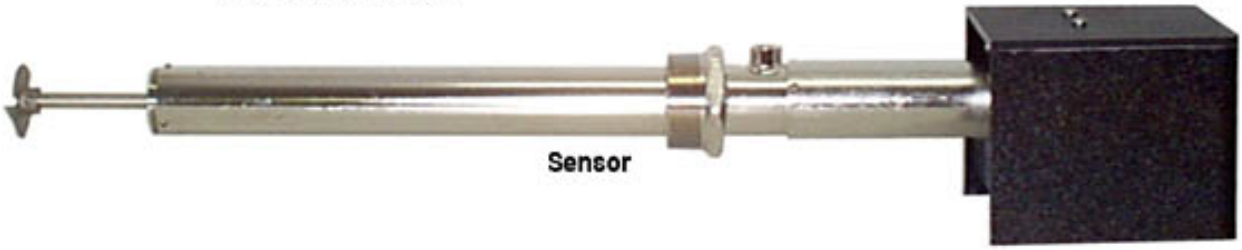
ZIEGLER & Associates

www.zieglerassociates.com

INSTRUCTIONS FOR MODEL 970-C
VACUUM PAN CONSISTENCY MONITOR & PROBE
WITH 24V MOTOR

NEMA 4X Enclosure

NEMA 1 Enclosure



Sensor

FOR PARTS AND INFORMATION CONTACT:

ZIEGLER & ASSOCIATES
11180 Ranchette Dr.
Jackson CA 95642
USA
PHONE 209-223-1090
FAX 209-223-1090
Email: info@zieglerassociates.com
Web: www.zieglerassociates.com

TABLE OF CONTENTS

NOTE: This manual is for use with Model 970-C Sugar Consistency Monitor & Probe with 24V motor (serial #1020 and higher). For lower serial numbers using the 130V motor, please visit www.zieglerassociates.com to download the appropriate manual.

DESCRIPTION

The Model 970-C Monitor is designed primarily to measure the consistency of syrups and massecuites boiling in sugar vacuum pans. It can be used for other fluids and slurries where viscosity is a good measure of solution concentration or where the viscosity is of prime importance to product quality.

It consists of a propeller type rotor driven by a small DC motor and a power supply housed in the Monitor case with an indicating meter to measure variations in current to the motor armature; it increases with rising viscosity of the fluid in which the propeller is turning. An amplifier converts the meter reading to a standard 4 to 20 mA output signal for actuating standard recorders, controllers or I/P transducers.

The meter scale is calibrated 0 to 100% of the desired viscosity range which can be selected by means of the zero and span adjustments on the front of the Monitor case. If set for zero with the rotor running in air and 100% with the rotor stalled, the range is from essentially zero to infinite viscosity and the readout is approximately logarithmic over the middle 80% of the scale. This feature enables the Monitor to give adequate readability over the wide range of consistencies encountered in sugar massecuites with viscosities between about 400 and 20,000 centipoise.

CONSTRUCTION

Wetted probe parts are stainless steel and the sleeve bearings are a Teflon-ceramic compound for proper coefficient of thermal expansion. They require water for lubrication and to keep syrup or crystals from entering the bearing surfaces. The monitor case is powdercoated steel.

INSTALLATION

Monitor and probe dimensions are given in Figure 1 and Figure 2. Normal probe location is in the side of a vacuum pan so the rotor is about midway between the lower tube sheet of the calandria and the pan bottom. Preferred mounting is position A in Figure 3 with a slight downward angle so that the rotor will be in an area of good massecuite circulation although horizontal mounting as at B is satisfactory. On some pans, it may be necessary to install as at C through the pan bottom to get the rotor in a good free area but the mounting angle should not be over 75 degrees from horizontal as there is danger of purge water leaking into the motor bearings. The rotor should be located between syrup feed inlets and away from any obstruction so that it will measure a freely moving sample of average massecuite.

Figure 1: Probe Dimensions

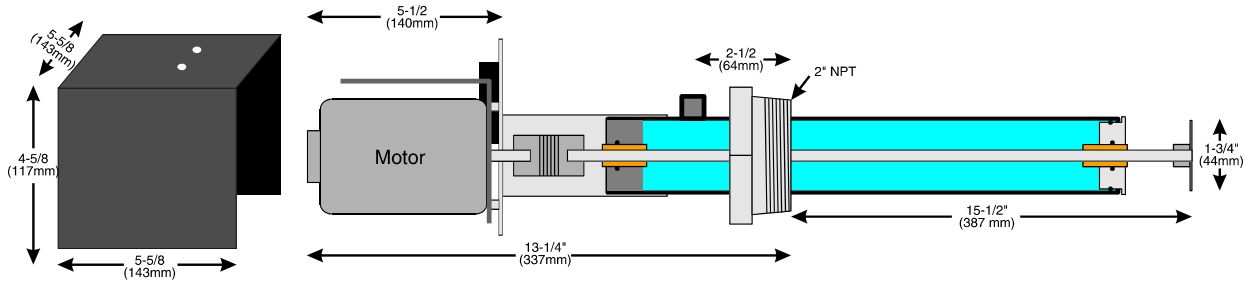
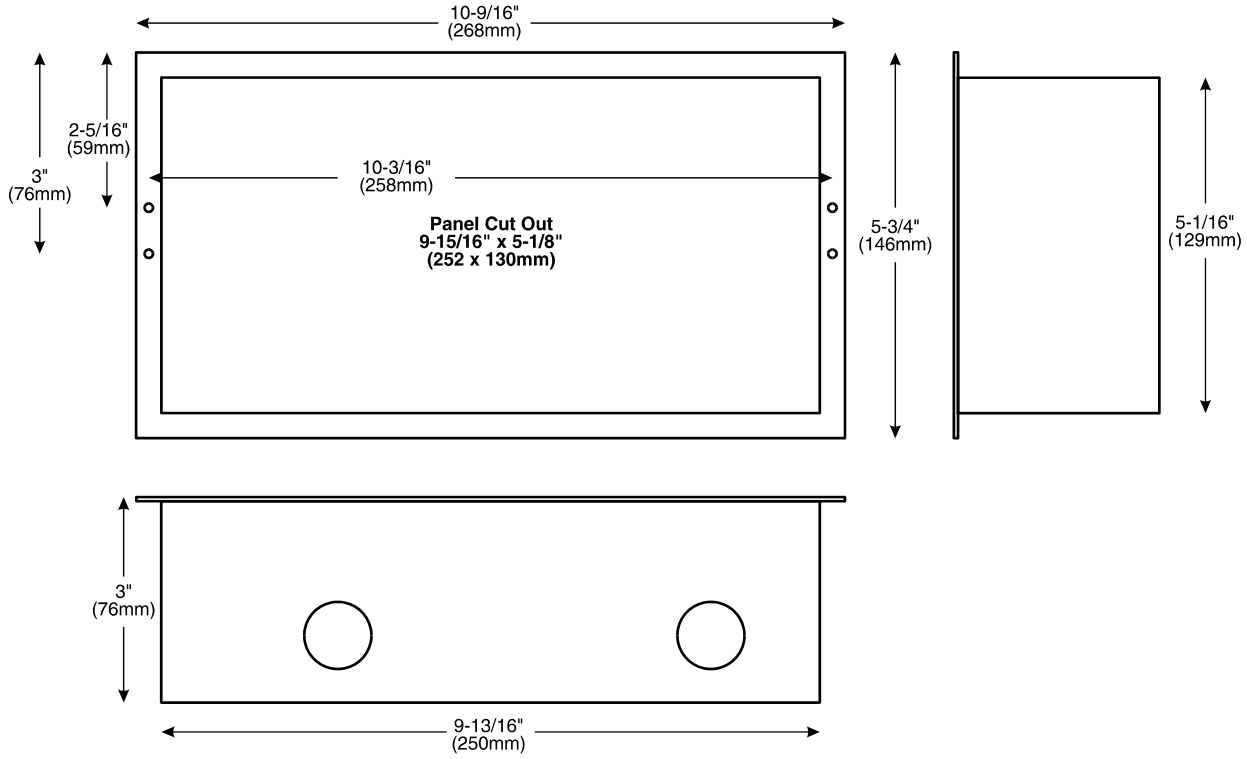
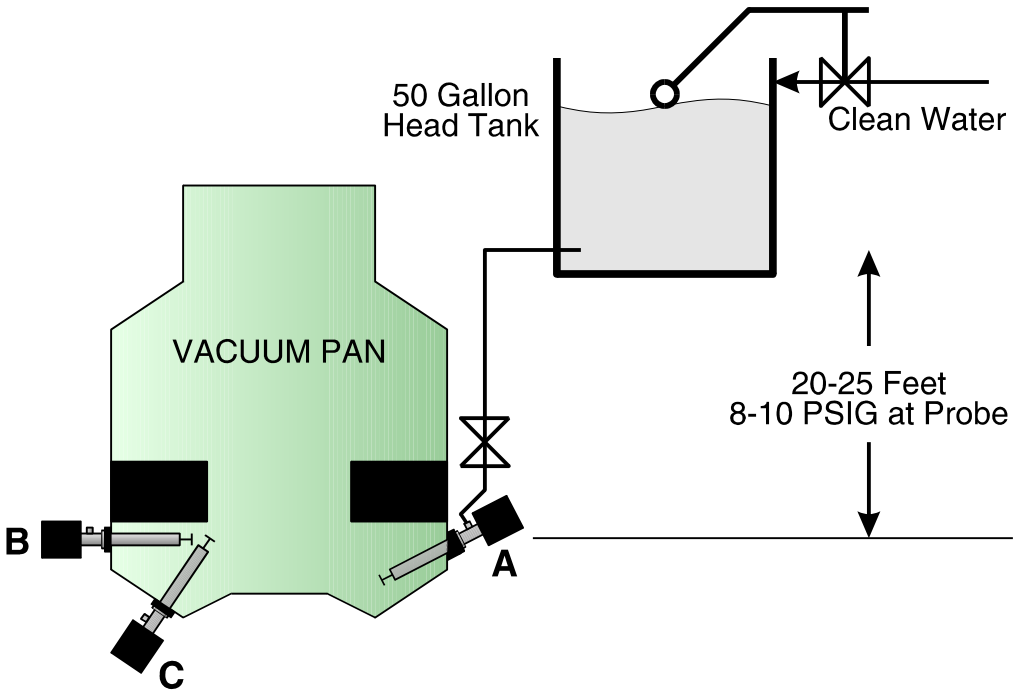


Figure 2: Mounting Dimensions for Monitor



Cut a hole in the pan at the selected location and weld on a 2" NPT coupling. As an alternate, a 2" NPT nipple may be used with a 2" union to allow easy withdrawal of the probe between strikes if it becomes necessary to inspect it or perform maintenance. A plugged half union can be used to close the opening until the probe is reinstalled.

Figure 3: Probe and Head Tank Location



Install the rotor on the shaft tightening the set screws securely. Screw the probe into the 2" connection using the hex head bushing, not the probe barrel, and tighten until the 1/4" NPT water inlet is at the desired position for easy access. If this is not at the top as normally shipped, loosen the three #8-32 set screws that retain the barrel in the mounting sleeve using the spline head set screw wrench provided and rotate the motor so that the elongated access hole in the sleeve faces directly downward to drain water leaking from the outer bearing. This is most important as water entering the motor can quickly cause serious damage to the windings. Do not switch motor leads on the terminal block as they are set for the correct motor rotation which is clockwise as viewed from the motor end.

If clearance is restricted so that the motor mounting plate cannot be turned freely when installing, loosen the three set screws in the mounting sleeve and the two set screws in the motor end of the flexible coupling (through the access hole) and carefully slide the motor assembly off the barrel. The barrel and shaft assembly may then be installed in the pan and the motor assembly replaced in the proper position with the access hole down. Before tightening the three retaining screws, push the flexible coupling onto the motor shaft to full immersion and tighten the two set screws securely being certain that one screw is over the flat on the motor shaft. Then secure the motor and barrel assemblies with the 3 set screws.

WATER PURGE

Probes must be continuously supplied with relatively clean water at a pressure higher than the head of the massecuite when the pan is full and vacuum is broken. This will be roughly 10 psig (0.7 Kg/Cm^2) for normal pans or more than 1.5 times the height of

massecuite above the probe. The water can be supplied to all probes on a pan floor from a suitable reducing valve but the recommended method is to locate a head tank of approximately 50 gallons capacity at a sufficient height above the probes to supply the required head and fit it with a float valve to provide a constant supply of water in spite of possible loss of water for several hours. Centrifugal wash water is generally suitable although clean condensate may be used. Avoid using raw water as it may produce scale on shafts and bearings as it is heated to pan temperature in the probe barrel. De-ionized water may be desirable in extreme cases. In any event, take the tank outlet off above the bottom so that sediment or scale will settle in the tank and not in the probe barrels. The required water flow is so small that several probes can be supplied through 1/4" OD tubing.

Water supplies lubrication for the plastic bearings and if the supply fails for any extended period, bearings and shaft will be damaged and may require replacement. A pressure gauge on the probe water supply line is a good precaution if it is routinely checked. If not, a simple pressure switch connected to an alarm to notify of water failure can prevent needless maintenance. If water does fail, turn off power to all probes until it is restored.

Bearing life can be prolonged if power to the probe is switched off between strikes. Experience indicates that adequately lubricated and purged bearings will not show excessive wear after one year running time. Replacement can be made easily; spare bearings and mounting parts are furnished. See the section on page 14 entitled "Bearing Replacement".

Syrup leakage into bearings will cause no damage but high meter readings will be noted until the contaminating syrup is gradually washed out by the purge water flow.

WIRING

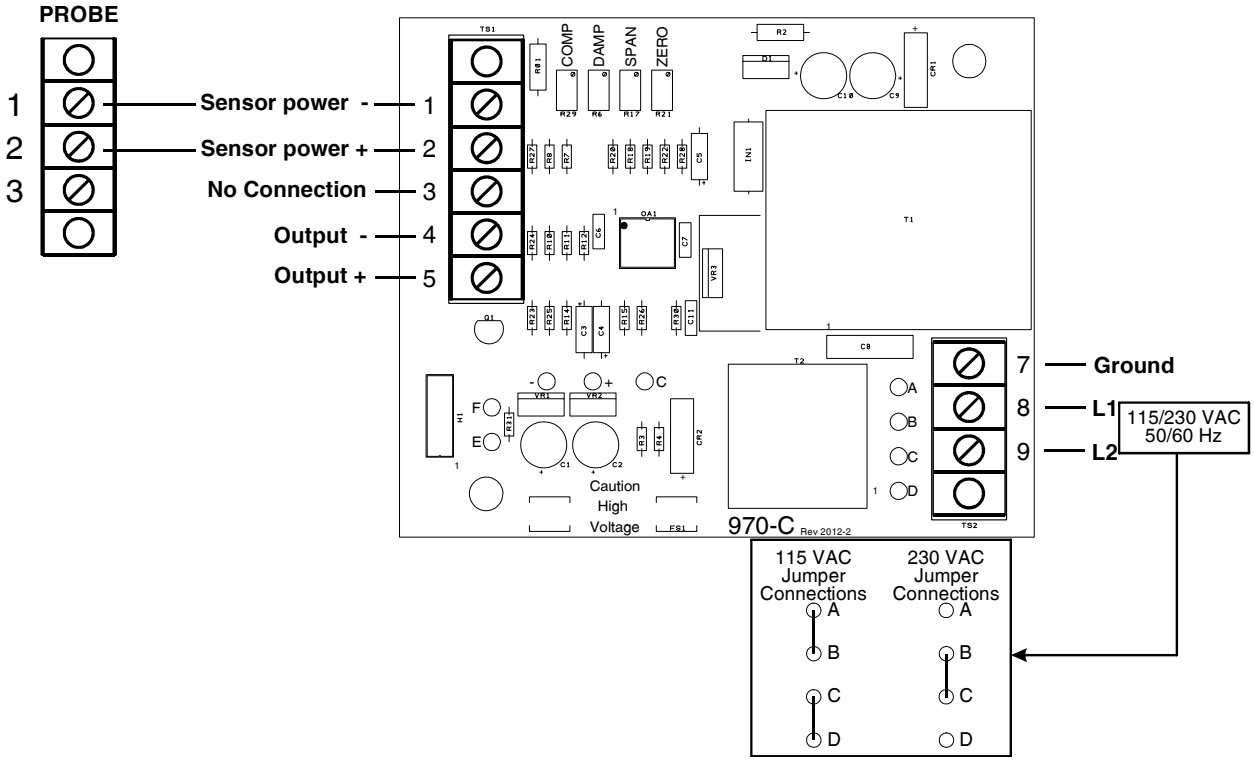
Locate the monitor at a point convenient for observation by the pan operator. Panel cut-out dimensions are given in Figure 2. Two #6-32 flat head mounting screws are furnished. Suitable stand-offs may be fashioned for face mounting. It should not be located at a place subject to excessive vibration. Remove the front panel (2 screws), pull out the plug on the circuit board and set the panel aside while mounting and wiring.

Connect the monitor to the probe with a 2-wire cable. Select the wire gauge from the table below to be sure the resistance of the wire will not affect the readings. Using wire that is too small will also cause the electronics to run hot.

Wire Length	**Wire Gauge**
Up to 25 feet (8m)	#22 or larger
25 – 40 feet (12m)	#20 or larger
40 – 60 feet (18m)	#18 or larger
60 – 100 feet (30m)	#16 or larger
100 – 160 feet (50m)	#14 or larger

The wiring diagram is shown in Figure 4. Terminals 1 and 2 of the probe connect to the corresponding terminals of the monitor. Terminal 3 is not used. **Before connecting power, be sure solder terminals A, B, C & D on the circuit board are jumpered for the proper line voltage as shown in Figure 4.** Bring 115/230VAC power to terminals 8 and 9. Maximum load is approximately 25 watts. It is suggested that power leads be brought through the right-hand case access hole and the probe and output cables through the left-hand inlet.

Figure 4: Probe to Monitor Wiring



Supply voltage variations below 100 VAC or above 135 VAC will introduce appreciable errors. If voltages are expected to drop below 100 VAC or rise above 135 VAC a constant voltage transformer such as SOLA Type 23-22-112-2 is recommended.

Connect standard 4 to 20 mA transducers, recorders or controllers to terminals 4 (-) and 5 (+). Other inputs can be used by adjusting the zero (Z) and span (S) trimpots on the circuit board to get the required range to make its output match the panel meter reading, e.g. 0-5, 1-5 mA etc. Voltage outputs can be obtained by putting a dropping resistor between terminals 4 and 5. To choose the resistor value, divide the desired full scale output voltage by .020 Amp. For example: (For a 1 to 5 volt output) 5 volts/0.020 Amp = 250 Ohm.

After wiring is complete, check all connections, install the plastic motor splash cover, insert the meter panel plug, making sure the arrow on the plug aligns with the 1 on the circuit board, and replace the front panel.

START-UP AND CALIBRATION

When installation is complete, turn on the purge water supply and allow 20-30 minutes for the barrel to fill before applying power. If the outer bearing is at a higher level than the rotor, a slow drip of water from the access hole is evidence that the bearings are covered.

Turn the power switch on and note the meter reading; it should be close to zero on the scale. Touch the flexible coupling through the access hole and note that the reading increases. Stall the probe and the reading should rise to about 100%. Allow the probe to run in the empty pan for 15 minutes or more until the reading stabilizes and, with the zero adjustment, set the reading to 0%. Stall the probe and set the span adjustment to a reading of 100%. These preliminary settings may be improved later for better readability in the range of most interest.

When syrup is drawn into the pan and covers the probe rotor, the indication will jump up to 20 or 25%. As the syrup is concentrated prior to seeding, it will climb to 30 or 35% and, for a time after seeding, will remain constant if the syrup concentration is unchanged. As the massecuite "pulls together", the increasing crystal crop will add to the syrup viscosity and the reading will rise to 40 or 45%. During final brixing to dropping consistency, expect readings around 80%.

If more readability is required, zero and span settings can be adjusted so that only the area of interest is covered. This is best done while a typical strike is being boiled. At the lowest viscosity to be measured, adjust the zero screw to get a 0% reading and just before pan drop when the viscosity is highest, set the span screw to read 100%. After final adjustments are reached, the two potentiometer shafts may be locked by tightening their outer hex nuts.

OUTPUT CALIBRATION

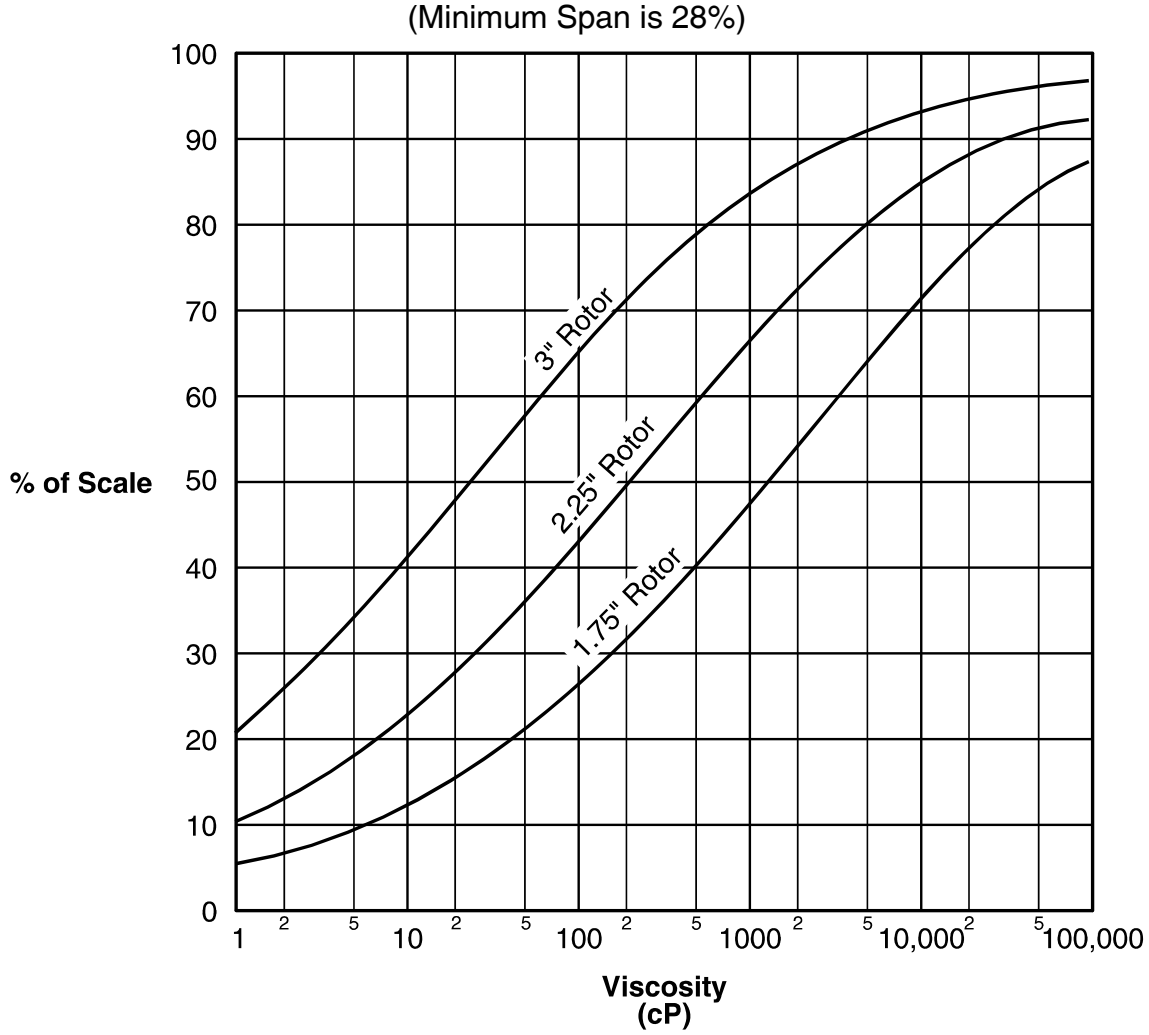
The meter has a range of 0 to 1 volt and an amplifier converts this to the normal 4 to 20 mA input of most transducers, recorders and controllers. For other ranges, two trimpots marked "Zero" and "Span" on the circuit board can be adjusted to accommodate others with inputs such as 0-5, 1-5, 0-16 mA etc. Voltage outputs can be obtained by connecting a suitable resistor between terminals 4 and 5. The easiest way to match meter reading with that of the receiver is to set span and zero pots on the front panel so that the meter is driven from 0 to 100% as the probe rotor is stalled and adjusting Zero and Span on the circuit board until the two readings agree at the two extremes. A dampening adjustment, marked “Damp” on the circuit board, adjusts dampening from 1 to 30 seconds. Turning the adjustment clockwise will increase dampening.

MONITOR CALIBRATION -- OTHER THAN PANS

The standard 970-C Monitor can be used as is or modified to provide good readability on syrups or slurries with much lower and narrower viscosity ranges than those normally encountered in pan massecuites.

Figure 5 is a plot of typical readings obtained in material of various viscosities; span and zero settings adjusted so that it reads 0 at zero viscosity and 100% at infinite viscosity. With the standard 1-3/4" diameter rotor, the best readability is obtained in the viscosity range 1.5 decades on either side of the 50% point of 1500 centipoise or roughly from 50 to 30,000 cP. By using a rotor of larger diameter, the curve can be centered around lower viscosity fluids. For example, a 3" rotor at narrower span settings can easily cover the viscosity area between 3 and 80 cP, corresponding to syrup concentrations of 50 to 75 brix at normal evaporator outlet temperature of 65^{0}C. Due to syrup characteristics, mid-scale readings of 50% will correspond to 65 brix giving excellent readability over the normal range of evaporator operation. The same applies to melters and molasses dilution tanks.

Figure 5: Rotor Characteristics



On narrow range applications, the easiest calibration method is to set minimum "SPAN" (on panel) to full clockwise and adjust "ZERO" (on panel) to get a mid-scale reading at the normally desired syrup concentration. For syrup measurement in open tanks such as melters the probe may be put through a 2" NPT coupling and the larger rotor affixed after the probe is in place. For in-line measurement, the probe can be put into a 3" or 4" bushing or flange and the rotor attached before installation in the line.

Adjustment note: SPAN adjustment does not affect meter reading at the bottom of the scale (zero); it only changes the rate of pointer movement above zero. That is why it is suggested that "ZERO" be first set at the low end of the scale, and then "SPAN" be adjusted to obtain the desired high reading at the upper end of the useful consistency range.

WATER LEAKAGE

If water dripping from the outer shaft bearing onto the pan floor is objectionable, a small funnel or drip pan can be located below the mounting sleeve access hole so that it can be carried away to a floor drain. Under no circumstances should the water flow from the access hole be restricted, or there is danger of it overflowing through the motor mounting plate and damaging the motor.

RECORDER DAMPING

Massecuite consistency measurement is often rather "noisy" due to erratic circulation patterns in vacuum pans. It is often desirable to damp the measurement rather heavily to produce a more meaningful record. There is a dampening adjustment on the circuit board labeled “Damp”. Dampening can be set from 1 to 30 seconds. Turning the “Damp” adjustment clockwise increases dampening. It should be set to a point that slows down the pen/meter movement when random fluctuations occur, but not enough to retard the indication of actual consistency trends. It is normal for the indication to move while adjusting the dampening. After adjustment, the indication will return back to the correct consistency.

BOILING BY CONSISTENCY

By watching the consistency indication on the 970-C Monitor, it is easy to adjust syrup feed throughout a strike to hold desirable massecuite consistency. The need for manual feed regulation can be eliminated by connecting a suitable controller to operate a feed valve.

On strikes starting from a footing of crystals it is only necessary to position the control set pointer at the desired consistency. That consistency will be maintained until the maximum massecuite level is reached and feed is shut off. During final concentration to dropping brix, the 970-C indication will rise to some optimum final consistency.

Strikes started from a syrup charge and seeded require some knowledge of syrup oversaturation (such as that provided by a Model 970-M Oversaturation Monitor) until

the massecuite reaches a suitable boiling consistency. But, feed control from the 970-C can be very helpful even during the early stages of such strikes. Consistency is a good measure of syrup viscosity and hence syrup concentration up until crystal yield rises to 5% to 10% of total solids. Above 5% to 10% solids the crystals begin to add to the viscosity of the syrup and the instrument reads consistency of the massecuite, not the syrup viscosity.

During concentration of a graining charge, the consistency reading will increase along with the syrup oversaturation since it is merely measuring the syrup viscosity. When the pan is seeded at the proper oversaturation, the consistency set point may be positioned to admit syrup feed and hold the concentration constant. As crystal area increases, the oversaturation begins to fall and the consistency set point can be raised in small steps to keep the oversaturation near the upper limit of the metastable zone. After a few upward adjustments, the set point will be 10 or 15% higher and the massecuite will have been brought safely to a good boiling consistency and will be held there until the pan is full and feed shut off.

With Consistency control, it is a simple matter to prolong a pan feeding cycle. On low grade pans especially, crystals grow slowly and, if feed is heavy, the pan may fill before grain has had tine to develop fully. Rather than dilute syrup feed in the supply tank, it is better to slow the rise in pan level by feeding some water to the pan itself. When a set flow of water is introduced, feed syrup flow will be quickly reduced by the consistency control to maintain its set point and the level rise will be slowed. If, due to insufficient syrup supply or the need to keep pans in sequence, it is necessary to stop syrup feed entirely, the water flow can be adjusted so that the syrup valve just closes but the consistency will remain constant. It is better to hold a pan on water at normal boiling consistency than to attempt it on heavy massecuite because it is difficult to get adequate mixing of the water feed when pan circulation is slow.

PAN CIRCULATION

The 970-C measures consistency in the vicinity of the probe rotor, not necessarily an average of the pan contents unless circulation is very good. On pans equipped with a mechanical circulator, consistency readings will be quite steady and representative of the average value. Even during final brixing, the monitor indication will rise quite smoothly to the dropping point. The circulation pattern may be more erratic on pans without mechanical agitation and this will be most evident on the monitor indication. If pan circulation almost ceases during final concentration, the monitor reading should be checked by other observations such as a proof stick sample.

Massecuite movement in vacuum pans is very sluggish except in the ebullition zone near the top surface where vapor bubbles form and break; in the calandria area it is almost negligible. Fresh syrup feed introduced near the top of the calandria center well will float to the surface instead of being drawn down to mix with the massecuite; even a mechanical circulator will not prevent this. Feed syrup must be mixed with the slow moving massecuite and the best way to do this is to introduce it at several points below the bottom tube sheet near the outside wall or into the discharge side of the circulator impeller. Hot feed that flashes upon entering assists the overall circulation.

Mechanical circulators only increase massecuite movement in the calandria area; they do nothing in the body of the pan to keep crystals in suspension. Without vigorous boiling above the calandria, crystals can settle out. Typical vacuum pans operated with less than 40 to 50^{0}C across the heating surface suffer from inadequate circulation.

A 970-C probe should never stall in fluid massecuites even at very high viscosity. Most reports of this difficulty are traceable to operation with low steam pressure letting crystals settle and pack around the probe rotor. On a few occasions, contaminated purge water has deposited scale or dirt in the bearings increasing the friction and producing high readings.

MAINTENANCE - BEARING REPLACEMENT

The 970-C Consistency Monitor is designed for long life, but any device with moving parts will eventually require maintenance. Excessive wear of probe shaft bearings will be indicated by increased water leakage from the outer bearing. Initially water flow will be only a few ml/min, but when leakage approaches 200ml/min, the bearings should be replaced with the spare set furnished.

Bearing replacement is quite simple, but it is best to perform the operation in the instrument shop. Refer to Figure 6 for probe component locations.

1. Disconnect water supply, remove motor splash cover and disconnect incoming wires. Remove probe from pan and wash off adhering syrup, protecting motor from splashing.

2. Loosen the two spline head set screws in the motor end of the flexible coupling and back off the three screws in the motor mount sleeve. Carefully pull barrel and shaft assembly out of the motor mount.

3. Remove rotor and pull the shaft out from the flexible coupling end. Remove the three set screws at the rotor end of the barrel and pull out the inner bearing retainer bushing.

4. Inspect shaft and inside of the barrel for possible scale or dirt accumulation and clean them up.

5. Press old bearings out of their retaining o-rings using finger pressure or a 5/8" rod if necessary. Inspect the two internal o-rings and the internal one on the inner bearing retainer and if necessary, replace with the spares furnished. Grease o-rings lightly with silicone lubricant.

6. Press new bearings into the retainers until the o-rings snap into the bearing groves. Be very careful not to get grease on the inside bearing surfaces or it will cause erratic and high readings until it is eventually washed out by the purge water.

7. Inspect shaft for excessive wear or scoring and replace if necessary. Wipe shaft clean and slide it through the outer bearing. Slip on the inner bearing retainer and press it into the barrel until it seats. Replace the three set screws that hold it in place so that the shaft is seated in the flexible coupling and set screws are tight. Replace rotor.

8. Slide barrel and shaft assembly into motor mount sleeve and tighten the three set screws with the water purge connection at the required angle.

9. Push flexible coupling fully on to motor shaft ensuring that one set screw is over the flat and tighten the two screws through the access hole.

10. Install probe, then connect water and wires. Be sure the barrel fills with water before operating. If probe is ever to be operated on the bench, pour barrel full of water and keep probe horizontal so that both bearings are wetted continuously.

11. New bearings and shafts sometimes give a high reading until they have run in for an hour or so. After the reading stabilizes, recheck zero and span adjustments as previously described.

TROUBLESHOOTING

If the motor fails to run, see if shaft and rotor are free by turning with a finger through the access hole. Check to see the voltage across test points A and D on the circuit board (see Figure 4) is 120 VAC (or 240 VAC if applicable). If not, check continuity of the 1/2 ampere fuse and the on-off switch on the front panel. Wiring terminals 1 (-) and 2 (+) and should be about 6 VDC when the motor is stalled and about 25 VDC when the motor is running free. A voltage greater than 26 VDC indicates either a faulty motor connection or an open circuit motor. An open circuit motor can be caused by excessively worn motor brushes.

Changes in armature current with rotor load actuate the indicating meter and supply the 4-20 mA output signal. With the motor running free, the armature current is at a minimum. The voltage between terminal 1 (+) and test point C (-) is a good measure of the armature current. With the motor running free, this voltage should be about 0.35 volts. With the motor at stall, the voltage should be about 2.0 volts. Armature current changes from about 280 mA to 1,500 mA as load is applied.

The motor should never stall completely in normal operation, even in very heavy massecuite. If it does, it could indicate worn motor brushes or a dirty commutator segment. Check brushes and replace if badly worn. Remove back end bell of motor and inspect the commutator, cleaning with fine sandpaper if needed. To be sure that external friction is not the cause, disconnect the probe shaft near the flexible coupling and check for dirty or scaled bearings or compaction of sugar crystals around the rotor.

The Bodine motors have special brushes that should be ordered from the supplier listed inside the front cover of this manual. When ordering replacement brushes, specify the motor manufacturer, motor type, voltage and brush dimensions.

The circuit board is protected by a 1/2 ampere fuse. Do not over-fuse, as circuit board damage can result.

INFORMATION

For additional information regarding parts for older models, installation or service, please visit www.zieglerassociates.com or contact the distributor listed inside the front cover of this manual.

MODEL 970-C SUGAR CONSISTENCY MONITOR PARTS LIST

PART#	ITEM	DESCRIPTION
970C009	Barrel	Sensor/probe shaft barrel
970C012	Bearing	Sensor/probe bearing
970C029	Bearing Retainer	Sensor/probe inner bearing retainer
970C038	Circuit Board - 24 Volt	Circuit board - 24 Volt
970C014	Flex Coupling	Sensor/probe flex coupling with set screws
970C004	Front Panel Assembly	Front Panel Assembly
970C026	Meter (Digital)	Digital indicating meter for front panel
970C037	Motor 24A2BEPM - 24 Volt	Motor (Bodine type 24A2BEPM) – 24 Volt
970C034	Motor Adaptor	Motor Adaptor for 24A2BEPM motor
970C017	Motor Bearing (Bodine - Z99038)	Motor ball bearing for all Bodine Motors (Bodine - Z99038)
970C036	Motor Brush (24V Bodine 49/)	Brush & spring for Bodine Motor (24 Volt)(1/4" x 3/16")(49/)
970C010	Motor Mount	Sensor/probe motor mount
970C033	Motor Spacers	Sensor/probe motor spacers 1/8" for 24A2BEPM Motor (set of 4)
970C022	O-Ring #114	O-Ring Bearing Retainer #114 - 5/8 x 13/16"
970C023	O-Ring #217	O-Ring Barrel Seal #217 - 1 3/16 x 1 7/16"
970C027	Potentiometer	10k ohm potentiometer for front panel
970C015	Rotor 1-3/4"	Sensor/probe rotor 1-3/4"
970C016	Rotor 3"	Sensor/probe rotor 3"
970C031	Screws	SS Screws and washers for splash hood (2 of each included)
970C002	Sensor	Sensor/probe unit
970C024	Set Screw	Set Screw 8-32 x 3/16" Spline Head SS
970C008	Shaft	Sensor/probe shaft
970C028	Splash Hood	Sensor/probe motor splash hood
970C013	Terminal Block	Sensor/probe terminal block
970C001	Transmitter	Transmitter
970C030	Wrench	Spline head wrench

Figure 6: Probe Component Locations

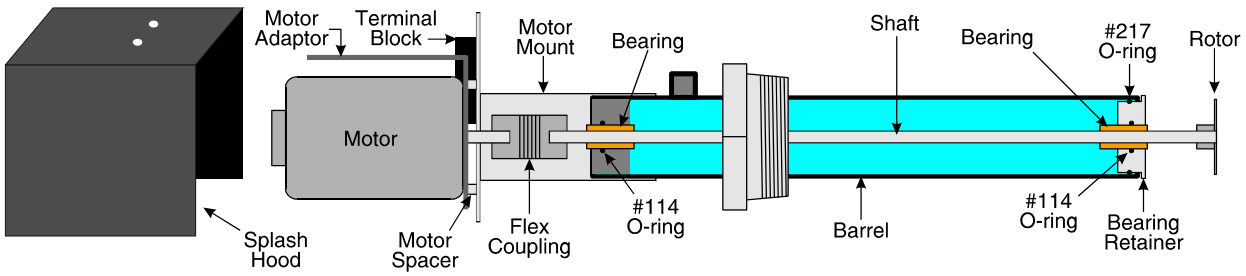


Figure 7: Circuit Diagram

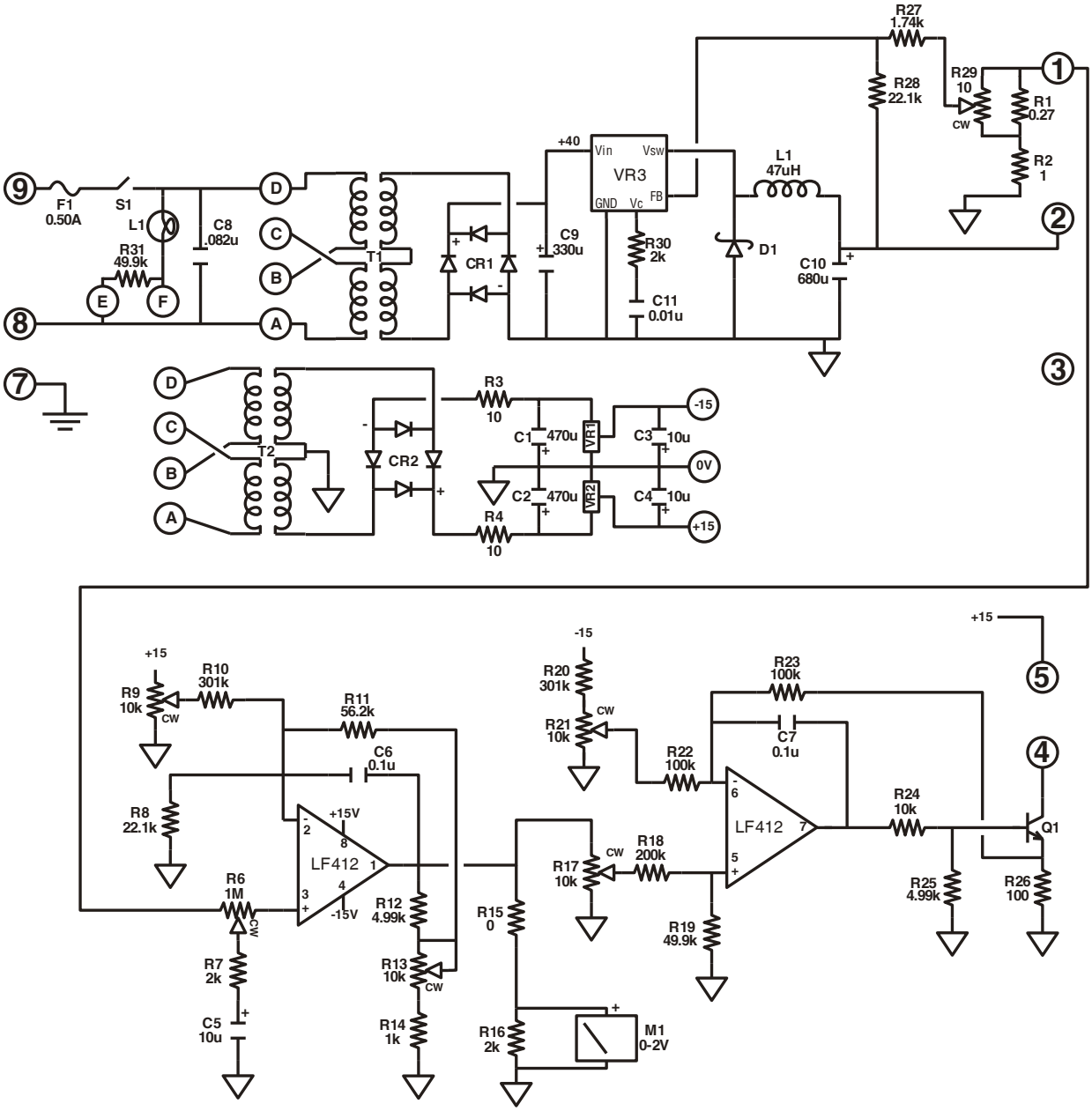
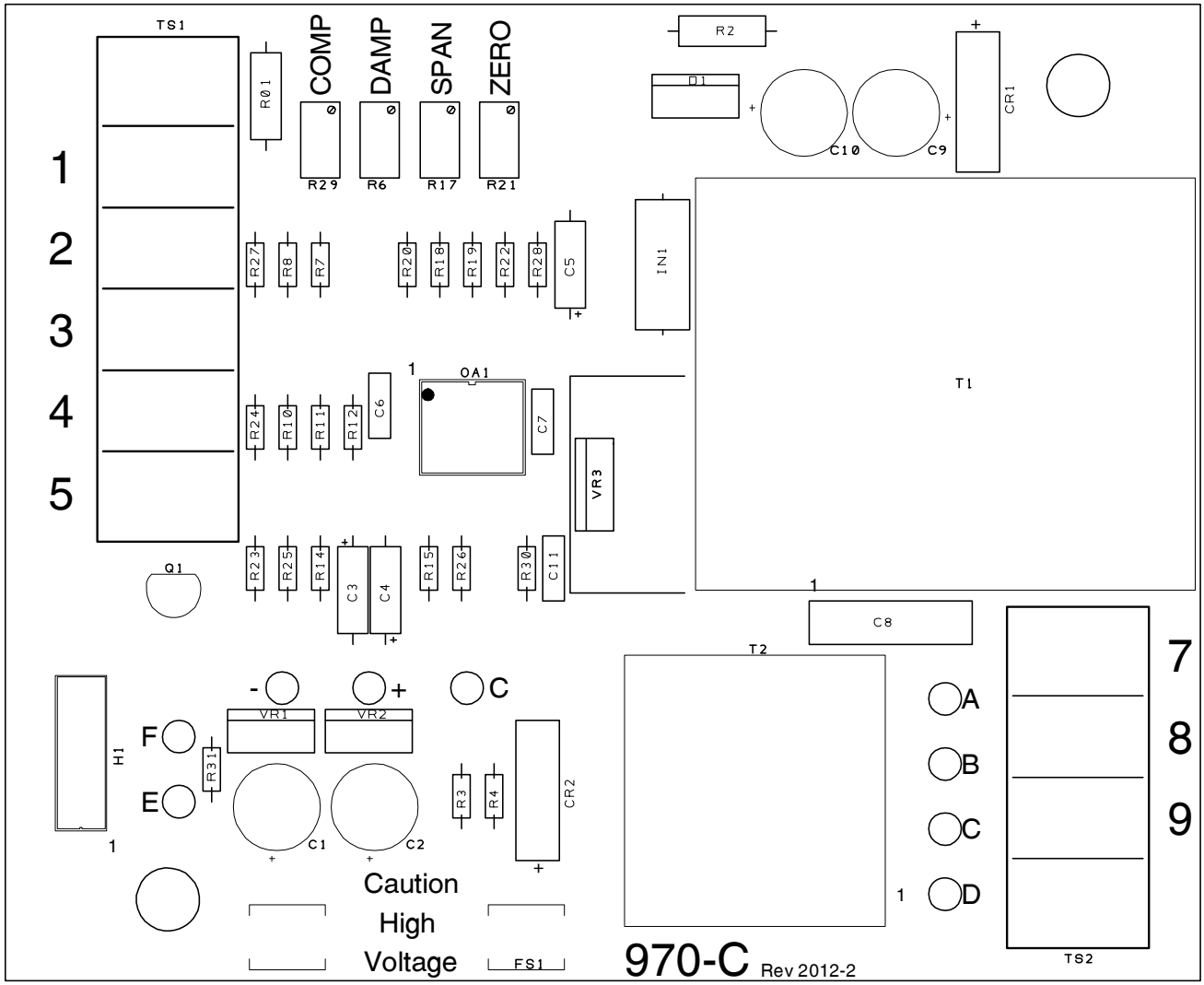


Figure 8: Circuit Board Component Locations



WARRANTY

Ziegler & Associates' products are warranted to be free from defects in material and workmanship for a period of one (1) year from the date of shipment. The final determination as to whether the product has failed due to defects in materials or workmanship rests solely with Ziegler & Associates. Products that have been proven to be defective in workmanship or materials will be repaired or replaced at Ziegler & Associates' facility at no charge to the buyer. Defective instruments must be returned to Ziegler & Associates freight prepaid. **THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE GIVEN IN CONNECTION WITH THE SALE OF ANY ZIEGLER & ASSOCIATES PRODUCT(S).** In no event shall Ziegler & Associates be liable for consequential, incidental or special damages. The buyer's sole and exclusive remedy and the limit of Ziegler & Associates' liability for any loss whatsoever, shall not exceed the purchase price paid by the purchaser for the product or equipment to which a claim is made.