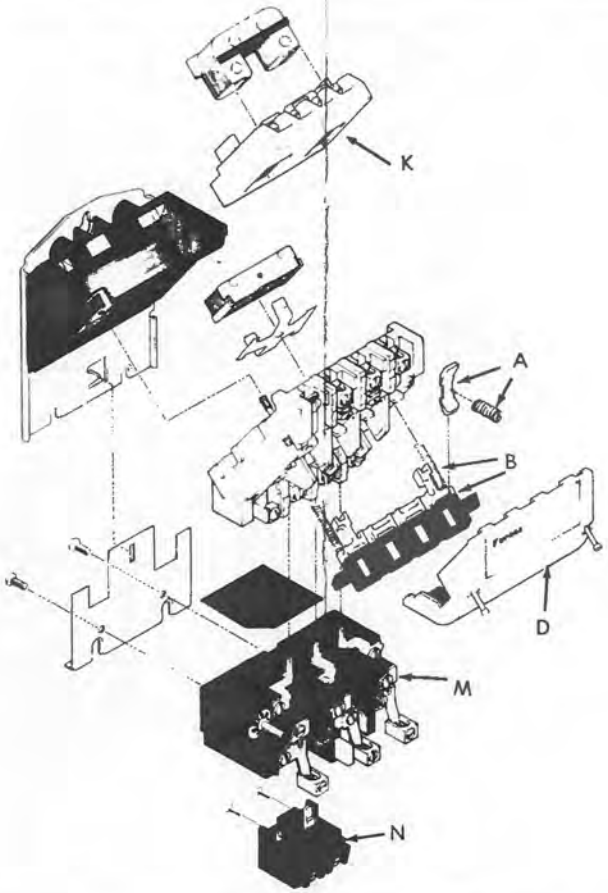
CORVALLIS, OREGON 97333

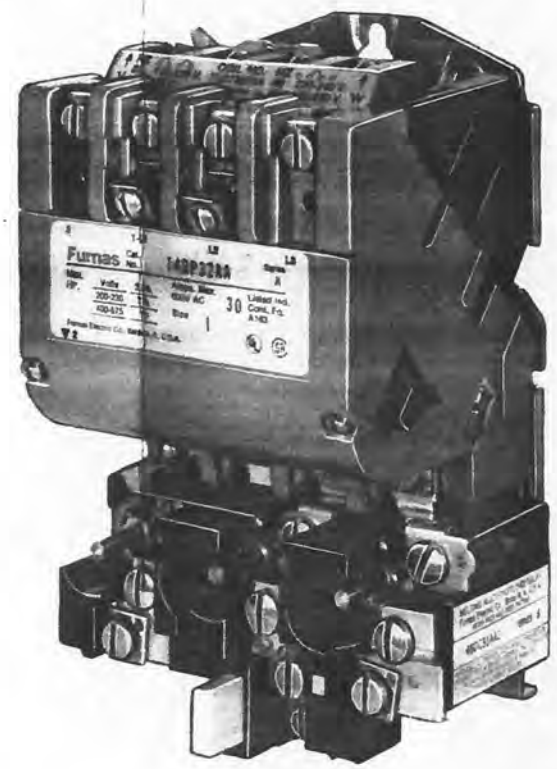
(503) 753-9713

December, 1983

Starters & Contactors
00, 0, 1, 1P & 1¾

Class 14 & 40
14BP, 14CP, 14DP, 14EP,
40BP, 40CP, 40DP, 40EP





Item	Part Description			Part Number
A	Contacts & Spring, One Complete Pole			
	Power Pole	Size	00	75BF14
			0	75CF14
			1	75DF14
			1P & 1¾	75EF14
	Interlock Pole (includes spring retainer)		All Sizes	75AF14
B	Cross Arm (less contacts) With Cross Arm Springs			75P1000
D	Contact Board Cover			D29079001
K	Coil			
	60 Hertz	50 Hertz		
	20v	110v		75D73070F
	110-120v/220-240v	110v/190-220v		75D73070A
	220-240v/440-480v	190-220v/380-440v		75D73070C
	550-600v	550v		75D73070E
	For other voltages specify the number stamped on the coil.			

Item	Part Description			Part Number
M	Overload Relays (includes baseplate)			
	Melting Alloy (std)	Size 00-1	1 Pole	48DC11AA3
			3 Pole	48DC31AA3
		Size 1¾	1 Pole	48EC11AA3
			3 Pole	48EC31AA3
	Bimetal	Size 00-1	1 Pole	48DC17AA3
			3 Pole	48DC37AA3
		Size 1¾	1 Pole	48EC17AA3
			3 Pole	48EC37AA3
	Amb Comp Bimetal	Size 00-1	1 Pole	48DC18AA3
			3 Pole	48DC38AA3
		Size 1¾	Pole	48EC18AA3
			3 Pole	48EC38AA3
N	Melting Alloy Overload Kit — NO Contact			48ACNO

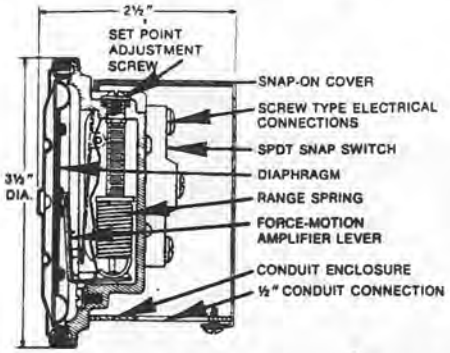
NOTE: When ordering replacement parts, give catalog number of control and part name and number.

SERIES 1900* PRESSURE SWITCH
Installation and Operating Instructions

Set points from 0.07" to 20" W.C. Repetitive accuracy within 3%, U.L. and C.S.A. listed, F.M. approved.

Series 1910 pressure switch. All pressure and electrical connections and set point adjustments are on one side for easy installation.

Series 1910 switch with conduit enclosure off. Shows electric switch and set point adjustment screw.



The Dwyer-engineered force-motion amplifier increases the leverage of diaphragm movement and results in a switch with excellent sensitivity and repeatability.

Advanced design and precision construction permit these switches to perform many of the tasks of larger, costlier units. Designed for air conditioning service, they also serve many fluidics, refrigeration, oven and dryer applications. For use with air and non-combustible gases. Series 1900 switches are available with set points of 0.07 to 20 inches water column. Set point adjustment can be made easily — before or after installation. Range screw is inside conduit enclosure to help prevent tampering. For easy mounting and access, pressure and electrical connections and set point adjustment are located on one side. This permits installation in corners or spaces too small for other switches.

SPECIAL MODELS AND ACCESSORIES

(See also OEM models on page 5 of Bulletin E-50)

Dwyer Accessory Part No. A-329

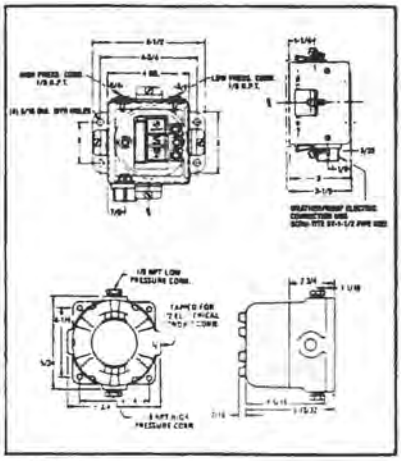
Special close coupled street elbow for right angle pressure connections. Can be installed on switch anytime. Zinc plated aluminum.

Weatherproof Enclosure:

16 ga. steel enclosure for unusually wet or oily conditions. Withstands 200 hour salt spray test. Gasketed cover. Weight 5 lbs. Switch must be installed at factory. Specify "WP" in addition to switch catalog number.

Explosion-Proof Housing:

Cast iron base and aluminum dome cover. Approximate weight 7 lbs. Specify "EXPL" in addition to switch catalog number.



PHYSICAL DATA

Temperature limits: 32°F. (−30° for dry air), to 180°F.
Maximum surge pressure: 10 psig.
Rated pressure: 45" H_2O.
Pressure connections: ⅛" NPT.
Electrical rating: 15 amps, 120-480 volts, 60 Hz. A.C. Resistive ⅛ H.P. @ 125 volts, ¼ H.P. @ 250 volts, 60 Hz. A.C. See INSTALLATION for de-rating information above 130°F.
Wiring connections: 3 screw type, common, normally open and normally closed.
Set point adjustment: Screw type inside conduit enclosure.
Housing: Zinc die casting and steel stamping. Zinc plated for 200 hour salt spray resistance.
Diaphragm: Molded Silicone rubber.
Calibration spring: Stainless steel.
Weight: 1 lb.

MODEL 1910 SWITCHES:
OPERATING RANGES AND DEAD BANDS.

To order specify Model Number	Operating Range Inches, W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1910-00	0.07 to 0.15	.04	.05
1910-0	0.15 to 0.5	0.10	0.15
1910-1	0.4 to 1.6	0.15	0.20
1910-5	1.4 to 5.5	0.3	0.4
1910-10	3.0 to 11.0	0.4	0.5
1910-20	4.0 to 20.0	0.4	0.6

Suggested Specification

Differential pressure switches shall be diaphragm operated with 3½" diaphragm to actuate a single pole double throw snap switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. Switches shall be Dwyer Instruments, Inc. Catalog No. 1910-____ for the required operating ranges.

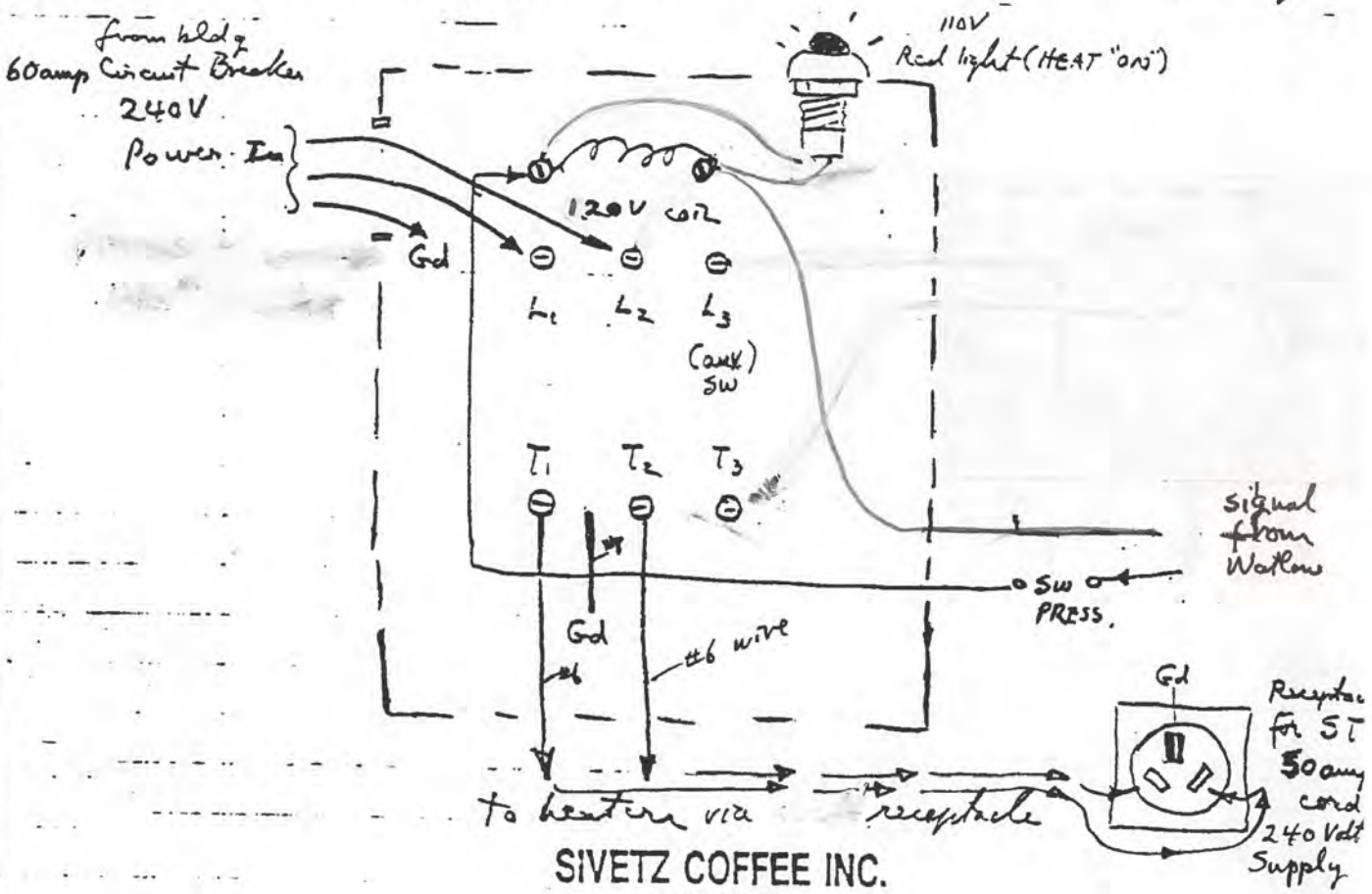
How to Order: See price list, Bulletin S-26.

*Patent No. 3,566,060

DWYER INSTRUMENTS, INC.
P. O. BOX 373 • MICHIGAN CITY, INDIANA 46360, U.S.A.
Telephone 219/872-9141

Magnetic Contactor Wiring

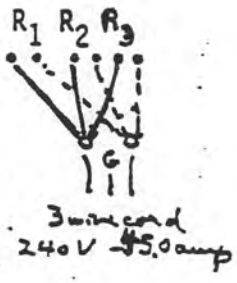
for, 8 lb-10½ Kw - 240 V 45 amp Roaster with START-STOP station + pilot light



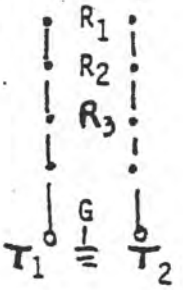
SIVETZ COFFEE INC.
349 SW 4th St
CORVALLIS, OREGON 97333

8 lb/ 10½ Kw ELECTRIC ROASTER WIRING

Actual



Schematic



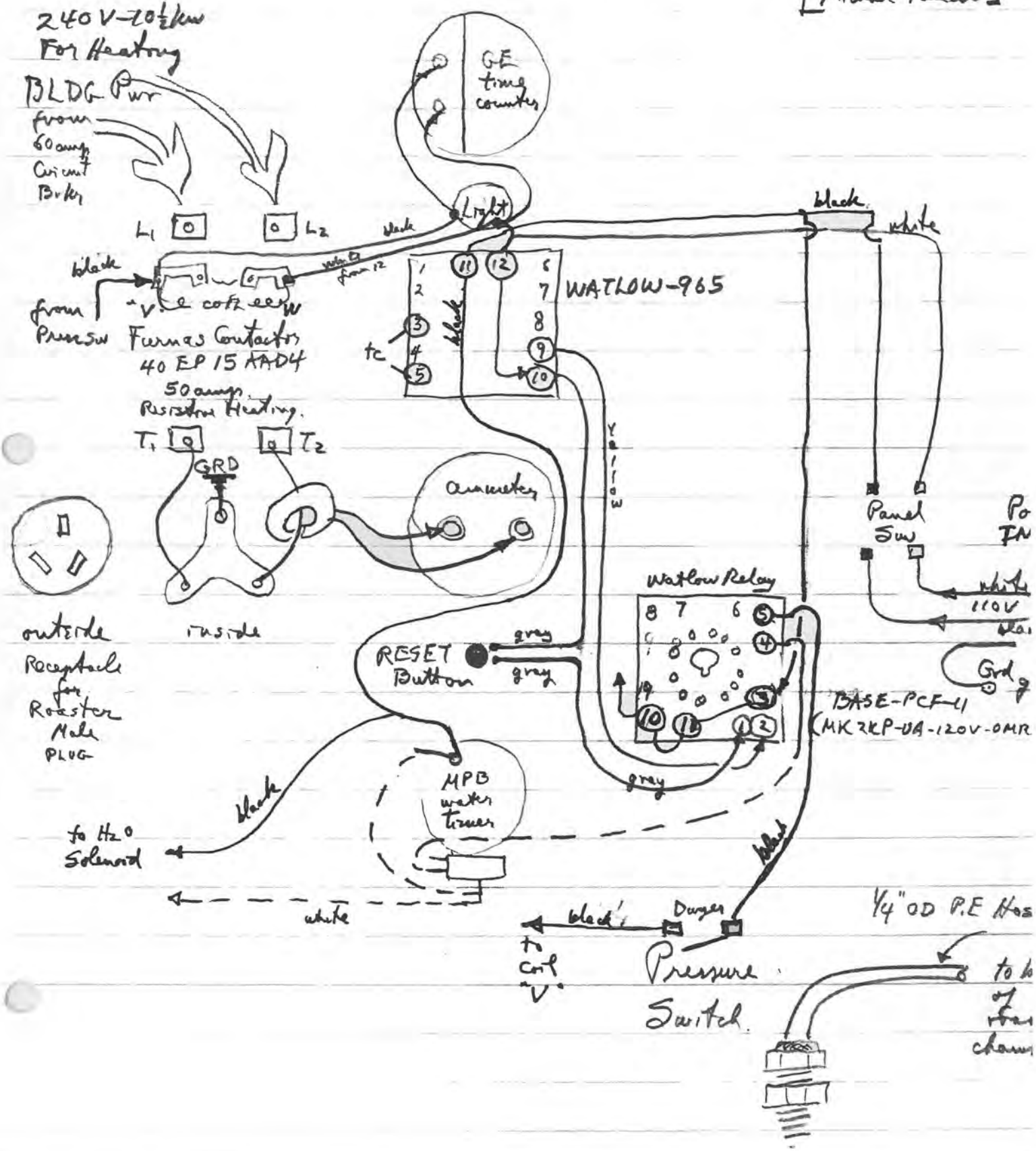
Rev. 2'91
Rev. 10-'88
" 8-'89

Aug '92
Srivets

8# Elec. Roaster Panel (Rear View) Wiring & Parts List.

12" wide x 22" high x 8" deep

[Michael Beech]



Series 965

1/16 DIN Microprocessor-Based Auto-tuning Control

User's Manual

WATLOW

Watlow Controls, 1241 Bundy Blvd., Winona, MN 55987, Phone: 507/454-5300, Fax: 507/452-4507

W965-MA10-9042
October, 1990

$10.00
Made in the U.S.A.

Use The Manual

How to Use the Manual

First...

This manual will make your job easier. Reading it and applying the information is a good way to become familiar with the Series 965. An overview:

Starting Out Chapter 1, Page 4.

Install/Wire Chapter 2, Page 6.

Front Panel Chapter 3, Page 13.

Setup Chapter 4, Page 14.

Tuning Chapter 5, Page 19.

Appendix Specifications, Page 24.
Noise Guidelines
Calibration
Glossary
Warranty

Notes

The user's manual contains informational notes to alert you to important details. When you see a note icon, look for an explanation in the margin.

♪ or ♫

♪ or ♫

NOTE:
Details of a "Note" appear here, in the narrow box on the outside of each page.

Safety Information

This user's manual also has **boldface** safety information notes to protect both you and your equipment. Please be attentive to them. Here are explanations:

STOP

WARNING:
Details of a "Warning" appear here, in the narrow box on the outside of each page.

The Stop Sign in the wide text column alerts you to a **"WARNING,"** a safety hazard which could affect you and the equipment. A full explanation is in the narrow column on the outside of the page.

CAUTION:
Details of a "Caution" appear here, in the narrow box on the outside of each page.

The Deer Crossing Sign in the wide text column alerts you to a **"CAUTION,"** a safety or functional hazard which could affect your equipment or its performance. A full explanation is in the narrow column on the outside of the page.

Your Feedback

Your comments or suggestions on this manual are welcome, please send them to: Technical Writer, Watlow Controls, 1241 Bundy Blvd., Winona, MN 55987, or phone 507/454-5300. The Watlow Series 965 User's Manual and integral software are copyrighted by Watlow Winona, Inc., © 1990, with all rights reserved. blr1090

Technical Assistance

If you encounter a problem with your Watlow Control, review all of your configuration information to verify that your selections are consistent with your application... Inputs, Outputs, Alarms, Limits, etc. If the problem persists after checking the above, you can get technical assistance by dialing: 1-507-454-5300

An Application Engineer will discuss your problem with you. Please have the following information available when calling:

- Complete model number
- Bar Code Number
- All configuration information
- User's Manual

The bar code number is located inside on the control chassis.

Contents

Figures, Tables, Charts

Chapter 1

Starting Out With The Watlow Series 965, A Microprocessor-Based Control

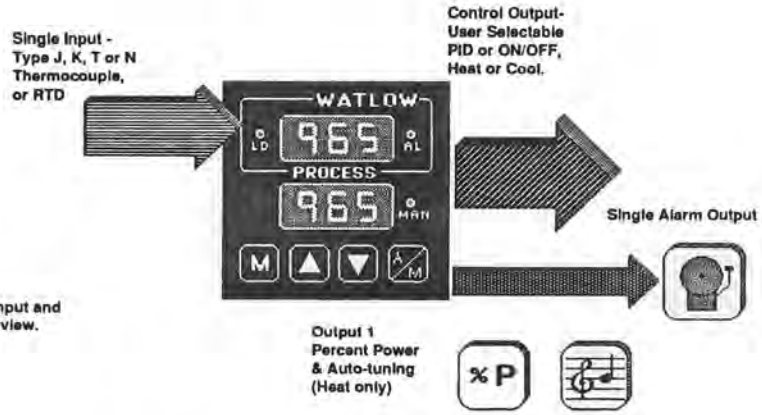


Figure 1 - Series 965 Input and Output Overview.

General Description

Welcome to the Watlow Series 965, a 1/16 DIN microprocessor-based, single input, dual output, auto-tuning temperature control, featuring Automatic/Manual capability with bumpless transfer and a NEMA 4X rating. In the Auto mode, the 965 has closed loop control with sensory feedback, while the Manual mode has open loop control with user defined output power level. The 965 accepts a Type J, K, T or N thermocouple or RTD input. The primary output is heating or cooling, while the secondary output is alarm only.

With the Series 965 you can select either PID or ON/OFF for Output 1. You may input a complete set of PID parameters, and select automatic tuning in the heating mode from the front panel for Output 1. This includes proportional band, reset/integral and rate/derivative. By setting the proportional band to zero, the Series 965 becomes a simple ON/OFF control with the switching differential selectable under the HYS Setup parameter.

Operator-friendly features include automatic LED indicators to aid in monitoring and setup, as well as a calibration offset at the front panel. The Watlow Series 965 automatically stores all information in a non-volatile memory.

Starting Out

Steps To Put Your Control To Work

To put your Series 965 to work, we suggest the following steps:

- Read the user's manual.
- Plan your installation and wiring.
- Cut the panel mounting hole and install the control.
- Wire your Series 965 to the system.
- Start the system and tune the Series 965.
- Make final adjustments to the control parameters and record the data.
- That's all there is to it.

Overview of the Series 965 Menus

Before getting into the details of installing and wiring the Series 965, take a look at Figure 2, and at the three different menus. "Setup," "Operation," and "Calibration." After you feel comfortable with the names and their functions, move on to installation and wiring.

Setup	Configure the 965's features to your application. Establish levels of operator access, input type, units of measure, low and high range limits, hysteresis, output, and alarm type.
Operation	Enter the set point, PID tuning values and alarm set point here. Parameters for proportional band, reset/integral and rate/derivative, and cycle time for Output 1, alarm low and high limits; calibration offset and auto-tune are here also.
Calibration	Supply various input signals to the Series 965, and performs auto-calibration. Also, select either U.S. or international parameters here. **Calibration procedures should only be attempted with proper equipment and by qualified personnel.**

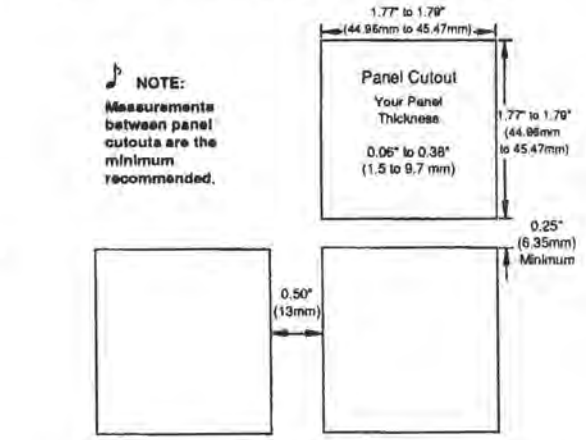
Figure 2 - Overview of the Series 965 Menus.

Where To Go From Here

If your Series 965 is already installed and wired, go directly to "How to Use the Keys and Displays," Chapter 3. If not, turn the page to Chapter 2, "How to Install and Wire the Series 965," and proceed from there.

Chapter 2

Install and Wire the Series 965



NOTE:
Measurements between panel cutouts are the minimum recommended.

Figure 3 - Series 965 Multiple Panel Cutout Dimensions

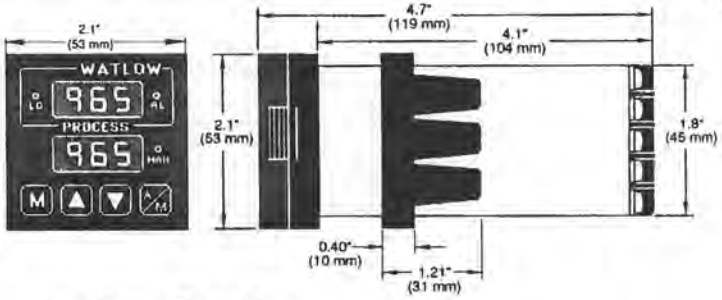


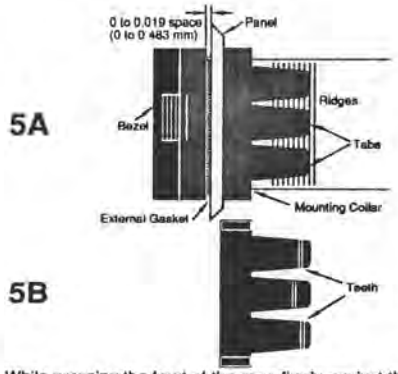
Figure 4 - Series 965 Dimensions

Installation Procedure

Follow this procedure to mount the Watlow Series 965 Temperature Control:

NOTE:
Removing the Series 965 chassis from its case will make mounting easier.

1. Make a panel cutout per the dimensions in Figure 3.
2. Remove the 965 chassis from its case. Holding each side of the bezel, press in firmly on the side grips until the tabs release. Pull the chassis out of the case. Put the chassis aside for later installation.
3. Make sure the rounded side of the external case gasket is **facing** the panel surface. Check to see that the gasket is not twisted, and is seated within the case bezel flush with the panel. Place the case in the cutout you just made. Make sure the gasket is between the panel cutout and the case bezel. See Figure 5A.



5A

5B

Figure 5 - Mounting, Case Side View & Collar Cross Section.

Mounting Collar Cross Section (notice the offset teeth on each tab)

4. While pressing the front of the case firmly against the panel, slide the mounting collar over the back of the control. The tabs on the collar must line up with the mounting ridges on the case for secure installation. See Figure 5A again. Slide the collar firmly against the back of the panel getting it as tight as possible. Make sure you cannot move the case within the cutout, if you can you do not have a NEMA 4X seal.

   Now, let's make sure we have a tight seal. Use your thumb to lock the tabs into place while pressing the case from side to side. Don't be afraid to apply enough pressure to install the control. The tabs on each side of the collar have teeth which latch into the ridges. See Figure 5B. Each tooth is staggered at a different height, so only one of the tabs on each side are ever locked into the ridges at any time.

   Looking at Figure 6, you see that the tabs on one side of the collar correspond with those on the opposite side. Make sure that the two corresponding tabs are the only ones locked in the ridges at the same time. If the matching tabs are not holding the case at the same time you **will not** have a NEMA 4X seal. You can make a visual check, or use your finger nail to pull out on each tab. **Only one on each side is engaged, and they must be corresponding as in Figure 6.** The space between the bezel and panel must be between 0 and 0.019" (0.48 mm).

NOTE:
To guarantee a proper NEMA 4X seal, make sure the gasket between the panel and the rim of the case is not twisted and is seated properly. PRESS FIRMLY.

Make sure that the two corresponding tabs below are locked in the ridges at the same time.

NEMA 4X Seal Example.

Figure 6 - Case Rear View and NEMA 4X Seal Example.

When removing the mounting collar, we suggest sliding a thin tool such as a putty knife or screwdriver under all three tabs on each side at once and pulling it back off the case.

5. Insert the control chassis into its case and press the bezel to seat it. Make sure the inside gasket is also seated properly and not twisted. The hardware installation is complete. Proceed to the wiring section from here.

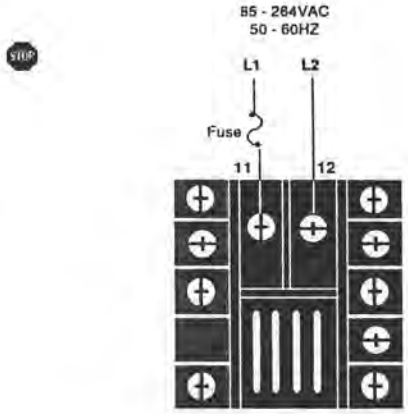
How to Wire the Series 965

The Series 965 wiring is illustrated by model number option. Check the unit sticker on the control and compare your model number to those shown here and also the model number breakdown in the Appendix of this manual.

All outputs are referenced to a de-energized state. The final wiring figure is a typical system example.

When you apply power without sensor inputs on the terminal strip, the Series 965 displays "- - -" or rEs (reversed sensor) in the Upper display, and a "0" in the Lower display. Press the A/M key twice, and ER 7 is displayed for one second. This error indicates an open sensor or A/D error. Remove power to the control and connect the sensor properly, see Page 9. All wiring and fusing must conform to the National Electric Code and to any locally applicable codes as well.

Figure 7 - Power Wiring



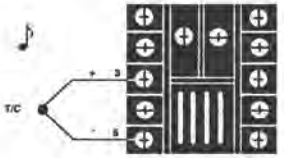
WARNING:
To avoid potential electric shock, use National Electric Code (NEC) safety practices when wiring and connecting this unit to a power source and to electrical sensors or peripheral devices.

Sensor Installation Guidelines

We suggest you mount the sensor at a location in your process or system where it reads an average temperature. Put the sensor as near as possible to the material or space you want to control. Air flow past this sensor should be moderate. The sensor should be thermally insulated from the sensor mounting.

Input Option "1", **Thermocouple Input**
Terminals 3 & 5
Model # 965A - **1** _ _ 0 - 0000

Figure 8 - Input Option "1", Thermocouple Wiring Diagram.

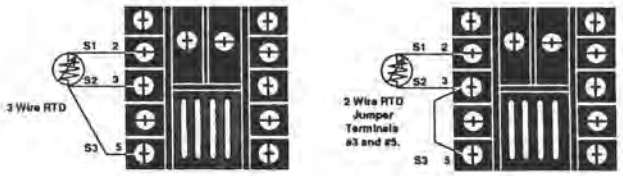


3	T.C. +
4	Not Used
5	T.C. -

NOTE:
Extension wire for thermocouples must be of the same alloy as the thermocouple itself to limit errors.

Input Option "2", for **2 or 3 Wire RTD**
Terminals 2, 3 & 5
Model # 965A - **2** _ _ 0 - 0000

Figure 9 - Input Option "2", for a 2 or 3 wire RTD Sensor Wiring.



2	S1 RTD
3	S2 RTD
4	Not Used
5	S3 RTD

NOTE:
Long lead lengths create electrical resistance. There could be approximately 4.5°F/2.5°C input error for every 1Ω of lead length resistance, when using a two wire RTD. That resistance, when added to the resistance of the RTD element, can result in erroneous input to the instrument. To overcome this problem, use a three wire RTD sensor, which compensates for lead length resistance. When extension wire is used for a three wire RTD, all three extension wires must have the same electrical resistance. (i.e. same gauge, length, copper stranded).

Output Wiring

Output 1 Option "C", **DC Output (Open Collector)**
Terminals 9 & 10
Model # 965A - _ **C** _ 0 - 0000

8 Not Used
9 D.C. +1
10 D.C. - 1

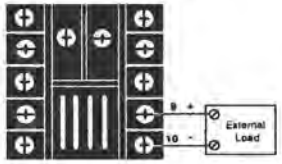


Figure 10 - DC Output 1 (Open Collector), Option "C" Wiring Diagram.

Switched DC
Watlow's solid state switch is a low current DC output (open collector) used to switch an external power switching device such as an SSR or an electromechanical relay. The input specifications of the power switching device must match those listed for the SS switch output. The power switching device must provide isolation between the SS switch output and load power since the SS switch output is a non-isolated output. The switched DC voltage will be between 7 and 10VDC with a source resistance of 500Ω maximum. The output is short circuit protected.

Output 1 Option "D", **Mechanical Relay, Form C, 5 Amp**
Terminals 8 - 10
Model # 965A - _ **D** _ 0 - 0000

8 N.C. 1
9 COM. 1
10 N.O. 1

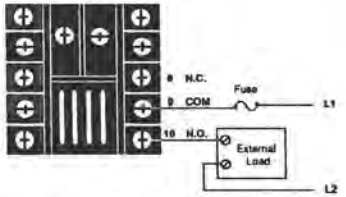


Figure 11 - 5 Amp Mechanical Relay, Output 1, Option "D" Wiring Diagram.

Mechanical Relay
The electromechanical relay is an electrical and mechanical device with moving parts. When power is applied to the relay solenoid, contact closure is created through movement of the "common" contact of the relay.

Output 1 Option "F", **Process, 4-20mA**
Terminals 9 & 10
Model # 965A - _ **F** _ 0 - 0000

8 Not Used
9 4-20 +1
10 4-20 - 1

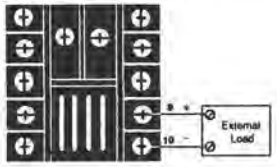


Figure 12 - 4-20mA, Output 1, Option "F" Wiring Diagram.

Process Output
Proportional value determined by the control to balance the sensor input and set point. This value will fall between 4-20 mA depending on your process output type. **Maximum load resistance is 300Ω.**

♪ **NOTE:**
For more information on alarms see Page 21.

Alarm Wiring

♫ **NOTE:**
When the alarm output is de-energized, the N.O. contact is open in the alarm condition.

Output 2 Option "A", **No Alarm Output 2**
Model # 965A - _ _ **A** 0 - 0000

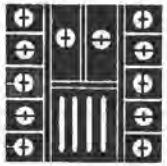


Figure 13 - None Used, Alarm Output 2, Option "A" Wiring Diagram.

Output 2 Option "C", **DC Output (Open Collector)**
Terminals 6 & 7
Model # 965A - _ _ **C** 0 - 0000

6 DC +
7 DC -

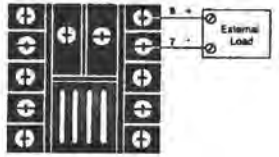


Figure 14 - DC Alarm Output 2 (Open Collector), Option "C" Wiring Diagram.

Switched DC
Watlow's solid state switch is a low current DC output (open collector) used to switch an external power switching device such as an SSR or an electromechanical relay. The input specifications of the power switching device must match those listed for the SS switch output. The power switching device must provide isolation between the SS switch output and load power since the SS switch output is a non-isolated output. The switched DC voltage will be between 7 and 10VDC with a source resistance of 500Ω maximum. The output is short circuit protected.

Output 2 Option "D", **Mechanical Relay, Form C, 5 Amp**
Terminals 1, 6 & 7
Model # 965A - _ _ **D** 0 - 0000

1 N.C. 2
⋮
6 COM 2
7 N.O. 2

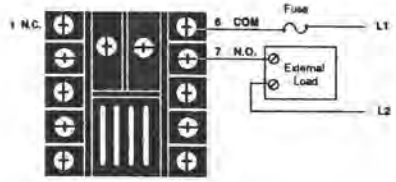


Figure 15 - 5 Amp Mechanical Relay, Alarm Output 2, Option "D" Wiring Diagram.

Mechanical Relay
The electromechanical relay is an electrical and mechanical device with moving parts. When power is applied to the relay solenoid, contact closure is created through movement of the "common" contact of the relay.

Wiring Example

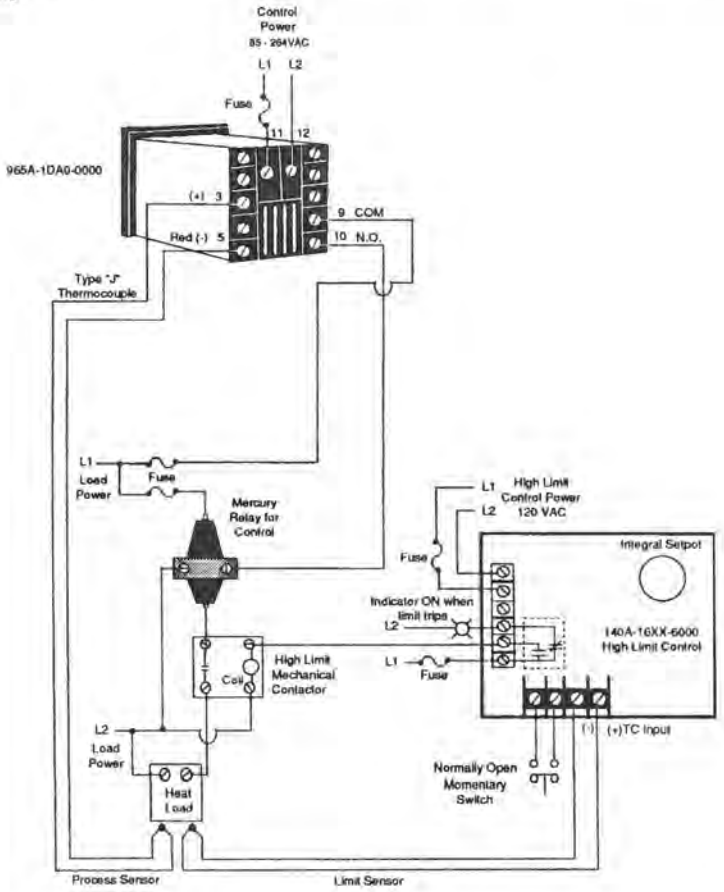
WARNING:

All wiring and fusing must conform to the National Electric Code NFPA70. Contact your local board for additional information. Failure to observe NEC safety guidelines could result in injury to personnel.

CAUTION:

Watlow mercury relay loads must have a unity power factor. For RESISTIVE LOADS ONLY.

Figure 16 - System Wiring Example



Chapter 3

Keys/Displays

How to Use the Keys and Displays

Use this page to learn the nature and function of the Series 965's keys and displays.

Series 965 Keys, Displays and Load LED's

NOTE:

The upper display wautomatically displays the process value after 1 minute without key strokes.

Upper Display
Red, 0.3" (8 mm) high, seven segment, three digit LED display, indicating either process actual temperature, the operating parameter values, or an open sensor. When powering up, the Process display will be blank for 5 seconds.

Figure 17 - Series 965 Keys and Displays

LD
When lit, this LED tells you when the control output is energized.

AL
When lit, this LED tells you when the alarm is active.

Lower Display
Red 0.3" (8 mm) high, seven segment, three digit LED display, indicating the set point, output value, prompts for data in the upper display, or error and alarm codes.

MAN
Lit when the control is in Manual operation. Press the A/M key twice to enter Auto operation. When blinking, this indicates that pressing the A/M key will toggle between Auto and Manual. After 5 seconds without pressing the A/M key, the LED stops blinking, and returns to its previous state.

UP/DOWN Keys
When pressed simultaneously for 3 seconds, the Setup Menu appears displaying the LOC parameter. Continue to press the UP/DOWN keys, and the Calibration Menu appears.

MODE Key
Steps the control through the Operating menu; also, in the Auto mode, new data is self entering in 5 seconds.

AUTO/MAN Key
Pressed once, it clears any latched alarms. If pressed again within 5 seconds, the control toggles between Auto and Manual mode. While in Manual mode, percent power is in the lower display.

UP Key
Increases the value of the displayed parameter. A light touch increases the value by one. Holding the key down increases the value at a rapid rate. New data is self entering in 5 seconds.

DOWN Key
Decreases the value of the displayed parameter. A light touch decreases the value by one. Holding the key down decreases the displayed value at a rapid rate. New data is self entering in 5 seconds.

Chapter 4

How To Setup The Series 965

Setting up the Series 965 is a simple process. First configure the 965's features to your application in the Setup Menu, then enter values in the Operating Menu. Both tasks use the MODE key to move through the menus and the UP/DOWN keys to select data. At this point, enter the Calibration menu, and select US or SI under the dFL parameter, if necessary. Rate, reset, and °F appear with US, and integral, derivative and °C appear with SI. See Appendix 3, Page 28.

♪ **NOTE:**
While in the Setup menu, all outputs are OFF.

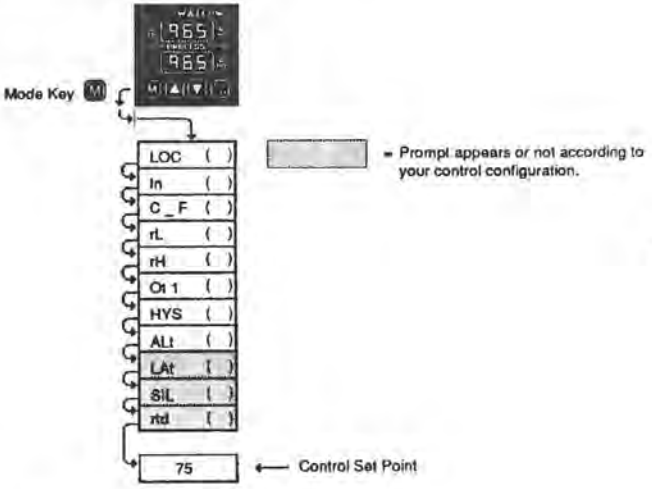


Figure 18 - The Setup Menu.

Figure 19 - Entering the Setup Menu.

Entering the Setup Menu

The Setup Menu displays the parameters that configure the Series 965's features to your application.

To enter the Setup Menu, press the UP andDOWN keys simultaneously for 3 seconds. See Figure 19. The lower display shows the LOC parameter, and the upper display shows its current level. All keys are inactive until you release both keys. You can reach the LOC parameter from anywhereexcept the CAL menu.

Use the MODE key to cycle through the menu; use the UP/DOWN keys to select Setup data. You may not see all parameters in this menu, depending on the unit's configuration and model number. After stepping through the menu, you will return to the control set point parameter under the Operation menu.

Setup Parameters

When you are at the top of the menu, the Series 965 displays the user level of operation in the upper display, and the LOC parameter in the lower display.

When you press the MODE key, the value of the next parameter appears in the upper display, and the parameter appears in the lower display.

Lock: Selects the level of operator lock-out as defined below. LOC
Range: 0 - 4 **Default:** 0

LOC 0: All operating parameters may be viewed or changed. Manual operation **is** permitted. When in manual operation, percent power is adjustable.

LOC 1: The set point and actual are the only visible parameters, set point **is** adjustable in this level. Manual operation and auto-tune **are** permitted. When in manual operation, percent power is adjustable.

LOC 2: The set point and actual are the only visible parameters, set point **is** adjustable in this level. Manual operation **is** permitted. When in manual operation, percent power is adjustable.

LOC 3: The set point and actual are the only visible parameters, set point **is** adjustable in this level. Manual operation is **not** permitted.

LOC 4: The set point and actual are the only visible parameters, set point is **not** adjustable in this level of lock-out. Manual operation is **not** permitted.

Input: Selects the sensor input type. Only those input types which are compatible with your unit will appear. See the model number information for your type. In
Range: J, K (appears as H), t, n, rtd **Default:** J **or** rtd

Celsius _ Fahrenheit: Selects the units of temperature measurement for the control. The default is dependent on the dFL parameter located in the Calibration menu. If dFL = US, the default is F. When dFL = SI, the default is C. C_F
Range: C or F

Range Low: Selects the low limit of the operating range. See the model number and specification in the Appendix for range values. See Table 1 on Page 16. rL
Range: Sensor range low to rH **Default:** Low limit of sensor type

Range High: Selects the high limit of the operating range. See the model number and specification information in the Appendix for your range values. rH
Range: Sensor range high to rL **Default:** High limit of sensor type

Output 1: Selects the output action for the primary output. Action in response to the difference between set point and process variable. Ot1
Range: ht, CL **Default:** ht

Hysteresis: Selects the switching hysteresis for Output 1 when you select 0 (ON/OFF) under the Pb1 parameter. See Page 17 for the Pb1 parameter. HYS
Range: 1°F - 99°F/1°C - 55°C **Default:** 3°F/2°C

Setup

ALt

Alarm Type: Determines whether the alarm type is process, deviation, or none. A process alarm is set at an absolute temperature to prevent over/underrange. See Chapter 5, "Using Alarms."
Range: Pr, dE, no **Default:** Pr

LAt

Latching: Selects whether the alarm is latching or non-latching. Latching alarms must be cleared before the alarm output will reset. Non-latching automatically resets the alarm output when the condition clears. This parameter will not appear if ALt = no.
Range: LAt or nLA **Default:** nLA

SIL

Silencing: Selects alarm silencing (inhibit) for the alarm. This parameter appears only when ALt = dE. For more information see Chapter 5 , "Using Alarms."
Range: On or OFF **Default:** OFF

rtd

RTD: Selects the RTD calibration curve for RTD inputs. This parameter will not appear unless In = rtd. JIS = 0.003916Ω/Ω°C, DIN = 0.003850Ω/Ω°C.
Range: din or JIS **Default:** din

Table 1 - Input Ranges.

Input Type	Sensor Range Low	Sensor Range High
J	32°F/0°C	999°F/750°C
K (appears as H)	-99°F/-99°C	999°F/999°C
t	-99°F/-99°C	662°F/350°C
n	32°F/0°C	999°F/999°C
rtd (1°)	-99°F/99°C	999°F/600°C

Setup Menu

Table 2 - Setup Menu Prompts and Descriptions.

Use this page as a master copy for configuring your Series 965.
Do not enter any values here; make photocopies instead.

Setup Parameters	Value	Range	Factory Default
LOC		0 - 4	0
In		J, K (appears as H), t, n, rtd Dependent on model number.	J or rtd
C _ F		C or F	Dependent on dFL.
rL		rL to rH	Input selection dependent.
rH		rH to rL	Input selection dependent.
Ot1		ht or CL	ht
HYS		1°F - 99°F, 1°C - 55°C	3°F/2°C
AL1		Pr, dE or no	Pr
LAt		LAt or nLA Dependent on AL1 = Pr or dE.	nLA
SIL		On or OFF	OFF
rtd		JIS or din	din

Operation

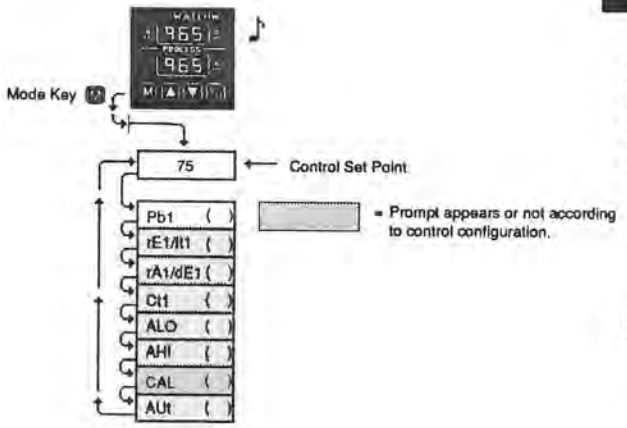


Figure 20 - The Operation Menu.

NOTE:
The upper display will always return to the process value after 1 minute without key strokes.

Operation Parameters

[SP]

Set Point: Sets the operating set point for Output 1. Represents the process value the system tries to achieve for Output 1. "SP" does not appear, the control set point value will.

Pb1

Proportional Band 1: A proportional band expressed in degrees, within which a controller proportioning function is active for Output 1. When Pb1 = 0, the unit functions as an ON/OFF control. The switching differential is then determined by the HYS parameter.
Range: 0 to 999°F/0 to 555°C **Default:** 25°F/14°C

rE1

Reset 1: A reset (integral) control action for Output 1 that automatically eliminates offset, or "droop," between set point and actual process temperature in a proportional control. This parameter will not appear if Pb1 = 0 or dFL = SI.
Range: 0.00 to 9.99 repeats/minute **Default:** 0.00

It1

Integral Time 1: An integral control action for Output 1 that automatically eliminates offset, or "droop," between set point and actual process temperature in a proportional control. Entering 00.0 disables integral. This parameter will not appear if Pb1 = 0 or dFL = US.
Range: 00.0 to 99.9 minutes/repeat **Default:** 00.0

rA1

Rate 1: The rate (derivative) function for Output 1 of the Series 965. The rate is determined by how fast the error is changing. This parameter will not appear if Pb 1 = 0 or dFL = SI.
Range: 0.00 to 9.99 minutes **Default:** 0.00

dE1

Derivative 1: The derivative function for Output 1 of the Series 965. The derivative is determined by how fast the error is changing. This parameter will not appear if Pb 1 = 0 or dFL = US.
Range: 0.00 to 9.99 minutes **Default:** 0.00

Ct1 — **Cycle Time 1:** Expressed in seconds for a controller to complete one ON/OFF cycle for Output 1. Time between successive turn ons. This parameter will not appear if Pb 1 = 0.
Range: 1 to 60 seconds **Default:** 5

ALO — **Alarm Low:** This parameter represents the low process alarm or low deviation alarm. This parameter will not appear if AL1 = no or your unit does not have alarms. See the model number.
If AL1 = dE: **Range:** 0 to -99°F/0 to -99°C **Default:** -99°F/-55°C
If AL1 = Pr: **Range:** rL to AHI **Default:** rL

AHI — **Alarm High:** This parameter represents the high process alarm or high deviation alarm. This parameter will not appear if AL1 = no or your unit does not have alarms. See the model number.
If AL1 = dE: **Range:** 0 to 99°F/0 to 99°C **Default:** 99°F/55°C
If AL1 = Pr: **Range:** ALO to rH **Default:** rH

CAL — **Calibration Offset:** Adds or subtracts degrees from the input signal.
Range: -180°F to 180°F/-100°C to 100°C **Default:** 0

AUt — **Auto-Tune:** This parameter initiates auto-tune for Output 1. This parameter only appears if Ot1 = ht.
Range: 0 = off, 1 = slow, 2 = medium, 3 = fast **Default:** 0

Operation Menu

Table 3 - Operation Menu Prompts and Descriptions.

Use this page as a master copy for your Series 965 Operation Parameters. **Do not enter any values here; make photocopies instead.**

Operation Parameters	Value	Range	Factory Default
Pb1		0 - 999°F/0 - 555°C 0=ON/OFF control. HYS =switch diff.	25°F/14°C
rE1		0.00 to 9.99 repeats/minute 0.00 = No Reset. Won't appear if Pb1 = 0 or dFL = SI.	0.00 repeats/minute
It1		00.0 - 99.9 minutes/rpt. 0.00 = No Integral. Won't appear if Pb1 = 0 or dFL = US.	00.0 minutes/repeat
rA1		0.00 to 9.99 minutes 0.00 = No Rate. Will not appear if Pb1 = 0 or dFL = SI.	0.00 minutes
dE1		0.00 - 9.99 minutes. 0.00 = No Derivative. Won't appear if Pb 1 = 0 or dFL = US.	0.00 minutes
Ct1		1 to 60 seconds Won't appear if Pb1 = 0, or if 4-20mA.	5 seconds
ALO - Deviation dE Process Pr		-99° to 0° rL to A1HI Will not appear if AL1 = no.	-99° rL
AHI - Deviation dE Process Pr		0° to 99° ALO to rH Will not appear if AL1 = no.	99° rH
CAL		±180°F/±100°C	0
AUt		0-3 Appears if Ot1 = Ht.	0

Chapter 5

How to Tune and Operate

Tuning - Automatic

Auto-tuning: The Series 965 can automatically tune the PID parameters to fit the characteristics of your particular thermal system.

The auto-tuning procedure operates on a thermal response value — slow, medium, or fast. Use the slow thermal response when your process does not need to reach set point too rapidly, or if it usually does not often exceed set point. A fast thermal response produces a rapid temperature change over a short period of time.

You can only auto-tune when Output 1 is heat. Once the auto-tune sequence has begun, the lower display flashes between At and the setpoint. The heat proportional band is set to 0 and the control goes into an ON/OFF mode of control at 90% of the established set point. The displayed set point remains unchanged.

Once the control finishes "learning" the system, it returns to a standard PID control with the heat PID values automatically set as a result of the auto-tuning. Tuning is complete within 80 minutes. Any change of the set point, while in auto-tune, re-initiates the auto-tune procedure.

To start auto-tuning:

1. **Press the MODE key** until the **AUt** prompt appears in the data display.
2. **Select a thermal response value,** 1=slow, 2=medium, and 3=fast, using the UP/DOWN keys. A thermal response value of 2 satisfactorily tunes most thermal systems.
3. **Press the MODE key.** While the control is in the tuning mode, the lower display alternately displays the normal information and the prompt **At**. The time between alternations is 1 second.
4. **When tuning is complete,** the displays return to their previous state and **AUt** reverts to 0. The 965 installs appropriate PID tuning parameters and saves them in the non-volatile memory.

To abort auto-tuning, operator must reset the **AUt** parameter to 0, or press the AUTO/MAN key twice. The auto-tuning process may also be aborted by cycling the power off and on. In all cases, aborting auto-tune restores all original values.

♪ **NOTE:**
Set the HYS parameter under the Setup menu to 3°F/2°C before auto-tuning your control.

Tuning - Manual

For optimum control performance, tune the Series 965 to the thermal system. The tuning settings here are for a broad spectrum of applications; your system may have somewhat different requirements. **NOTE: This is a slow procedure, taking from minutes to hours to obtain optimum value.**

1. **Apply power to the Series 965** and enter a set point. Begin with these Operation Parameters: **Pb1** = 1, **rE1/It1** = 0.00, **rA1/dE1** = 0.00, **Ct1** = 5, **CAL** = 0, **AUt**= 0.

2. **Proportional Band Adjustment**: Gradually increase **Pb1** until the upper display temperature stabilizes to a constant value. The process temperature will not be right on set point because the initial reset value is 0.00 repeats per minute. (When **Pb1** = 0; **rE1/It1** and **rA1/dE1** are inoperative, and the 965 functions as a simple ON/OFF control.) The HYS parameter determines the switching differential value.

3. **Reset/Integral Adjustment**: Gradually increase **rE1**, or decrease **It1** until the upper display temperature begins to oscillate or "hunt." Then slowly decrease **rE1** or increase **It1** until the upper display stabilizes again near set point.

4. **Cycle Time Adjustment**: Set **Ct1** as required. Faster cycle times sometimes achieve the best system control. However, if a mechanical contactor or solenoid is switching power to the load, a longer cycle time may be desirable to minimize wear on the mechanical components. Experiment until the cycle time is consistent with the quality of control you want.

5. **Rate/Derivative Adjustment**: Increase **rA1/dE1** to 1.00 minute. Then raise set point by 20° to 30°F, or 11° to 17°C. Observe the system's approach to set point. If the load temperature overshoots set point, increase **rA1/dE1** to 2.00 minutes.

   Raise set point by 20 to 30°F, or 11 to 17°C and watch the approach to the new set point. If you increase **rA1/dE1** too much, approach to set point is very sluggish. Repeal as necessary until the system rises to the new set point without overshooting or approaching the set point too slowly.

6. **Calibration Offset Adjustment:** You may want your system to control to a temperature other than the value coming from the input sensor. If so, measure the difference between that temperature (perhaps at another point in the system) and the process value showing in the upper display. Then enter the **CAL** offset value you want. Calibration offset adds or subtracts degrees from the value of the input signal.

Manual and Automatic Operation

To change from manual to auto operation, press the AUTO/MAN key twice.

Manual operation provides direct (time proportioned % power) control of the outputs from -100% to 100%. The 965 allows a negative output value only with a CI (Cool) selection on Ot1, a positive output value is allowed with heat only. Automatic operation provides closed loop ON/OFF or PID control. When the operation transfers from a closed loop to an open loop, the 965 retains the power level from the closed loop control. When the 965 returns to the closed loop control, it restores the previous set point temperature.

The MAN LED indicates auto or manual operation. When the LED is ON, the control is in Manual operation. When the LED is OFF, the control is in AUTO operation. When the LED flashes, press the key again within five seconds to complete the change in operation. If the sensor is open and LOC = 0, 1 or 2, the Series 965 switches to Manual operation (time proportioned % power), if the output was stable before the break occurred.

When transferring from auto to manual operation, the control output(s) remain stable ("bumpless," smooth transition). When transferring from manual to automatic operation, the control output(s) may change significantly. In manual, the output value (% power) appears in the lower display. In automatic operation, the set point appears.

NOTE:
When the alarm output is de-energized, the N.O. contact is open in the alarm condition.

Using Alarms

The Series 965 has two alarm types, Process or Deviation. A **Process alarm** sets an absolute temperature when the process exceeds that absolute temperature limit. Process alarm set points may be independently set high and low.

A **Deviation alarm** alerts the operator when the process strays too far from set point. The operator can enter independent high and low alarm settings. The reference for the deviation alarm is the set point. Any change in set point causes a corresponding shift in the deviation alarm. Example: If your set point is 100°F/38°C, and you have a deviation alarm set at +7°F/4°C as the high limit, and -5°F/3°C as the low limit, the high alarm trips at 107°F/41.6°C, and the low alarm at 95°F/35°C. If you change the set point to 130°F/54.4°C, the alarms follow the set point and trip at 137°F/59°C and 125°F/51.6°C.

CAUTION:
An alarm display will be masked by an error condition or when the control is in the Calibration or Setup Menus.

Alarm Silencing is available with the deviation alarm. When SIL is selected as "on," the **non-latching** mode automatically enables the alarm out-put on initial power up. In the **latching** mode, the operator must manually disable the alarm by pressing the AUTO/MAN key once. In both cases alarm silencing disables the alarm output relay, but the AL LED displays the alarm condition until the process value is within the "safe" region of the deviation alarm band. Once the process value crosses into the "safe" region, both a latching or a non-latching alarm is ready. Any future deviation outside this safe band triggers an alarm.

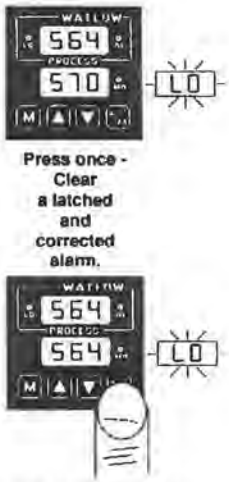
Both Process and Deviation alarms can be latching or non-latching. The operator must **manually reset a latching alarm** before the alarm will reset. The operator must also remove the condition that created the alarm. When the operator removes the condition causing the alarm, a **non-latching alarm automatically** resets the alarm output.

Flashing 'LO" or "HI" in the lower display indicates an alarm. The Lower display alternately shows information from the current parameter and the "LO" or "HI" alarm message at one second intervals. The alarm output is de-energized and the AL LED is lit.

To clear an alarm...

- **First correct the alarm condition, then...**
  - **If the alarm is latching...**
    Clear it manually; press the AUTO/MAN key once as soon as the process temperature is inside the alarm limit by 1°F/0.6°C.
  - **If the alarm is non-latching...**
    The alarm clears itself automatically as soon as the process temperature is inside the alarm limit by 1°F/0.6°C.

Figure 21 - Alarm Display Examples



Press once - Clear a latched and corrected alarm.

How To Deal With Error Codes ♪

Three dashes, "- - -" or "rES" (reversed sensor), in the upper display indicate a Series 965 error.

- **If operator access is LOC 0, 1 or 2...**
  - Press the AUTO/MAN key twice to see the error code for one second.
- **If operator access is LOC 3 or 4...**
  - The error code is already in the lower display.
- **Error code definitions and actions...**

Er 1 - Sensor overrange error
The sensor input generated a value higher than that allowed for the range of the sensor, or the A/D circuitry malfunctioned. Enter a valid input. The A/D value is above the range limits, but within the A/D conversion limits. Make sure the **In** parameter matches your sensor.

Er 2 - Sensor underrange error
The sensor input generated a value lower than that allowed for the range of the sensor, or the A/D circuitry malfunctioned. Enter a valid input. The A/D value is below the range limits, but within the A/D conversion limits. Make sure the **In** parameter matches your sensor.

Er 3 - Ambient error
Check the specification for the ambient temperature range.

Er 4 - Configuration error
The unit's microprocessor is faulty; call the factory.

Er 5 - Non volatile checksum error
The nonvolatile memory checksum discovered a checksum error. Unless a momentary power interruption occurred while the unit was storing data, the nonvolatile memory is bad. Call the factory.

Er 6 - A/D underflow error
The A/D circuit is underrange. An open or reversed polarity sensor is the most likely cause. Check the sensor; if the connection is good and functions properly, call the factory. The A/D underrange voltage is too low to convert an A/D signal. Make sure the **In** parameter matches your sensor.

Er 7 - A/D overflow error
The A/D circuit is overrange. An open or reversed polarity sensor is the most likely cause. Check the sensor; if the connection is good, and the sensor functions properly, call the factory. The A/D overrange voltage is too high to convert an A/D signal. Make sure the **In** parameter matches your sensor.

- **To clear a corrected error...**
  - Cycle power to the control.

♪ **NOTE:**
Electrical noise or a noise event, vibration or excess environmental moisture or temperature may cause Series 965 errors to occur. If the cause of an error is not otherwise apparent, check for these.

Figure 22 - Error Code Display Examples

Press twice - Read error

Er 1, 2, 3, 6 & 7 Errors - Control Outputs May Be ON

- **If operator access is LOC 0, 1 or 2...**

  ...and the control was in AUTO operation when the error occurred, it goes into MANUAL (% power) operation. If the output power is less than 75% power, and a <5% change in power occurred within the last two minutes, the 965 switches into Manual operation at the last Automatic power level. If the control was in MANUAL operation, it remains there. (You must press the AUTO/MAN key twice to see the error code.) The alarm output (if present) is in its alarm state (LED lit). The upper display reads "- - -" or rES. The lower display indicates the error code.

  If the control was operating with stable output values when the error occurred, it continues to operate at those levels on a % power basis. If output values were not stable, the control outputs go to 0% power (OFF)

- **If operator access is LOC 3 or 4...**

  The control remains in AUTO operation. The control outputs shut OFF. The AUTO/MAN and MODE keys are inactive. The UP/DOWN keys may be used together to enter the Setup Menu. The alarm output (if present) is in its alarm state (LED lit). The upper display reads "- - -" or rES. The lower display indicates the error code.

- **To clear a corrected error...**
  - Cycle power to the control.

Er 4 & 5 Errors - Control Outputs Will Be OFF

- **Error codes Er 4 and Er 5 result in these conditons:**
  - The control is in AUTO operation with the output OFF.
  - The alarm output, if present, is in the alarm state (de-energized with the LED lit).
  - The upper display indicates the process value.
  - The lower display indicates the error code.
  - All keys are inactive.
  - All Setup Menu parameters return to default values.
  - The above conditions occur regardless of the value of LOC, or the presence of the Setup or Calibration Menus.
- **To clear a corrected error...**
  - Cycle power to the control.

Specifications

Appendix 1

Control Mode

- Microprocessor-based, user selectable control modes.
- Single input, single control output.
- Single alarm option.
- Control output: User selectable as: Heat, Cool.
  - ON/OFF: Switching differential determined by the HYS parameter for Output 1.
  - PID parameters:
    Proportional band: 0 to 999°F/0 to 555°C.
    Reset: 0.00 to 9.99 repeats per minute.
    Integral: 0 and 00.1 to 99.9 minutes per repeat.
    Rate/Derivative: 0.00 to 9.99 minutes.
    Cycle time: 1 to 60 seconds.
- Alarm output: User selectable as:
  - Process, Deviation or None.
  - Separate high and low set points.
  - ON/OFF: 1°F/0.6°C switching differential.

Operator Interface

- Membrane front panel.
- Dual, three digit 0.3" (8 mm) LED displays.
- MODE, AUTO/MANUAL, UP, and DOWN keys.

Input

- Thermocouple or RTD input.
- Automatic cold junction compensation for thermocouple.
- RTD input 2 or 3 wire, platinum, 100 ohm @ 0°C software selectable, JIS curve #3916 (0.003916 Ω/Ω/°C) or DIN curve #3850 (0.003850 Ω/Ω/°C).
- Selectable sensor break protection de-energizes control outputs to protect system.
- Grounded or ungrounded sensors.
- °F or °C display, user selectable.
- Operating ranges user selectable.

J t/c:	32	to	999°F	or	0	to	750°C
K t/c:	-99	to	999°F	or	-99	to	999°C
T t/c:	-99	to	662°F	or	-99	to	350°C
N t/c:	32	to	999°F	or	0	to	999°C
1° RTD:	-99	to	999°F	or	-99	to	600°C

Primary Output (Heating or Cooling)

- Electromechanical relay, Form C, 5A @ 250VAC maximum, rated resistive load, 5A @ 30VDC.
- Switched DC (Open collector), 500Ω minimum load resistance, 1KΩ load, 7mA minimum,10mA maximum, non-isolated, short circuit protected.
- 4-20mA reverse or direct acting into a 300Ω maximum load impedance, non-isolated.

Alarm

- Electromechanical relay, Form C, 5A @ 250VAC maximum, rated resistive load, 5A @ 30VDC.
- Switched DC (Open Collector), 500Ω minimum load resistance, 1KΩ load, 7mA minimum, 10mA maximum, non-isolated, short circuit protected.
- Latching or non-latching.
- Process or deviation.

Accuracy

- Calibration Accuracy and Sensor Conformity: ± 0.1% of span, ± 1 LSD, 77°F ± 5°F (25°C ±3°C) ambient & rated line voltage ± 10%.
- Accuracy Span: 1000°F or 540°C minimum.
- Temperature Stability: 0.2°F/°F (0.2°C/°C) change in ambient.
- Voltage Stability: ± 0.01% of span / % of rated line voltage.

Agency Approvals

- UL, CSA pending.
- NEMA 4X rating pending.

Terminals

- #6 compression type screw terminals.

Power

- 85 - 264 VAC, 50/60Hz ±5%.
- 9VA maximum.
- Data retention upon power failure via nonvolatile memory.

Operating Environment

- 32 to 149°F/0 to 65°C.
- 0 to 90% RH, non-condensing.

Dimensions

Height:	2.1 in	53 mm
Width:	2.1 in	53 mm
Overall depth:	4.7 in	119 mm
Behind panel depth:	4.1 in	104 mm
Weight:	0.5 lb max.	0.2 kg

Model No.

Series 965 Model Number Information

The Series 965 Model Number, listed on your unit sticker, is defined below.

965A-___0-0000

Control Series
965 = 1/16 DIN, single input and output, single alarm, dual digital displays.

Input Type
1 = Type J, K, T, N thermocouple
2 = RTD 1°

Control Output
C = Switched DC, (Open Collector), non-isolated
D = Mechanical Relay, Form C, 5A
F = Process 4-20mA, non-isolated

Alarm Output
A = None
C = Switched DC, Open Collector
D = Mechanical Relay, Form C, 5A

Accessories
- Mounting Collar 0822-0395-0000
- Case Gasket 0830-0402-0002
- Internal Bezel Gasket 0830-0402-0001

Appendix 2

Noise and Installation Guidelines

Installation Guidelines For Preventing Noise

For improved electrical noise immunity, install the Series 965 as far away as possible from motors, relays, and other similar electrical noise generators.

Do not run low power (sensor input) lines in the same bundle as AC power lines. Grouping these lines in the same bundle can create electrical noise interference which may result in error codes in the Series 965.

The Culprit

Most noise problems stem from inadequate wiring practices. They're the major means of coupling noise from its sources to the control circuit. The following information will tell you how to eliminate or decrease noise.

An Information Resource

For wiring guidelines , refer to the IEEE Standard No. 518-1982, available from IEEE, Inc. 345 East 47th Street, New York, NY 10017.

Noise Sources

- Switches and relay contacts operating inductive loads such as motors, coils, solenoids, and relays, etc.
- Thyristors or other semiconductor devices which are not zero crossover-fired (randomly-fired or phase angle-fired devices).
- All welding machinery.
- Heavy current carrying conductors.
- Fluorescent and neon lights.

How To Decrease Noise Sensitivity

- Physical separation and wire routing must be given careful consideration in planning the layout of the system. For example, A.C. power supply lines should be bundled together and physically kept separate from input signal lines (sensor lines). A 12" (305 mm) minimum separation is usually effective. Keep all switched output signal lines (high power level) separate from input signal lines (sensor lines). Cross other wiring at 90° angles whenever crossing lines is unavoidable.

- Another important practice is to look at the system layout; identify and locate electrical noise sources such as solenoids, relay contacts, motors, etc. Route the wire bundles and cables as far away as possible from these noise sources. Don't mount relays or switching devices close to a microprocessor control. Don't have phase angle-fired devices in the same electrical enclosure or on the same power line with the control.

- Shielded cables should be used for all low power signal lines to protect from magnetic and electrostatic coupling of noise. Some simple pointers are:

  ◊ Whenever possible, run low level signal lines unbroken from signal source to the control circuit.
  ◊ Connect the shield to the control circuit common at the control end only. Never leave the shield unconnected at both ends. Never connect both shield ends to a common or ground.
  ◊ Maintain shield continuity at daisy chain connection points by reconnecting the broken shield.
  ◊ Assume no electrostatic shielding when using the shield as a signal return. If you must do this, use triaxed cable (electrostatically shielded coaxial cable).

- Use twisted pair wire any time control circuit signals must travel over two feet, or when you bundle them parallel with other wires.

- The size or gauge of wire should be selected by calculating the maximum circuit current and choosing the gauge meeting that requirement. Using greatly larger wire sizes than required generally will increase the likelihood of electrostatic (capacitance) coupling of noise.

- Do not daisy chain A.C. power (or return) lines, or output signal (or return) lines to multiple control circuits. Use a direct line from the power source to each input requiring A.C. power. Avoid paralleling L1 (power lead) and L2 (return lead) to load power solenoids, contactors, and control circuits. If an application uses L1 (power lead)to switch a load, L2 (return lead) has the same switched signal and could couple unwanted noise into a control circuit.

- Grounding the chassis of each piece of equipment in the system is very important. Here is a simple practice that works best. 1) Connect each individual equipment to the over-all chassis immediately adjacent to that piece. 2) Tie all the major chassis ground terminals together with one lead (usually green wire) tied to ground at one point. Don't connect ground to the control case if the control is in a grounded enclosure (preventing ground loops).

How To Eliminate Noise

- Use "snubbers" ("QUENCHARC™") to filter out noise generated by devices such as relays, relay contacts, solenoids, motors, etc. A snubber is a simple filter device using a 0.1µf, 600 volt, non-polarized capacitor in series with a 100 ohm, 1/2 watt resistor. The device can be used on A.C. or D.C. circuits to effectively dampen noise at its source.

- The ultimate protection is an "uninterruptable" power supply. This "senses" the A.C. power line; when the line fluctuates, a battery powered 60Hz inverted circuit takes over, supplying power within one-half to one cycle of the A.C. line; very expensive.

Appendix 3

Before attempting to calibrate, make sure you have the proper equipment called for in each procedure.

Calibration Menu

In the Calibration Menu, various input signals must be supplied in order for the control to go through its auto calibration. The calibration menu can only be entered from the LOC parameter in the Setup menu. Press the UP/DOWN keys simultaneously for 3 seconds (± 1 second). The CAL parameter appears in the lower display with "no" in the upper display.

Figure 23 - Entering the Calibration Menu.

♪ NOTE:
Calibration values will not be retained unless you are in the MANUAL mode. Do not enter the MANUAL mode until you are at the correct input parameters.

♫ NOTE:
While in the Calibration Menu, the control output is OFF and the alarm output (if present) is ON.

Any inadvertent change in the displayed data, when pressing the UP/DOWN keys, is ignored. Calibration values won't be retained unless you are in the MANUAL mode. Press the UP/DOWN key to change the upper display to "YES." Press the MODE key to enter the calibration sequence.

Upon entering the calibration menu, the top display window indicates CAL. The upper display continues to indicate CAL (with the exception of calibration of the 4-20mA output) while the operator walks through the entire calibration parameter list. While calibrating the 4-20mA output, the upper display contains a numeric value to be slewed up or down until the output value is correct. The control uses the lower display to prompt the user as to what the input should be. The **rSt** parameter restores the factory calibration values to the Series 965. If you calibrate your control incorrectly, you have the option to default to the original values. Once you leave the CAL menu, the values are entered.

The dFL parameter allows you to select either U.S. parameters which include displaying rate, reset, and °F, or you can select SI (System International). The parameters displayed here are integral, derivative, and °C.

Once the information has been properly established and maintained for at least 5 to 10 seconds, the MODE key may then be used to display the next prompt. After the final input is established, press the MODE key twice to return the unit to the configuration menu at the top of the parameter list.

CAL ( )	YES to calibrate, No skips to display test.
CLO ( )	Input 0.00mV for T/C or 59.59Ω for RTD.
CHI ( )	Input 40.00mV for T/C or 317.33Ω for RTD.
tC ( )	Hook up "J" T/C compensator, with inputs shorted. T/C units only.
4AO ( )	Enter 4-20mA output calibration value for 4mA.
2AO ( )	Enter 4-20mA output calibration value for 20mA.
rSt ( )	Restores factory calibration values.
Display	Factory use only.
dFL ( )	Select US (rate, reset,°F) or SI (integral, derivative, °C)
mem	Factory use only.

Figure 24 - Calibration Parameters

Thermocouple Field Calibration Procedure

Before attempting to calibrate, make sure you have the proper equipment called for in each procedure.

Equipment Required

- Type "J" Reference Compensator with reference junction at 32°F/0°C, or Type "J" Thermocouple Calibrator set at 32°F/0°C.
- Precision millivolt source, 0-40mV min. range, 0.01mV resolution

Setup And Calibration ♪

1. Connect the AC line voltage L1 and L2 to the proper terminals on the 965. See Chapter 2.
2. Connect the millivolt source to Terminal #5 Negative and Terminal #3 Positive on the Series 965 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Figure 23 on Page 28.

IMPORTANT:

When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in MANUAL mode **only** when you are in the correct parameters.
5. At the **CLO** prompt, enter 0.00mV from the millivolt source to the control. Allow at least 10 seconds to stabilize. Press the MODE key.
6. At the **CHI** prompt, enter 40.00mV from the millivolt source to the Series 965. Allow at least 10 seconds to stabilize. Press the MODE key.
7. At the **tC** prompt, disconnect the millivolt source, and connect the reference compensator or T/C calibrator to Terminal #5 Negative, and Terminal #3 Positive on the Series 965 terminal strip. Allow 10 seconds for the control to stabilize. The unit will leave the CAL mode if 1 minute passes between key activations. To conclude the T/C calibration, advance the MODE key to the next prompt or exit the CAL menu. Press the AUTO/MAN key twice to exit the MANUAL mode.

♪ NOTE
Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Tables, Pages 15 and 18.

♫ NOTE:
Not all parameters will appear. They are dependent on your unit type. Use only the steps that apply to your unit.

RTD Field Calibration Procedure

Before attempting any calibration procedure, make sure you have the proper equipment called for in each procedure.

Equipment Required

- 1KΩ precision decade resistance box with 0.01 ohms resolution.

Setup And Calibration

NOTE:
Not all parameters will appear. They are dependent on your unit type. Use only the steps that apply to your unit.

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 16 and 18.

1. Connect the AC line voltage L1 and L2 to the proper terminals of the 965. See Chapter 2.
2. Connect the decade resistance box to Terminal #2, 3 and 5 on the terminal strip. Use regular 20 - 24 gauge wire of the same length and type.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. See Figure 23 on Page 28. Press the MODE key until the **CLO** prompt is displayed.

IMPORTANT:
When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

4. Press the AUTO/MAN key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON. Make sure the unit is in MANUAL mode **only** when you are in the correct parameters.
5. At the **CLO** prompt, set the decade resistance box to 59.59. Allow at least 10 seconds to stabilize. Press the MODE key.
6. At the **CHI** prompt, set the decade resistance box to 317.33. Allow at least 10 seconds to stabilize. The unit will leave the CAL mode if 1 minute passes between key activations. To conclude the RTD calibration, advance the MODE key to the next prompt or exit the CAL menu. Press the AUTO/MAN key twice to exit the MANUAL mode

4-20mA Output Field Calibration Procedure

Before attempting any calibration procedure, make sure you have the proper equipment called for in each procedure.

NOTE:
Not all parameters will appear. They are dependent on your unit type. Use only the steps that apply to your unit.

Equipment Required

- 300Ω, 1/2 watt 10% resistor.
- 4 - 1/2 digit Digital Multimeter.

Setup And Calibration

NOTE

Before calibration on an installed control, make sure all data and parameters are documented. See Setup and Operation Charts, Pages 16 and 18.

1. Connect the AC line voltage L1 and L2 to the proper terminals of the 965. See Chapter 2.
2. Connect the multimeter in series with the 300Ω resistor to Terminal #9 Positive and #10 Negative on the Series 965 terminal strip. Use regular 20 - 24 gauge wire.
3. Apply power to the unit and allow it to warm up for 15 minutes. **After warm-up** put the unit in the CAL menu. Press the MODE key until the **4A0** prompt is displayed.

IMPORTANT:
When the MANUAL LED is ON the unit is automatically calibrating. Your sequence is VERY important. Always move to the next prompt before changing the calibration equipment.

4. Press the A/M key twice to enter the MANUAL mode. The unit is calibrating when the MANUAL LED is ON.
5. At the **4A0** prompt, the multimeter should read approximately 4mA. Allow at least 10 seconds to stabilize.
6. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 3.85mA ± 0.10mA. Press the MODE key.
7. At the **2A0** prompt, the multimeter should read approximately 20mA. Allow at least 10 seconds to stabilize. The unit will leave the CAL mode if 1 minute passes between key activations except for 4-20mA units.
8. Use the UP/DOWN keys (reverse acting) to adjust the reading on the multimeter for 20.15mA ±0.10mA.
9. To conclude the 4-20mA output calibration, advance the MODE key to the next prompt or exit the CAL menu.

Glossary, A-O

This glossary includes general thermal system control terms.

Alarm: A condition, generated by a controller, indicating that the process has exceeded or fallen below the set or limit point.

Alarm Silence: Disables the alarm relay output on power up.

Anti-reset: Control feature that inhibits automatic reset action outside the proportional band.

Automatic prompts: Data entry points where a microprocessor-based control "prompts" or asks the operator/programmer for information input.

Auto-tune: Automatically tunes the Series 965 PID parameters to fit the characteristics of your particular thermal system.

Bumpless transfer: When transferring from auto to manual operation, the control output(s) will not change ("bumpless," smooth transition).

Closed loop: Control system that has a sensing device for process variable feedback.

Cold junction: Point of connection between thermocouple metals and the electronic instrument.

Cold junction compensation: Electronic means to compensate for the effective temperature at the cold junction.

Cycle time: The time necessary to complete a full ON-through-OFF period in a time proportioning control system.

Derivative: Anticipatory action that senses the rate of change of the process, and compensates to minimize overshoot and undershoot. Also "rate."

Deviation alarm: An alarm referenced at a fixed number of degrees, plus or minus, from set point.

Default parameters: The parameters, or programmed instructions, permanently stored in microprocessor software to provide a data base.

DIN: Deutsche Industrial Norms, a widely-recognized German standard for engineering units.

Display capability: In a digital indicating instrument, the entire possible span of a particular parameter or value.

Droop: Difference in temperature between set point and stabilized process temperature.

Duty cycle: Percentage of "load ON time" relative to total cycle time.

Hysteresis: In ON/OFF control, the temperature change necessary to change the output from full ON to full OFF.

Hunting: Oscillation or fluctuation of process temperature between set point and process variable.

Input (sensor): Process variable information being supplied to the instrument.

Integral: Control action that automatically eliminates offset, or "droop," between set point and actual process temperature. Also "reset."

Isolation: Electrical separation of sensor from high voltage circuitry. Allows for application of grounded or ungrounded sensing element.

JIS: Japanese Industrial Standards. Also Japanese Industrial Standards Committee (JISC). Establishes standards on equipment and components.

NEMA 4X: Intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water.

Offset: Adjustment to actual input temperature and to the temperature values the Series 965 uses for display and control.

ON/OFF control: Control of temperature about a set point by turning the output full ON below set point and full OFF above set point in the heat mode.

Open loop: Control system with no sensory feedback.

Output: Action in response to difference between set point and process variable.

Overshoot: Condition where temperature exceeds setpoint due to initial power up or process changes.

Glossary, P-Z

P control: Proportioning control.

Parameter: A physical property whose value determines the response of an electronic control to given inputs.

PD control: Proportioning control with rate action.

PI control: Proportioning control with auto-reset.

PID control: Proportioning control with auto-reset and rate.

Process variable: Thermal system element to be regulated, such as time, temperature, relative humidity, etc.

Programmed display data: Displayed information which gives the operator/programmer the "programmed" or intended process information, i.e., intended set point, intended alarm limit, etc. See "Actual displayed data."

Proportional band: Span of temperature about the set point where time proportional control action takes place.

Proportioning control: See Time Proportioning Control.

Rate: Anticipatory action that senses the rate of change of temperature and compensates to minimize overshoot. Also "derivative."

Rate Band: A thermal control band that defines where the rate (derivative) function begins. A Watlow rate band occurs centered on set point at one or more times the width of the proportional band.

Reference junction: Synonymous with cold junction. See "Cold junction."

Reset: Control action that automatically eliminates offset, or "droop," between set point and actual process temperature. Also "integral."

Reset windup inhibit: Synonymous with anti-reset. See "Anti-reset."

RTD: Resistance Temperature Detector. Resistive sensing device displaying resistance versus temperature characteristics. Displays positive temperature coefficient.

Set point: Intended value of the process variable.

Switching sensitivity: In ON/OFF control, the temperature change necessary to change the output from full ON to full OFF.

Thermal system: A regulated environment consisting of a heat source, heat transfer medium, sensing device and a process variable control instrument.

Thermocouple: Temperature sensing device that is constructed of two dissimilar metals wherein a measurable, predictable voltage is generated corresponding to temperature.

Thermocouple break protection: Fail-safe operation that assures output shutdown upon an open thermocouple condition.

Three mode control: Proportioning control with reset and rate.

Time Proportioning Control: Action which varies the amount of ON and OFF time when "close" to the set point, i.e., in the proportional band. This variance is proportional to the difference between the set point and the actual process temperature. In other words, the amount of time the output relay is energized depends on the system temperature.

Triac: Solid state switching device.

Upper display data: Displayed information which gives the operator/programmer real or "actual" data, i.e., actual process temperature. See "Programmed display data."

Warm Start: Start-up condition where all program information is remembered by the instrument's memory back-up protection.

Zero switching: Action that provides output switching only at the zero voltage crossing points of the AC line.

Index

Warranty

Warranty

The Watlow Series 965 is warranted to be free of defects in material and workmanship for 36 months after delivery to the first purchaser for use, providing that the units have not been misapplied. Since Watlow has no control over their use, and sometimes misuse, we cannot guarantee against failure. Watlow's obligations hereunder, at Watlow's option, are limited to replacement, repair or refund of purchase price, and parts which upon examination prove to be defective within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse, or abuse.

Returns

1. Call Watlow Customer Service, 507/454-5300, for a Return Material Authorization (RMA) number before returning any item for repair. We need this information:
   - Ship to address
   - Bill to address
   - Contact name
   - Phone number
   - Ship via
   - Your P.O. number
   - Symptoms and/or special instructions
   - Name and phone number of person returning the material.

2. Prior approval and an RMA number, from the Customer Service Department, is needed when returning any unused product for credit. Make sure the RMA number is on the outside of the carton, and on all paperwork returned. Ship on a Freight Prepaid basis.

3. After we receive your return, we will examine it and determine the cause for your action.

4. In cases of manufacturing defect, we will enter a repair order, replacement order, or issue credit for material. A 20 percent restocking charge is applied for all returned stock controls and accessories.

5. If the unit is unrepairable, it will be returned to you with a letter of explanation. Repair costs will not exceed 50 percent of the original cost.

Watlow Controls

Watlow Controls is a division of Watlow Electric Mfg. Co., St. Louis, MO, a manufacturer of industrial electric heating products, since 1922. Watlow begins with a full set of specifications and completes an industrial product that is manufactured totally in-house, in the U.S.A. Watlow products include electric heaters, sensors, controls and switching devices. The Winona operation has been designing solid state electronic control devices since 1962, and has earned the reputation as an excellent supplier to original equipment manufacturers. These OEMs depend upon Watlow Controls to provide compatibly engineered controls which they can incorporate into their products with confidence. Watlow Controls resides in a 100,000 square foot marketing, engineering and manufacturing facility in Winona, Minnesota.

PRINCIPLES
ROASTING COFFEE BEANS

SIVETZ COFFEE CO.
349 S. W. 4th Street
Corvallis, OR 97333
(503) 753-9713

The coffee bean roasting process IS GRAPHICALLY DEPICTED on the accompanying Bean Temperature vs Flavor level chart. Final bean temperature can only be accurately measured in a fluid bed type roaster, not in a cylinder. Palatable roasts lie between 440°F & 480°F which limits are "light" and Italián, whereas the best flavored roasts lie between 450°F & 460°F which can be called "European". There are culturally sought roasts, like Arabic which can be as light as 415°F, or burnt up to 490°F.

The eye can only crudely judge degree of roast, and is not always accurate nor reproducible.

Most commercial coffees used in the USA are near 12 wt% moisture, and roast weight losses can vary from 14 wt% to 20+ wt%, 25 wt% when burnt. Decaf coffees usually have about 8 wt% moisture, vs 12 wt% for naturals. Some times Colombian beans have 14 wt% moisture, as do new crop in some growing country situations, e.g. KONA.

A well roasted bean is brown from its outer edge to inner core.

A uniformly roasted batch of beans is uniform in color when of good quality. Poor quality beans or non-uniform beans give non uniform roast bean colors.

ROASTING PROCESSES... are characterized by heating up the beans and driving off the moisture. Initially released water is called free water. When bean temperatures reach 340°F, bound water is slowly released.

At near 400°F, and slightly higher, the 2 to 4 wt% sucrose within the bean begins to caramelize, turn brownish and darker with increased temperatures. Water and carbon dioxide from sugar decomposition, is released with increasing amounts of aldehydes, ketones, esters, sulfides (from protein), etc. that give the characteristic coffee aromas between 430°F and 450°F. At higher temperatures, the aldeghydes/ketones diminish and more acrid aromatics predominate. Light roasts have more acids than dark roasts.

The bean temperature attained is closely related to bean color and taste.

At about 420°F **PYROLYSIS** occurs, which is the decomposition of sugars caramelization and release of heat (exothermic reactions). Hence, once beans are heated to the **PYROLYSIS** point, the beans themselves give up heat. As roasts get darker, it is often essential to use a small amount of water spray to **STOP THE PYROLYSIS** hence control degree of roast. At over 400°F no water is absorbed by the roasting beans, as some people unwittingly claim. During **PYROLYSIS** the beans swell to almost twice their green volume, and this is accompanied by "**POPPING**" sounds, which is very normal to good beans. Higher grown denser beans like Sumatra require about a 5°F higher treatment. Much **CHAFF** is released from the swelling beans at near 400°F. Mike Sivetz

SIVETZ COFFEE BEAN ROASTER

Corvallis, Oregon

8 lb
OPERATIONS of (3½ Kg) ELECTRIC COFFEE BEAN ROASTING MACHINE

(refer to sketch of unit)

PRINCIPLES of Roaster Operations

The principle of roasting coffee beans is by using a hot air blast up a perforated opening at the base of a cone. This causes the coffee beans (or grain) to spout up at the center, simultaneously being heated and cleaned. The beans resting in the chamber slope slide down the cone to be relifted, thereby effecting good circulation for uniform heating.

It is important to keep the beans moving ALWAYS; stationary beans will overheat and possibly burn. Therefore, the operator or attendant must be present during the 8 min. roast period.

INLET AIR TEMPERATURE:-----Fixed Heat Input vs Variable Air Flow and temperatures

It must be clearly understood that the heaters put out a fixed rate of heat (1½ Kw); If air flow is higher, (faster blower operation with higher voltage), the issuing air temperature into the beans is lower, and visa-versa. For example, a 6 pound charge of green coffee beans, requires less air flow to spout it; hence, the entering air is hotter, and roasting occurs faster. If 9 lbs green beans are loaded, more air flow is required for spouting; and roasting time is longer due to air which is not so hot.

WARNING DO NOT ROAST LESS THAN 8 lbs green coffee beans in this roasting machine.
" " " MORE " " " " " " " " "

SAFETY Features & Considerations

1) The heat will not be switched on, unless the blowers deliver air pressure-working
2) There is only one electrical lead to heaters ..... source of power.-240V.
3) When the beans reach the set or desired temperature, e.g. 448°F the electric heat "cuts off". The blower continues to operate, to cool beans.
4) THE ATTENDANT MUST NOT, MUST NOT LEAVE THE ROASTER. Allow 8½ min for roasting and ~4.5 minutes for cooling the roasted beans.

OPTION-5) The ventilation system carries away most of the released chaff (combustible) to the cyclone, and deposits the chaff in the 5 gallon can. The suctioned air over the roaster also removes dust and smoke (in last 3 minutes) * dilutes smoke.

6) The owner of the roaster should have a 60 amp circuit breaker for the roaster; so that any "short-circuit" for whatever reason, cuts-off power.

NOTE: If blower FAILS ... while roasting, immediately suction off the beans IF beans are below 200°F by means of the shop vacuum (on other circuit 110V). If beans are over 200°F with power off tilt unit, to flow & dump the beans and cool the beans.

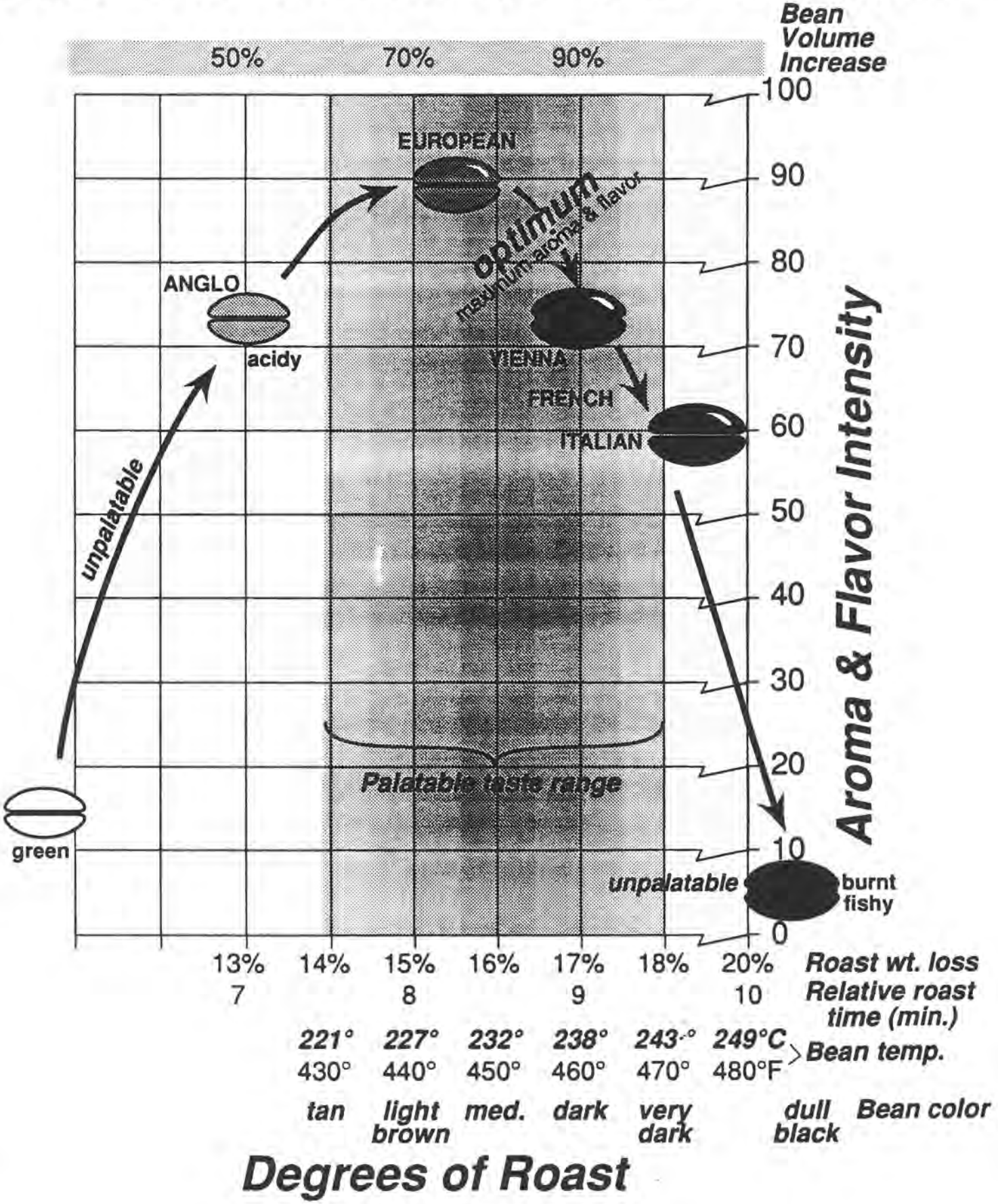
CAUTION: A fire is unlikely, if the roaster is operated as instructed.

Not having beans moving or power loss, when near 400°F, can cause a few beans to burn. Even a few burnt beans can give off annoying smoke and give impression of exaggerated fire situation. In such cases, (1) immediately cut-off heat, and switch-off circuit breaker to roaster. (2) lay roaster on concrete floor (clean) and hoe-out the beans onto the floor or onto metal tray. The glowing few beans will be seen and they will stop glowing and smoking in less than a minute. This is unlikely to occur, but to be prepared and to be forewarned is sensible.

Applying a water spray from the pint bottle, to extinguish any glowing beans.

* Make Hoe and
* MAKE A WOOD FRAME 6" high, and with 1/4 mesh screen approx 18" x 18" for holding warm beans, but which allows air to naturally pass & cool beans.

Understanding Roasting of Coffee Beans
Degree of Roast vs Intensity of Aroma Development



Degrees of Roast

Simplified Graph by Sivetz, © 1991
Sivetz Coffee Co., 349 SW 4th Street, Corvallis, OR 97333
(503) 753-9713

New Book

A CRITIQUE ON CAUSES OF DECLINE OF:

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COFFEE QUALITY

by Michael Sivetz, Ba. & Ma. Science in
Chemical Engineering
COFFEE CONSULTANT-worldwide
Manufacturer of Roasting Machinery

with 35 years industrial and commercial experiences
in the coffee industry worldwide

Outline

1987 Rev. March 1989

Sivetz COFFEE, Inc. phone 503 753 9713
COFFEE BEAN ROASTING MACHINES
ENGINEERING & CONSULTING
349 S.W. 4th ST.
CORVALLIS, OREGON 97333 – U.S.A.

SIVETZ **COFFEE**

Rev. 8'92
Jan. 1978
Rev. 9-'79 & 2'80
Rev. 10-'81
Rev. 3'86
" 8'89

(9)

BEAN ROASTING PROCEDURE

1) Weigh exactly 8 lbs and load green coffee beans into roast chamber. Use a proper scale, and plastic pail.

2) Start blower on ventilation system. Clean out chaff can.

3) CLAMP 1/4" mesh screen over top of roaster. Insert thermocouple (front) — PUSH reset button for (Watlow) Control. (circuit breaker already on). SET desired "cutoff" temperature

3) "Dial-up" voltage regulator, which speeds up blower until beans are spouting.

(4) When air pressure rises heat comes on automatically.

(5)a Initially make notes of voltage % used on regulator, bean temperature (read off the digital), and time in minutes. Also note bean color and when chaff is released & "popping" sounds occur at near 400°F.

(5b) EXAMPLE ---Voltage regulator dial settings during roasting:-
With ambient inlet air temperatures of about 70 to 80°F, initial spouting voltage is about 70% of scale, and diminishes to 60% in 2 min, and 50% at 6 min and thereafter; until at 45% at near 400°F bean temperature (when roasting begins) until say 450°F End of Roast

(6) Beans begin to yellow at near 270°F; they release chaff "pop" and are light brown near 390°F.

(7) A French dark roast will end (with about a 8°F override) kept 468°F & rise to 476°F.
Experience will indicate the bean "cut-off" temperatures. A French roast is about a 18½ wt % loss. An American roast is about a 15 wt% loss, and an Italian roast will take bean temperatures to about 468°F and a 19½ wt % loss. OBSERVE THAT AT THE END OF THE ROAST, WHEN HEAT IS SHUT OFF, THE BEAN TEMPERATURE CONTINUES TO RISE, & IT IS IMPORTANT TO JUDGE OVERRIDE & TO COOL BEANS IMMEDIATELY.

(8) When the electric heat goes off - (light goes off), auto water spray onto the spouting beans until the bean temperature falls to below 425°F. The voltage to blower will have to be raised to speed air flow during the cooling period, to maintain vigorous spouting. At 100°F beans, voltage dial is set to zero (shut-off toggle sw).

(9) The ROASTED beans are immediately unloaded with plastic cup or pour over.

NOTE:-
The next green bean charge should be ready for filling. A "just-used" warm roaster will reduce the roasting time, 1 to 2 minutes.

Initially weigh roasted beans to determine % roast "weight-loss" = $\frac{\text{Green Wt} - \text{Roast Wt}}{\text{Green Wt.}} \times 100$

MAINTENANCE.....

Periodically, e.g. after several weeks, depending on intensity of use of roaster, it may be necessary to change air filters, if they start to reduce air flow. Also if there is some indication that stones or fine coffee particles are falling into heater chamber, these may "short" out heaters (unlikely but has occurred), so dismantling/cleaning is req'd

PROFESSIONAL S

AIR VENTILATION & CHAFF COLLECTION

Try to arrange roaster on steel plate or concrete floor so that it can be slid out away from 10"D hood duct in order to load green coffee beans as well as unload roast beans.

A 6" high gap between top flange of roast chamber and bottom of 10"D vent duct is sufficient to see bean movement, with 50 watt spot light shining in.
That 6" space will also allow outside air to be sucked in, so chaff is carried for the most part into the cyclone for collection.
SEEING THE BEANS MOVING SPOUTING AND ROASTING IS AN EXCITING PART OF THE PROCESS.
The buyer provides the ducting required for vent system. Also fuses for blower. (beyond blower

Sivetz **COFFEE**

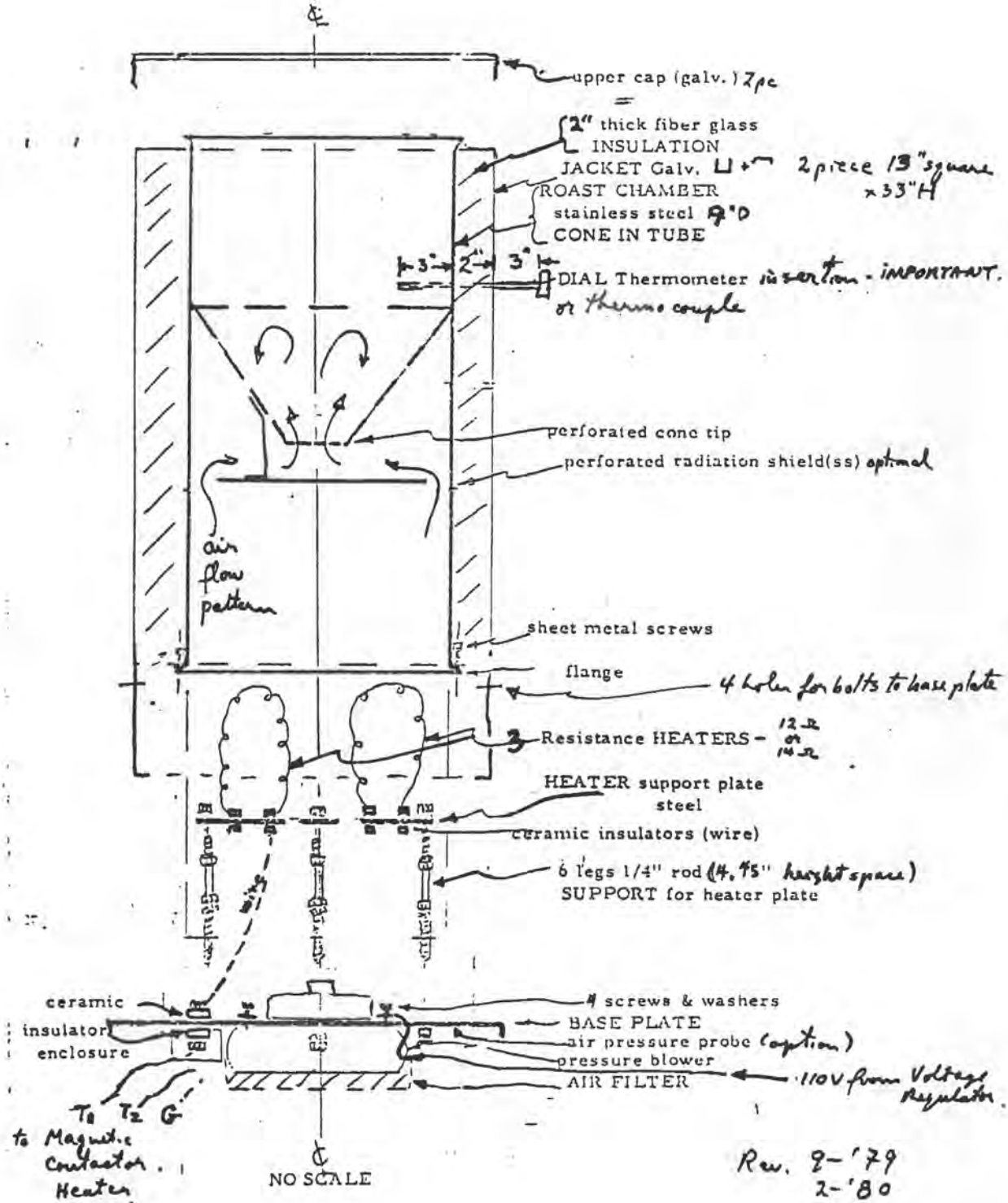
Corvallis, Oregon

EXPLODED VIEW .... DISASSEMBLED PARTS
sectional

Electric COFFEE BEAN ROASTER - 10.5 KW, 240 Volts } 45 a.

ATTENDED ROASTER

keep Coffee beans MOVING



Rev. 9-'79
2-'80
10-'81

(11)

Sivetz **COFFEE**

Corvallis, Oregon

Sept. 1979 Rev. 8'87
Rev. 10-'81 & 3'86

DISMANTLING INSTRUCTIONS for 3.6Kg (8 lb) 10½ Kw ELECTRIC Coffee Bean Roaster

It is advisable to have a "clamp-on" ammeter to ascertain when full current (45 amp) is not being drawn, to confirm if a heater element has burned out. For example, each heating element (Q 39585) puts out 3.5 KW heat at 240 volts. 3 heaters will put out 10½ Kw, each draws 15 amperes @ 240V. The 110V blower may draw 6 amperes. ---- if one element burns out, the amperage will fall 15 amp. Roasting will be prolonged or become impossible because inlet air temperatures are too low. Having confirmed this situation, dismantling is required to replace the "burned-out" heater. Spare heaters or replacement coils should be on hand. TIME TO DISMANTLE AND REASSEMBLE ROASTER when skilled takes about one hour.

1) Disconnect male plug from power source. Work on clean bench. Have tools ready. and wires from inverted roast chamber.

2) Unscrew sheet metal screws to remove forward front panel. Then slip off 3 sided panel. Remove 4 bolts of base plate to jacket with insulation

3) Unscrew 8 small sheet metal screws at base flange (note marked seam orientation to plate). Lift off 9" D stainless steel tube carefully.

4) Now the 3 heaters are revealed. Visually inspect for broken resistor wire.

5) REMOVE 1/4" nuts that hold heater support plate to blower plenum to gain access to underside wire terminals of heaters. Two sheet metal screws (sheet metal) hold the heater plate from below; REMOVE SCREWS.

6) Disconnect two electrical wires to faulty heater.

7) REPLACE NEW HEATER, wires and support screws.

8) TEST that all heaters are working: ["short out" Dwyer pressure switch wiring terminals] Cpush heater switch "ON" for ~3 seconds only enough to have heaters glow "red" to confirm that all are working. true IMMEDIATELY switch off power. Disconnect power leads [remove Dwyer "short"].

9) RE-ASSEMBLE stainless steel tube flange 80T with 12 sheet metal screws. Make sure tube is properly oriented (index mark) and seals firmly to base plate (to avoid air leakage out).

10) RE-BOLT insulated 3 sided jacket to base plate. Then replace front panel with sheet metal screws, and then two tops pieces 7 ea.

If customer is unqualified to do this work, please HAVE a qualified electrician or appliance repair man do work. Phone me if there are any questions. Any repair work undertaken is under your own RESPONSABILITY.

NO ROASTERS or PARTS are to be returned without written permission and agreed disposition.

Such disassembly and vacuum cleaning is recommended periodically, since charred coffee beans or stones (foreign matter) can fall through cone holes onto radiation plate and into blower plenum bare plate.

A carefully taken care of roaster will give years of service with only occasional heater element replacement.

INCREASED PRODUCTION with-out heater replacements and less labor, can be obtained with the SIVETZ line of gas fired automatic cutout roasters. heat.

Coffee Bean ROASTING DATA

SIVETZ COFFEE CO.
349 SW 4th Street
Corvallis, OR 97333
(503) 753-9713

DATE _____

by _____

1. ROASTING MACHINE _____

2. GREEN COFFEE BEANS:
   a.- TYPE & QUALITY _____
   b.- WEIGHT . . . . . _____ Kg _____ lbs
   c.- DENSITY . . . . . _____ grams/ liter

3. PURPOSES:
   _____
   _____

4. ROASTED COFFEE BEANS:
   a.- WEIGHT _____ Kg _____ lbs
   b.- YIELD _____ wt %
   c.- LOSS _____ wt %

5. TASTE
   _____
   _____

6. ROASTING DATA:

TIME min.	TEMPERATURES-°F inlet AIR	TEMPERATURES-°F BEANS	BLOWER Volts	COMMENTS

CONCLUSIONS & RECOMMENDATIONS

_____
_____
_____
_____

SIVETZ COFFEE CO.
349 S.W. 4th Street
Corvallis, OR 97333
(503) 753-9713

MAINTENANCE

Although there is very little work to be done, some repairs and cleaning are very important:

1. REPLACEMENT OF "BURNED-OUT" HEATER (see dismantling instructions).
2. KEEPING ADEQUATE PARTS ON HAND, e.g. heaters.
3. INLET AIR FILTER must be kept clean. Spares can be obtained from Sears.
4. Lighting must be kept up.
5. Room ventilation must be always in working order.
6. Roast bean unloading may be done with a plastic scoop, shop vacuum, or pour overs. These tools must be kept clean and handy.
7. There should be no encrustation on roast chamber walls. Black PATINA is OK. If such develops then it should be scoured off, by laying roast chamber on side on table.
8. Care should be taken not to allow any foreign matter to fall into perforated air inlet at base of roast chamber.
9. Since some charred or broken beans may fall thru these perf. holes, the interior of the heater section should be thoroughly cleaned out when a heater is replaced.
10. There ought not be any dangling wires, worn wires, overheated wires, and the circuit breakers on both the 240V & 120V lines must always be in working order.
11. An assortment of proper tools, "_____" is necessary to reduce the effort and time in replacing heaters and dismantling.
12. The 2" fiber glass insulation may get worn after several years, and it must be kept in first class condition.
13. It is advisable to keep a maintenance log book, as a useful record on possibly repetitious repairs.

Rev. 8 '92
4'89

Coffee Bean ROASTING DATA

SIVETZ COFFEE CO.
349 SW 4th Street
Corvallis, OR 97333
(503) 753-9713

DATE 3/6/90
by Andy

1. ROASTING MACHINE 8/b

2. GREEN COFFEE BEANS:
   a.- TYPE & QUALITY Uganda
   b.- WEIGHT . . . . . _____ Kg 8 lbs
   c.- DENSITY . . . . . _____ grams/ liter

3. PURPOSES:

4. ROASTED COFFEE BEANS:
   a.- WEIGHT _____ Kg 6.7 lbs
   b.- YIELD 83.75 wt %
   c.- LOSS 16.25 wt %

5. TASTE

6. ROASTING DATA:

TIME min.	TEMPERATURES-OF inlet AIR	TEMPERATURES-OF BEANS	BLOWER Volts	COMMENTS
1		102	96	
2		175	84	
3		235	78	
4		285	75	
5		325	"	
6		365	70	
7		400	68	
8		422	65	
8.9		456	"	HEAT OFF COOLING

CONCLUSIONS & RECOMMENDATIONS

SAFETY CONSIDERATIONS

SIVETZ COFFEE CO.
349 S.W. 4th Street
Corvallis, OR 97333
(503) 753-9713

SAFETY starts with reading this manual.
And SAFETY means that the installer and operator understands how all components work.
If at any phase there is not competency, get a qualified electrician, technician or service man.

Phone us on any questions.

The following list is simply a guide:

1. Is your circuit breaker rated at 30 amperes at 240 volts?
2. Is there adequate lighting in work area, and a spot light into roast chamber?
3. Is the 120 volt supply to the blower voltage regulator on a separate breaker?
4. Have you installed an adequate room vent fan?
5. Is the floor concrete or steel sheet over wood?
6. Are your service people: electrician, operator, etc. skilled at their trades?
7. Have you itemized the spare parts you need?
8. Are you attending the roaster all the time?
9. Are you monitoring the bean temperature dial thermometer frequently at end of roast period?
10. Are you there at the end moment to apply a few shots of water spray to stop roast?
11. Are you air cooling roasted beans back to room temperature?
12. Do not go over 475°F on Italian bean roast, because beans can be ignited over that temperature.
13. Are you prepared to deal with beans if a fire occurs?
14. Is you installation safe relative to not endangering a residence, etc.?
15. Are you fully aware that the 3 lbs green beans is a working load, and it should not be increased; nor decreased below 1.5 lbs ?
16. Chaff is very combustible.
    Be sure to keep the top screen free of chaff, if screen is used.
    Be sure to vacuum chaff off floor frequently.
17. Red pilot light indicates electric heating is "ON."
18. Do not work when tired, because carelessness sets in.
19. Do not allow yourself to be diverted by talking to visitors, etc.
    Full attention to the manual roasting is required for safety and accuracy.
20. All wiring must be installed according to code.

4'87
Rev 5'89

COFFEE TECHNOLOGY

Examining the degree of roast

by Michael Sivetz

SIVETZ COFFEE CO.
349 S. W. 4th Street
Corvallis, OR 97333
(503) 753-9713

The growth in the gourmet coffee retail trade since the early 70's in the U.S. has been punctuated by the setup of the Specialty Coffee Association of America (SCAA), by the offerings of individual varieties of roasted coffee beans from original sources like Kona, Celebes, Jamaica, Kenya, Sumatra, etc. and at various levels of roasts. The Coffee Development Group (CDG) formed in the mid 80's sponsored and supported by the ICO (International Coffee Organization) has prepared a number of general descriptive posters and flyers in order to educate the public and retailers about coffee.

In this period, there also have been over 200 new retail and wholesale roasters setting up new businesses, many of which have been quite successful.

Amid all this growth and education, I have prepared and sold several books, namely: *Coffee Technology, Coffee Origin & Use,* and *Coffee Quality* have been widely sold both to new and traditional coffee roasters. The SCAA has organized a number of trips to coffee growing areas to help educate their members, e.g. Kona, Kenya, Jamaica, Costa Rica, and future trips to Indonesia and more.

However, amid all this growth in knowledgeable people and consumers there have been some serious lack of standards. Because different roasters service different markets, many are not truly knowledgeable, not are all totally ethical, and this confusion has hurt the integrity of what is generally known as the retail gourmet trade.

Authenticity of coffee bean origins are not always strictly used, freshness of roasted beans are often lacking, beverage preparations are frequently unsatisfactory, and so the consumer is confused and disappointed. It would take a book to cover even the several variables mentioned, but there is one aspect I'd like to address, and that is the generally communicated levels of bean roasts.

The degree of bean roast is critical to proper flavor development, and usually at the retail level, it is not adequately defined. Even worse, many wholesale roasters do not have accurate roast standards and do not properly speak of roast standards as they should recognize.

On top of this we have cultural and microcultural nomenclature and traditions that confound what is offered and what is requested by the consumer. I would be speaking for myself, but I've had many roasters in the trade ask me to make a clarifying statement regarding this, especially dark roasts.

But first a word about light roasts. Across the U.S., there is a wide difference in taste prefence and use on roasting. On the East Coast and in the Midwest, a light roast is predominant. In the South a darker roast than the East Coast is more evident, but in the West, Southwest, and southern Florida, dark to burnt roasts are used.

It is important to understand where burnt roast beans occur and why. There are two basic reasons for this: historical, and the type of coffee beans used.

Historically, going back perhaps 100 years and to Europe, especially the Mediterranean coastal area countries, primative roasting equipment was used, which resulted in scorched beans and oil release that coated all beans. Also low grade coffee beans with many defects will burn and scorch more readily than wholesome beans, causing non-uniform roasted bean colors and tastes. Further, the degree of roasting was an art form where the operator grew to know his machine and how it performed and related "the degree of roast" to his final objectives. With this background common terms like French and Italian roasts were evolved, without any real scientific basis.

What many people do not realize is that a proper Italian roast is not oily when properly done with good quality beans. Oilyness comes from a cylindrical roaster that is so hot it scorches many beans, and from the manual control of the operator and his judgment and also from lower quality beans. In fact there is a wide use of low grade beans in dark roasts because sometimes the roaster has an attitude, "that if I'm going to burn the beans, why should I use good beans?"

On the contrary, because dark roasts can cause scorching and fires and not develop a uniform bean roast with non uniform beans, it is all the more important to get a dark yet not oily roasted bean.

Degrees of Roasts

I wish to explain the scale of roasts used commercially. This can be related absolutely to the roasting weight loss (w/o water add back), to the final highest bean temperature and to the roast bean color. Colors can be measured on various reflectance instruments from scans of coffee grounds and is a routine measurement with many large commercial roasters. Bean temperatures can only be measured in fluid bed systems.

Roast weight loss can be measured on any system, but only after the roasting process is completed, by weighing the roasted beans and dividing the original weight of green coffee beans.

The general relationship between end-*bean* temperature, and roast weight loss, virtually independent of roast times in the 5 to 18 minute range, can be categorized in general as follows:

430 °F A light roast with about 14 wt percent loss or slightly less. This gives a very acidy tasting cup, usually astringent with little coffee aroma, but is widely used in the hotel and restaurant trade in the U.S.

440 °F A more developed roast flavor but still on acidy side, less astringent. Widely used in canned coffees, although 430 °F may also be used.

450 °F Very close to an optimum flavor roast (maximum aromatics).

460 °F Possibly just past an optimum flavor roast.

NOTE: Different coffee beans, of varied origin and growth sometimes require final roast bean temperature different from other origins.

460/465 °F European roast, often referred to as Vienna in U.S. retail shops.

470 °F *to* **475 °F** is a ***genuine Italian roast***, that when made with top quality coffee beans is uniformly dark brown and not oily, and is what would and does make excellent espresso demitasse coffee. Real desirable coffee flavor can be tasted without harshness or burnt taste or burnt aroma. The roast loss is close to 20 wt percent.

In Europe most connoisseurs recognize this roast and taste level. Unfortunately, in the U.S. and in Latin America where low grade beans high in defect are used to prepare dark roasts and oiliness appears that is recognized by the uneducated at their traditionally roasted coffee beans. It is their tradition, but that is not properly roasted or quality beans. Of course, such commentary brings emotions to high levels, but in fact it is the truth when properly examined. The undesireable result of such consumer concept is to ask the roaster to go to 485 °F and take a 23 wt percent loss.

Here we have lost a lot of the real coffee flavor and have introduced a definite burnt note. In the extreme some consumers even ask for darker coffee when roast losses reach 25 wt percent, and in my experience shouldn't even be prepared.

density

espresso est.

9-11

Sum for Czars

9m = 380

14.3

470° plus 20 scc. = cannot medium

Col. for Czars

9m = 391

13.9

470° plus 40 scc = dark

Sum for Grizz

9m = 380

485° plus wfcw = not

14.7

quite

go

490