23.1A

OPERATING MANUAL

Methods and Equipment
Developed during the Project

CENTRAL AVALANCHE HAZARD FORECASTING

July 1975 - March 1979

(Y-1700)

Department of Atmospheric Sciences
University of Washington

September 1978

Prepared for
Washington State Highway Commission
Department of Transportation
in cooperation with
US Department of Transportation
Federal Highway Administration

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INTRODUCTION

The Central Avalanche Hazard Forecasting project has been funded by the Washington State Highway Commission since July 1975 in order to test the feasibility and effectiveness of central avalanche forecasting for the Cascade Mountain Passes and adjacent territory. Historically, avalanche forecasting in the Cascade Mountains has been done locally on an area-by-area basis by Highway Department personnel and by Forest Rangers and professional ski patrolmen at individual ski areas. This project explored the possibilities of improving both mountain weather and related avalanche forecasts for use by WSDT during winter operations in the mountain passes and, secondarily, explored the usefulness of an area-wide forecasting service to other, cooperating agencies. The aim of this work has been to establish the technical and administrative framework for an operational, on-going mountain weather and avalanche forecasting service for Western Washington under the joint support of interested public agencies. This aim has been achieved in autumn 1978 by the operation of an avalanche forecasting office administered by the US Forest Service, housed by the National Weather Service, and supported by WSDT, with additional peripheral support from both the public and private sectors.

Previous reports published by the project include: Interim Report, June 1976 (Report No. 23.2); Final Report, June 1977 (Report No. 23.3); and the Implementation Report, December 1978, which will be published in Spring 1979. If you would like to obtain copies of any of these reports, contact WSDT Public Transportation and Planning Division in Olympia (SCAN 234-6149) or the Avalanche Research Office on SCAN 323-7180 or write Avalanche Research, Department of Atmospheric Sciences AK-40, University of Washington, Seattle, WA 98195.

Phil Taylor, Research Engineer, has done an outstanding job of developing much of this equipment and devising methods of operation. He is, unfortunately, no longer with the University. He will be working in Autumn 1978 with the US Forest Service as a consultant in addition to his continuing work with the US Geological Survey.

This Operating Manual is intended to be an informal document with limited distribution and its format reflects that informality.

(1)

GENERAL

(2)

i) Remote telemetry--Stevens Pass. In the first year of operation difficulties in communication with WSDH field personnel at Stevens Pass severely hampered the snow and weather feedback process necessary for operational forecasting for this area. These communication difficulties stemmed partly from a very bad phone system (beaver destruction of phone company land lines was a large problem, often resulting in shorted lines, significant line static and wrong numbers), partly from the range limitations of field radios, and partly from the lack of a 24-hour/day radio operator at the Berne Snow Camp to serve as a focal point for reaching field personnel. Further, during high avalanche hazard periods when current hourly snow and weather data from this area were needed most by forecasters to update local avalanche advisories and forecasts, control personnel responsible for such data were involved in active control work and not able to observe or transmit data.

As a result of these data communication problems, and in order to have snow and weather input from this generally high hazard area available at all hours at the Forecasting Office, project staff constructed and installed a remote, automatically telemetered meteorological instrumentation system in the Stevens Pass area during the autumn and early winter of 1976. Wind direction and wind speed sensors were placed on top of a 40-foot Rohn tower installed on the northeast edge of the

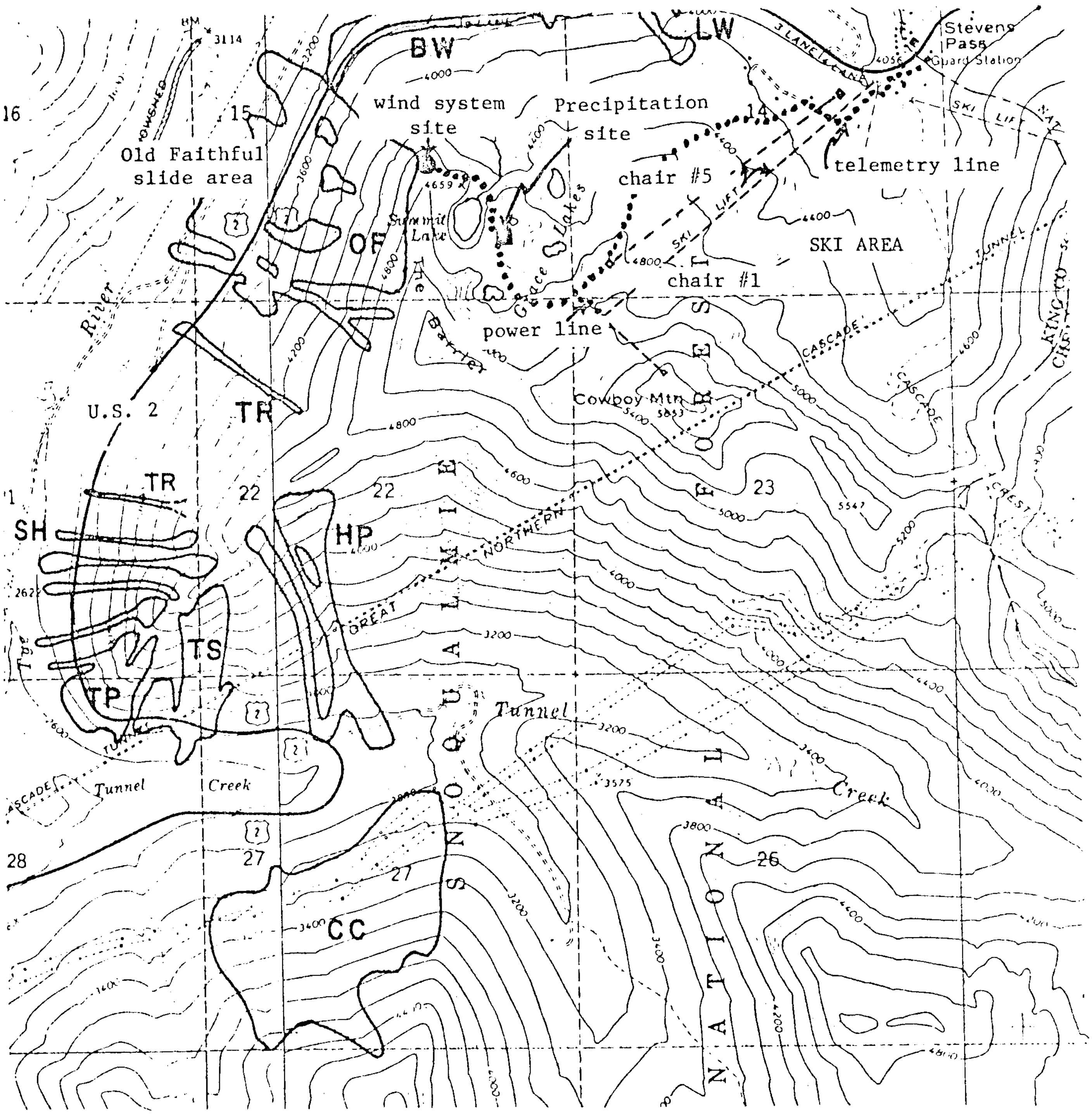
Old Faithful ridgeline (a very active avalanche area affecting the Stevens Pass highway) at the 4800 foot level. An existing radiation-shielded temperature thermistor (earlier utilized by WSDH personnel prior to a break in the telemetry line), located in a nearby fir tree along the same ridgeline, was connected to the telemetry system to provide high altitude temperature data. Another new, similarly shielded, thermistor was installed at the Pass level (4000 feet) on the USFS snow study platform to give lower altitude temperature input to the Forecasting Office. Finally, a heated precipitation gage, newly designed, tested and constructed by project staff, was placed on top of a 20-foot Rohn tower (with wind baffles) which was installed in a tree-shielded low wind area in the Summit Lakes Basin to the southeast of the anemometer site. See Figure 2 for more specific locations of these instrumentation sites.

Although the past season was relatively light in comparison with most Cascade winters, sufficient snowfall and winds (in heavy riming situations) were experienced to give the instrumentation system a vigorous test. During the course of the season, the newly designed anemometer system did not rime-up and reliably indicated wind speeds near the Old Faithful slide area and at Stevens Pass in general (see Appendix C for a detailed description of this wind speed system). Minor modifications (e.g., improvement of heat transfer and lowering of initial starting speed) of the anemometer system are anticipated before further use, but the concept appears to be quite reliable. The precipitation gage used at the Summit/Grace Lakes Basin site consisted of a standard tipping bucket rain gage mechanism incorporated into a newly designed and constructed "snow precipitation gage." In general, the modified precipitation gage operated quite well with resolution to .01 inch. See Appendix C for a more technically detailed description of this system.

Temperature-sensing units at both the high (anemometer site) and low elevation (Pass level USFS snow study plot) sites consisted of standard temperature thermistors housed in double-radiation shields designed by Phil Taylor, project engineer. In all instances these units have proved very reliable.

Telemetry equipment used in the automatic transmission of data was housed in the ski area lift shack at the top of Chair #5. A detailed description and outline of this equipment and the telemetry operation is given in Appendix C. Phone calls for Stevens Pass data were initiated automatically every hour at the Forecasting Office by a one-number dialer system (a combination of phone company and project engineered equipment). An automatic answering device at the top of Chair #5

FIGURE 2. Remote telemetry sites at Stevens Pass.



(5)

answered the call and keyed a scanning device which then sequentially transmitted sensor output (already encoded--voltages converted to frequency) over the phone line to awaiting decoders and recorders at the Forecasting Office and at Berne Snow Camp.

j) Remote telemetry--Hurricane Ridge. In addition to re-installation of the shielded temperature thermistor at Hurricane Ridge, a modified wind speed sensor was also installed at this site in the autumn of 1976, following the recommendations in last year's report (p. 20 and Appendix C). The wind speed sensor was newly designed and constructed by project staff and is the same type of sensor installed for the Stevens Pass telemetry system. The sensor and transmitter were bolted to an existing telephone pole at the Hurricane Ridge generator building, and were exposed to all but rarely occurring east-northeast winds, where the pole interfered. The telemetry to transmit the sensor input to the Forecasting Office followed the same operation as last year.

Due to the light snow year, it is uncertain whether or not the anemometer system had a true test in regard to the heavy riming problem usually experienced at this site. Operation of the telemetry system was quite reliable overall (especially temperature values), but some recorded wind values were substantially lower than those expected through meteorological considerations alone. It is possible that high wind separation from the ground occurs downstream from the anemometer site, creating eddies on the summit, but this is not substantiated by Park personnel. Another season of wind measurement at this site (with some equipment modifications as discussed in section 5.1) appears necessary before consideration of possible sensor re-location. Substantial static in the anemometer line may have caused distortion of the wind speed signal and this problem needs to be corrected before real analysis of the received wind speed values is possible. However, with completion of the recommendations for improving this telemetry system, it is believed that reliable real-time weather information received from this site would give forecasters significant lead-time on forecasts for storm situations moving toward the Cascades from the west.

23.3
June 77

APPENDIX C

Stevens Pass Telemetry System

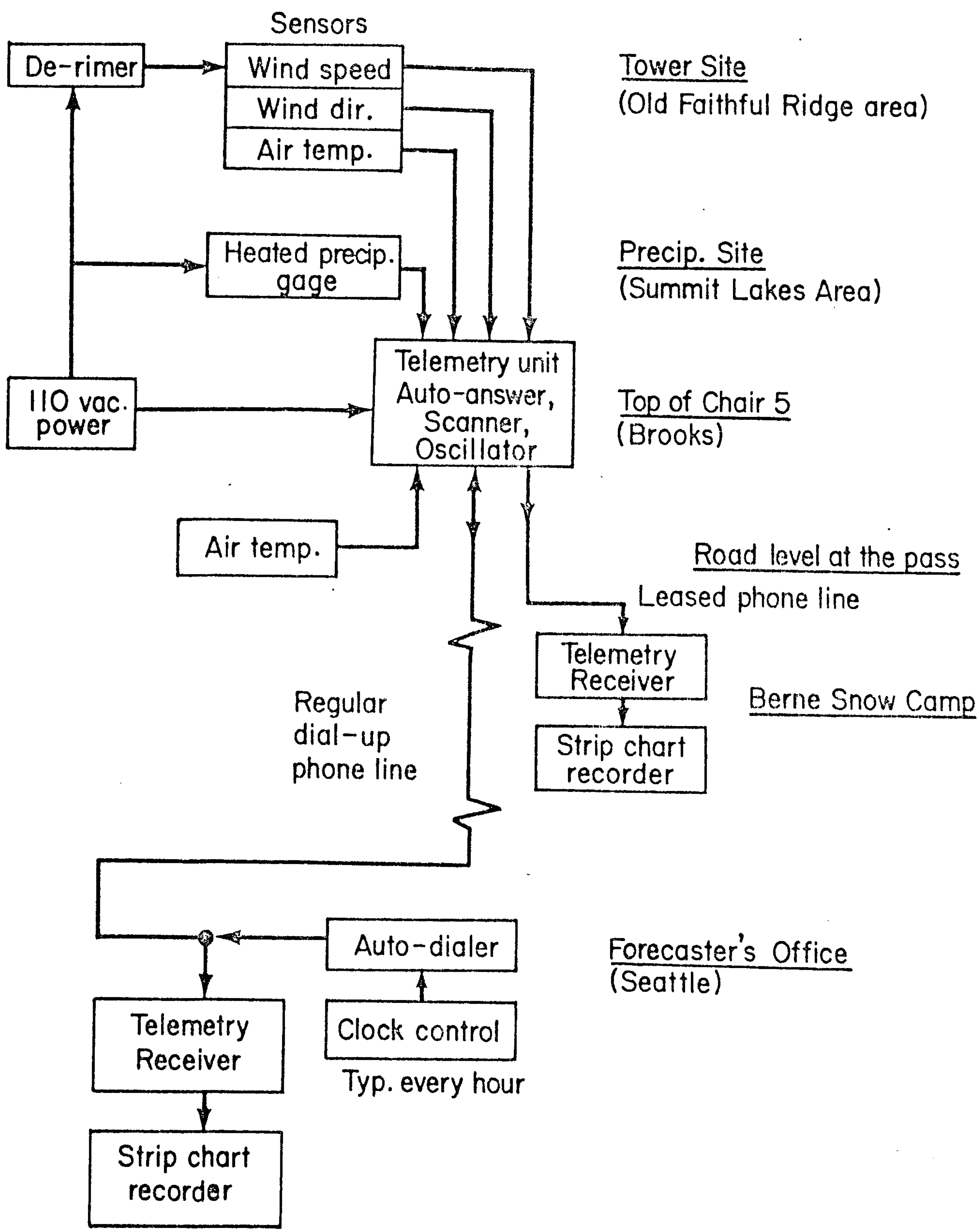
This system provides the avalanche forecaster in Seattle with automatic hourly meteorological data from the Stevens Pass area via telephone lines, and is shown in the block diagram of Figure 11. Sensor inputs from the Old Faithful Ridge tower, the Summit Lakes area, and the Pass road level are connected by buried land lines to the telemetry unit located in the lift shack at the top of Chair 5 (Brooks). The telemetry unit is connected by phone line back down to the Pass. The sensors are interrogated from Seattle utilizing a telephone auto-dialer under clock control, activated automatically every hour, or manually, as desired. The phone call is routed to the telemetry unit, which automatically answers, scans the input sensors in sequence, and returns the data over the phone lines as a frequency modulated signal. The signal is received in Seattle, converted back to analog, and presented on a strip chart recorder (see Figure 12 for a sample record). At the end of the transmission sequence the auto-answer and dialer units reset, and the system awaits the next activation.

As seen in Figure 11, the data signal was also planned to be received at the Berne Snow Camp by a line leased from the telephone company. During the winter 1976/77, this line was never operational, so this read-out was re-located to the USFS Office at the Pass Summit. Following is a more technical description of the more important components of this system.

- Wind Speed Sensor. This is an experimental University of Washington design, illustrated in Figure 13, consisting of an aluminum disk rotor heated electrically from beneath (through radiation and turbulent conduction) to achieve rime-free operation. Heaters are Chromalox Type A Rings; GE Calrod units were also utilized. Power is approximately 1200 watts and is controlled by a Thermologic Mini-Term Series 4200 Probe and Proportional Controller. An Electric Speed Indicator Model WS-301 Speed Transmitter was used with no modification so that the standard cups could replace the experimental disk if desired. In this case, standard de-riming heat lamps were available. Due to its higher mass, the experimental sensor does require slightly higher minimum wind speed for initial cup rotation (<4 mph will not turn the cups) than commonly used speed sensors, but this does not appear to be a problem in avalanche forecasting where winds >10 mph are most effective in wind transport of loose snow.

(7)

FIGURE 11. Stevens Pass Telemetry System.



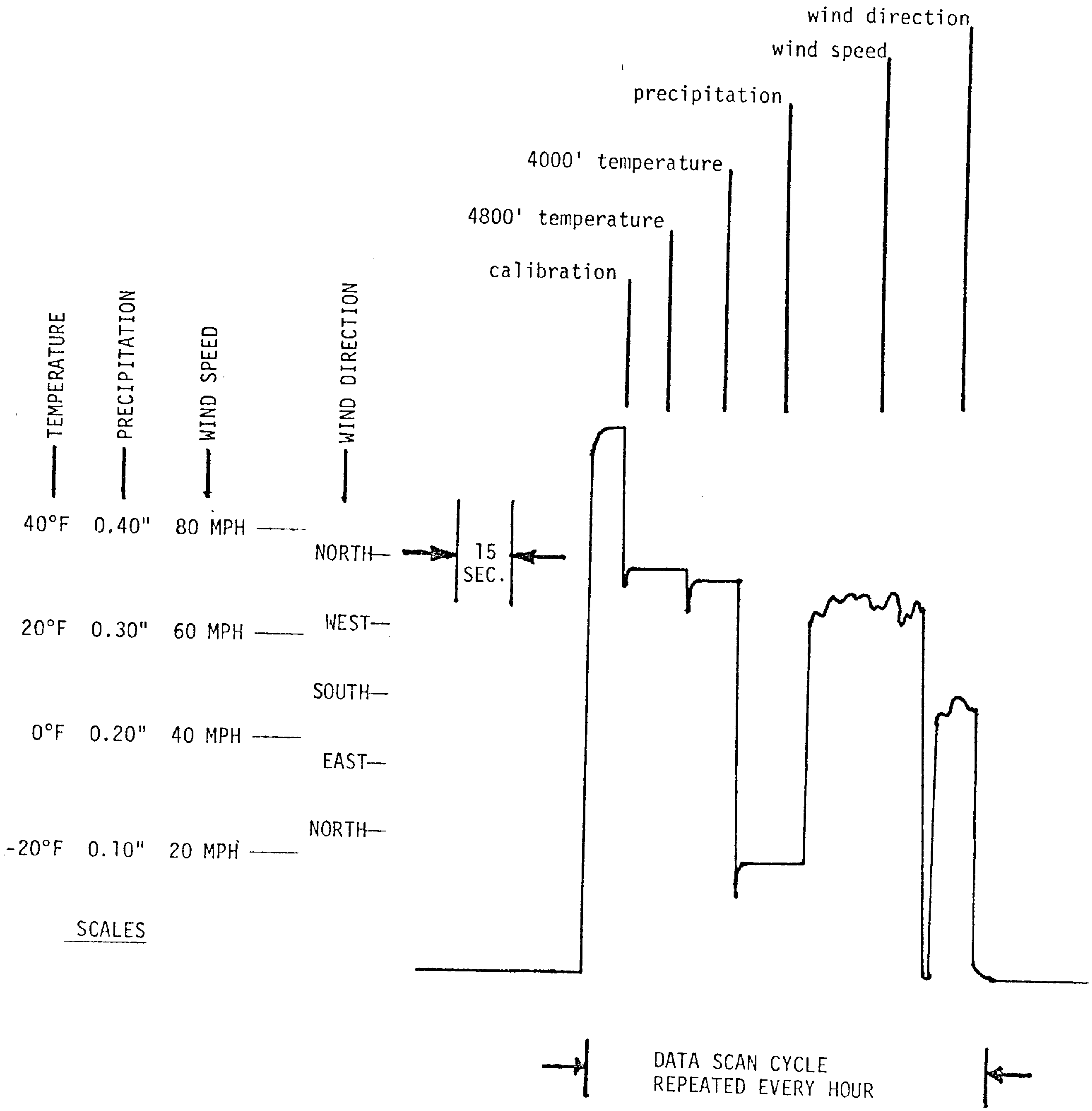
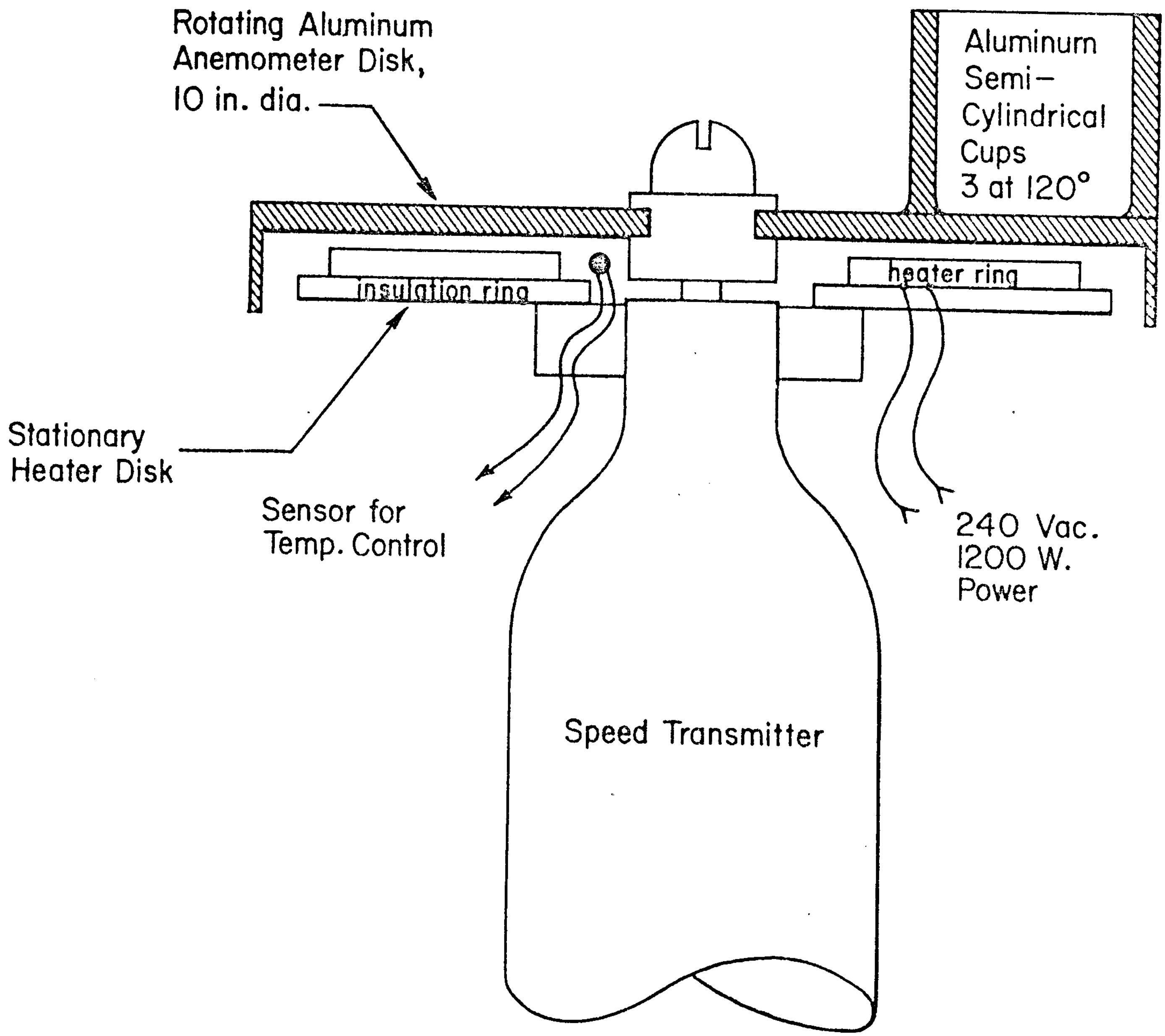


FIGURE 12. Output from Stevens Pass.

FIGURE 13. Wind speed sensor.



Operation was successful, and minor improvements in design are planned for any future operation.

- Wind Direction Sensor. Electric Speed Indicator Co. Model F420-C-2R. These sensors are mounted on a 40 foot Rohn tower, guyed and braced, in the Old Faithful Ridge area.

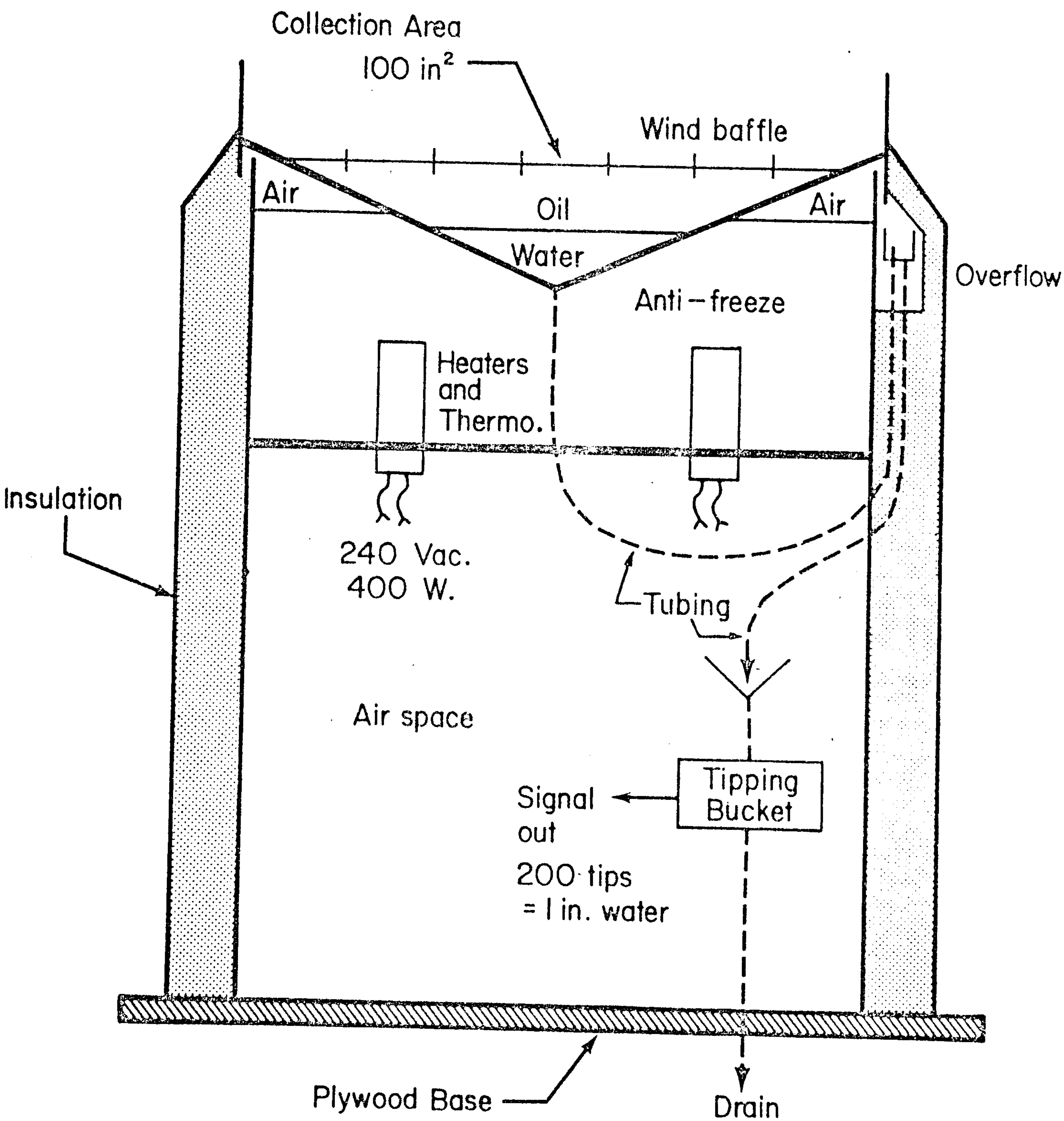
- Air Temperature Sensors. YSI Thermistor, University of Washington bridge circuit and double radiation shield housing.

- Heated Precipitation Gage. This is also an experimental design by the University of Washington (illustrated in Figure 14). Incoming frozen precipitation is melted as it settles through a heated oil bath, collecting in the funnel bottom which is connected by tubing to an overflow device. Equilibrium is such that an equivalent amount of water dribbles away to the measuring device, a Metrology Research Model 302 tipping bucket mechanism (200 contact closure tips representing 1 inch of water on the collection area). The oil bath is heated by thermal conduction from a lower pan filled with anti-freeze solution, and containing Chromalox Type RIN Immersion Heaters, with a Chromalox Thermoswitch acting as a thermostat. Total heating available is about 400 watts. A 50 watt light bulb was placed in the air space under the pan and was adequate to prevent freezing of the tipping bucket mechanism, the waste drain, and the connecting tubing. A "blue-foam" sleeping pad from Recreational Equipment Inc. was used as an insulating layer around the gage. A Weather Measure Model P565 Wind Shield was mounted with the gage on a 20 foot Rohn tower in the Summit Lakes area.

- Instrument Towers. The instrumentation towers at the Old Faithful ridgeline/anemometer site and at the Summit Lakes Basin/precipitation site were installed in late autumn, with consideration given to expected snow creep, high winds and/or tower riming. The tower support system at both sites consisted of a 500 pound reinforced concrete base with imbedded lag bolts to which the hinged tower base plate is bolted. At the more exposed anemometer site, 27 foot tubular aluminum side struts with concrete bases were attached to the tower at an angle near the 20 foot level to help prevent possible snow creep and wind damage. The towers, themselves, are composed of 10 foot triangular Rohn tower sections (#25 AG), and guyed with 3/16 inch steel cable. Examination of the tower systems after the winter showed no signs of weakness and in general the towers appeared to be of adequate strength for use in an extreme mountain environment.

- Telemetry Land Lines, Power Cables. Instrumentation telemetry utilized six-pair, armored, direct burial wire (19 AWG) which was buried in the autumn by polaski and shovel over most of the distance from the top of Chair #5 in the ski area to the instrument sites, through the Grace/Summit Lakes Basin. Very uneven and soggy ground prevented usage of conventional ditch-digging equipment. A combination of existing and newly-installed USFS wire was utilized from the top of Chair #5 to the Snow Ranger's quarters at the base of the ski area

FIGURE 14. Heated Precipitation Gage.



where the phone lines to Seattle and the Berne Snow Camp are located. Any splices necessary in these lines were soldered and taped firmly with electrical tape and a waterproof, self-sealing rubber compound tape. Junction boxes hoisted into trees along the burial route provided field staff access to the line if necessary during the winter season. Necessary power for heating instruments during the winter was provided by the ski area management and electrician. Power hook-up was made at the top lift station of Chair #1 in the ski area, where circuit breakers and a step-up power transformer were installed. Step-down power transformers were required at both instrument sites. These transformers were custom designed and supplied by Tierney Electrical Manufacturing Co. Power lines utilized were rated for direct-burial, and were a combination of 8-1, 10-2 and 12-2 power cables. The 12-2 cable was surplus, in poor condition, and needs replacement. These lines were buried over much of their distance to minimize problems with snow creep and rodents.

- Telemetry Unit. Major components are a Bramco Model AA-1 Auto Answer, a Singer RC4-8 Cam Scanner with A18 gear set, and a Richard Lee Co. Model TX-1 RM transmitter. Precipitation gage bucket tips are accumulated with a Haydon Stepping Motor No. 31316 coupled to a Bowons 3435S single-turn, continuous rotation potentiometer. Standard Power, Inc. CPS-15 Series power supplies were used. In addition, a Bramco Model ME42C Tone Encoder was used to activate the Berne Snow Camp recorder.
- Forecasting Office, Seattle. The clock control used here was a Midtex Cyclemaster Model 620-7595, with an Industrial Timer C5F-5M relay. The Auto-Dialer and its associated Model CBT Data Coupler were leased from Pacific Northwest Bell. A Singer RC4-4 Cam Timer with A18 gear set was used for control. The telemetry receiver is a Richard Lee Co. Model RX-1 FM Data Receiver, and the strip chart recorder was an Esterline Angus Model MS401 BB Miniservo.
- Berne Camp Read-out. Utilizes similar Singer Cam Timer, FM Data Receiver, and chart recorder as above. In addition, a Bramco Model MD42c/P Tone Decoder was used to initiate data recording on command from the telemetry unit as it received a call.

The telemetry system performed satisfactorily, although some difficulties were encountered in using some pre-existing buried land lines. These would need to be replaced for any future operation. Continued development in the sensor technology initiated here is important to insure data quality during stormy weather.

This scheme for automatic analog data transmission over the phone lines has a great deal of inherent flexibility, and should easily accommodate future changes in the avalanche data network.

(13)

FROM : WSHD 23.2 JUNE 76
UPDATED : WSHD 23.3 JUNE 77

APPENDIX C

Hurricane Ridge Telemetry

During the winter of 1975-76 the system described here was used to telemeter air temperature measurements from Hurricane Ridge (northern Olympics, altitude 5300 feet) to the Forecasting Office at the National Weather Service office in Seattle. The measurement is made by manually interrogating the sensor through a regular SCAN phone line and standard Park Service communications radios located in Port Angeles and at the repeater on Hurricane Ridge. The sensor responds immediately, giving the forecaster a direct visual reading of the existing temperature, supplementing the regular twice-daily radiosonde temperature data obtained from Quillayute. During critical storm periods, for example, hourly readings may be made.

Referring to the attached block diagram, the system operation is as follows: Using a touch-tone phone the Seattle forecaster dials the telemetry phone number at Park Headquarters, Port Angeles. This phone automatically answers, connects to the Park Service radio network, and monitors any voice traffic that may be on the air. Finding the radio busy for more than about 30 seconds, the forecaster would hang up and dial again later. The remote phone hangs up automatically after about one minute. If, however, the forecaster finds the channel clear he interrogates the sensor by pressing one of his touch-tone digits (pre-arranged) for about one second. This tone (tone A on the diagram) is decoded at the Port Angeles site, and in turn keys the radio transmitter which sends its own one second tone (B) to the Hurricane Ridge repeater, turning on the telemetry unit. The telemetry scanner then sequences through an automatic cycle lasting 7-8 seconds, consisting of the air temperature (5 seconds) and calibration inputs (2 seconds) which are converted to frequency, and pass through the output relay to modulate the Hurricane Ridge repeater transmitter. The scanner resets automatically after about 20 seconds.

The transmitted signal is received back at Park Headquarters, and the audio portion is sent over the phone line to the Seattle forecaster where it is converted back to analog voltages and displayed in sequence in degrees Celsius on a small digital panel meter located beside the phone. The forecaster then hangs up, and the Port Angeles auto-answering unit resets

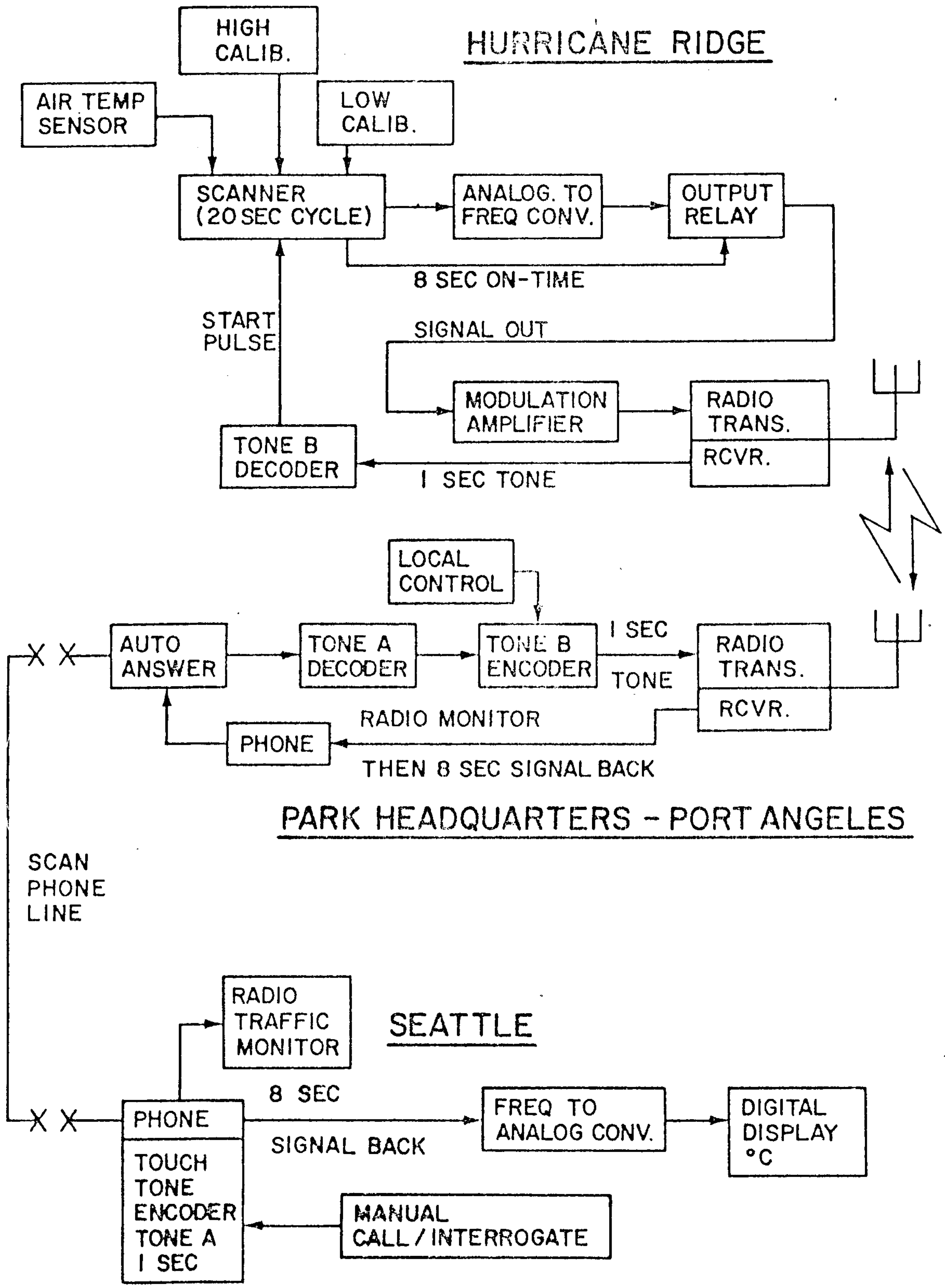
APPENDIX C (continued)

shortly thereafter. After about one minute the process can be repeated if desired. The system was used as sparingly as possible, however, in order to minimize interference with routine Park Service communications.

Mr. Ron Richmond of Olympic National Park was especially helpful in setting up the radio link. Park Service personnel were also able to manually interrogate and read out air temperature from Park Headquarters, which helped them schedule maintenance trips to Hurricane Ridge during the winter.

(15)

APPENDIX C (continued)



Hurricane Ridge telemetry system diagram shows the method for telemetering air temperature from Hurricane Ridge to the Forecasting Office in Seattle. A combination telephone and radio link is utilized.

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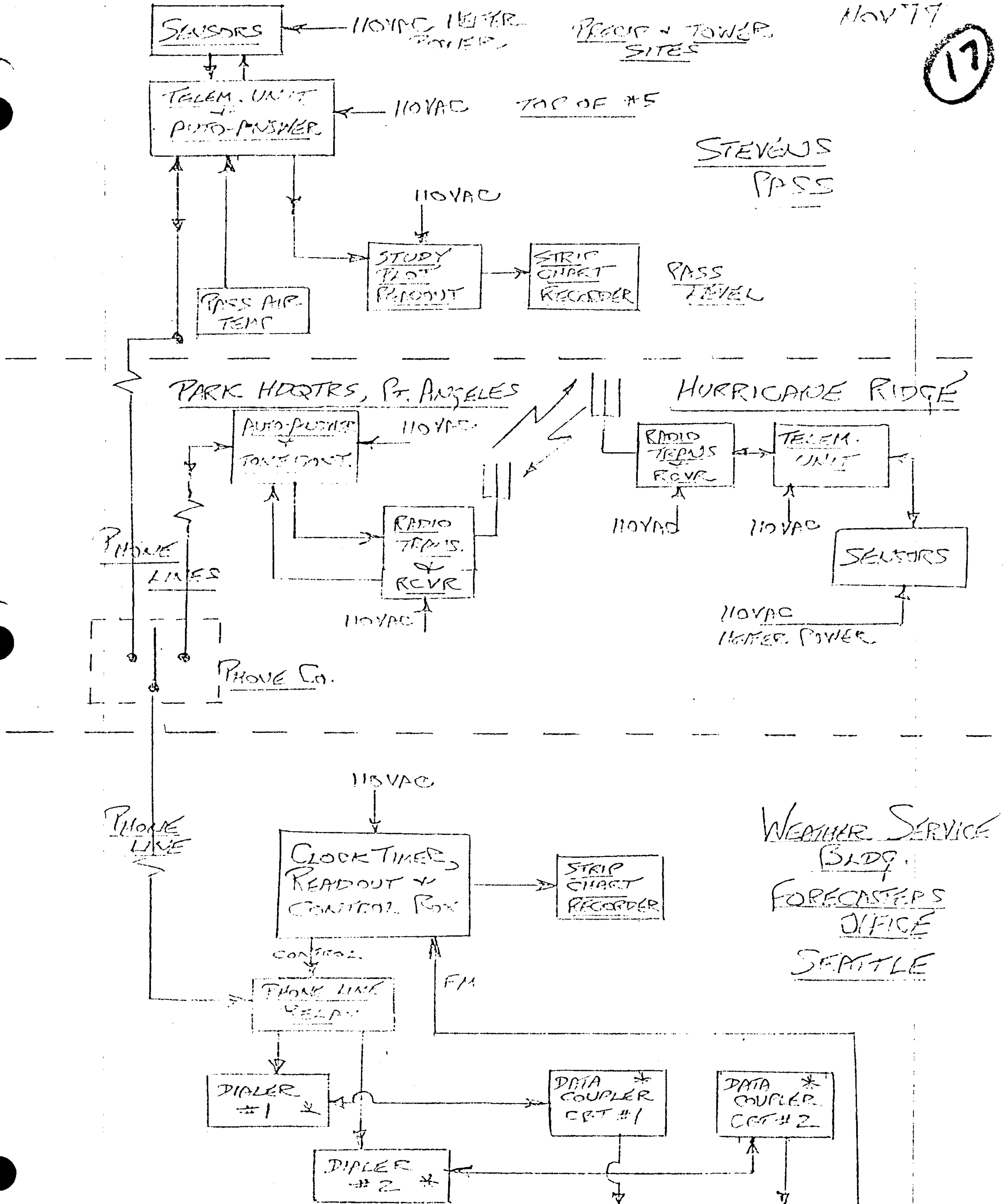
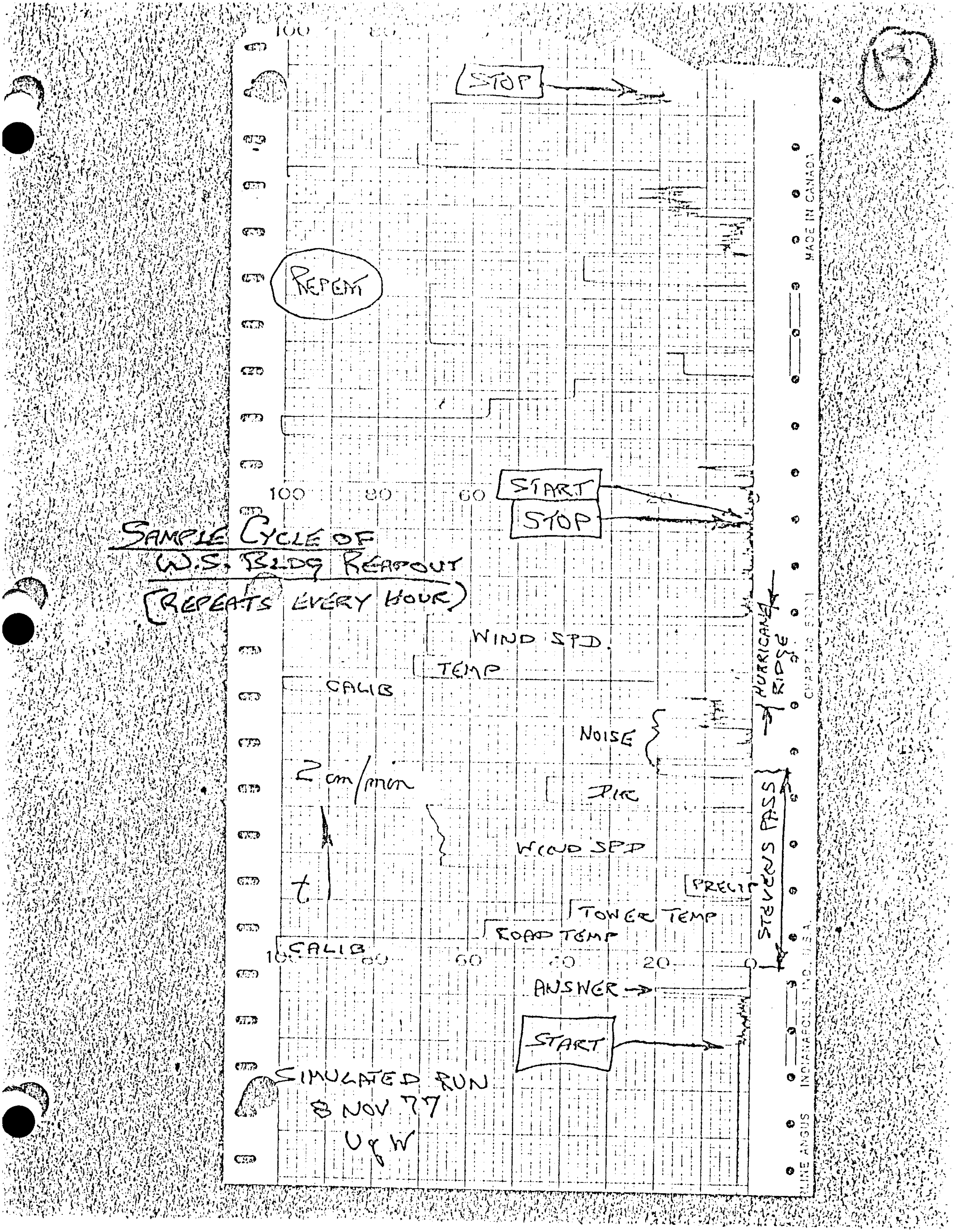
DESCRIPTION AND CALIBRATION



* DIALERS + DATA COUPLERS LEASED FROM BELL TEL.


SAMPLE CYCLE OF
W.S. BLDG READOUT
(REPEATS EVERY HOUR)
STOP
REPEAT
START
STOP
100
80
60
20
0
WIND SPD.
TEMP
CALIB
NOISE
2 cm/min
DIR
t
WIND SPD
PRECIP
TOWER TEMP
ROAD TEMP
CALIB
40
HURRICANE RIDGE
STEVENS PASS
ANSWER
START
SIMULATED RUN
8 NOV 77
U of W
MADE IN CANADA
INDIANAPOLIS, IND. U.S.A.

TELEMETRY SYSTEM OPERATION

General

First read GENERAL, which have been copied from WSHD Research Program Reports 23.2 June 76 and 23.3 June 77 which will provide a generalized description of the system, and some of its historical development. The most recent system block diagram is shown with a sample readout on page 18. This shows the addition of the second one-number dialer during the Fall 77. Following is a more detailed description to be used while referring to the attached schematics and timing diagrams.

Check List for Normal Operation

Power ON : Weather Service Bldg. Control Box
Stevens Pass Telemetry Unit
" " Heater Power for Wind Speed and Precip. Sensors
" " Study Plot Readout Control Box
Port Angeles Control Box and Radio Transmitter/ Reciever
Hurricane Ridge Telemetry Unit
" " Radio Transmitter/Reciever
" " Heater Power for Wind Speed Sensor

Auto-Answer TIMER IN
MANUAL OUT

Scan Motor Switches ON

Strip Chart Recorders ON
1 vdc full scale
either 2 or 4 cm/min chart speed
Pen DOWN
Adequate paper

Sensor inputs and phone lines connected, line to Study Plot connected.

Note on Interpreting Timing Diagrams

The circled number, for example (3) , identifies the cam switch in the scanner. N.C. (normally closed) or N.O. (normally open) refers to the contact in that switch which connects to the C. (common) to provide the desired function.

Cam timing and indexing are easily changed with a 1/4" box wrench and fingers - see the enclosed instructions. Cycle times may be easily changed by exchanging cam gear sets. Use caution to avoid upsetting the logical flow of events.

Weather Service Bldg. Control Box

This unit controls the two autodialers (one for Stevens Pass, one for Hurricane Ridge) on a pin-programmed clock control, and turns on the strip chart recorder. The Clock activates typically every hour; its N.O. contacts close, starting the timer, whose N.O. close for the setting of about 5 ½ minutes. The output is Timed AC which operates the recorder, and fires the solenoid on the scanner, which then controls the scanner motor through the contacts set (5) & . When the Timed AC shuts off (timer goes N.C.) the recorder stops, the solenoid releases so the motor will stop when its control contact releases at the end of one revolution. About 9 minutes later the clock goes back to N.C., removing power from the timer allowing it to reset. If Manual triggering is desired the toggle switch must remain ON until the timer has completed its run. (The timer resets when the Manual switch is turned off.)

A few seconds after the scanner starts, (1) goes N.C. grounding the OH1 contact to CBT1 (off-hook command to Data Coupler # 1 - see attached Bell literature on these terminals.) This dials the phone number for the telemetry unit at Stevens Pass, and takes about 10 seconds. DA (Data Access) command is Off while dialing. Scanner (2) goes N.C. grounding DA1 to the CBT1 terminal, connecting the phone line to the DT1 and DR1 contacts to the telemetry receiver RX-1. The receiver converts the incoming FM to 0-1v analog d.c. which is sent to the strip chart recorder. After about 3 minutes (1) and (2) goes N.O. , OH1 and DA1 go open, hanging up the phone. A few seconds later 3 goes N.C., labelled "OH2", which activates the Phone Line Relay and the Receiver Input Relay, switching their respective functions to the #2 dialer and its CBT2. In addition, the Receiver Input Relay grounds the OH2 contact, dialing the number for the Hurrincane Ridge telemetry. (4) then goes N.C., grounding the DA2 contact to CBT2, connecting the phone line to the telemetry receiver. About 2 minutes later DA2 and "OH2" opens, releasing the Phone and Receiver relays, releasing OH2 and hanging up the phone. About a half minute later the timer runs out stopping the recorder, and releases the motor control solenoid, allowing the scanner to stop automatically at the end of its 6 minute cycle. After a wait of about 30 seconds to be sure the remote stations are hung up and reset, the system may be re-interrogated manually, or the clock dial may be moved ahead to the next hour position. Instructions for setting the clock pins are inside the clock cover - CAUTION- The pins are L.H. thread. Pull out the power plug while setting clock to prevent false triggering. Motor ON-Off switch is used to stop or manually advance the scanner in mid-cycle while testing. (Timer still runs). To keep one of the numbers from dialing lift its OH wire from the terminal strip. The CCT1 and CCT2 lites, indicating a "coupled thru" connection , were removed to reduce the load on the 24vdc supply. (If desired to check, use ohmeter - they ground when "coupled thru"). The dialers and Data Couplers are Bell Telephone equipment, so call them if the trouble is there.

Stevens Pass Telemetry Unit

Refer to Instrument and Power Cable Layouts, Sensor Locations, Wiring Diagrams, Schematics and Parts Layouts. Timing Diagrams for the scanner sequences are also included.

Auto-Answer and Scanner Control

Whenever this phone number is rung the AA-1 Auto-Answer answers the line sending Switched 12vdc to its terminal 15, and connects its diverted line (terminals 6 & 7) internally through coupling transformers to the incoming phone line. The Switched 12vdc line supplies power to the Tone Encoder, and is also used to activate the Study Plot Relay and the Switched 110vac Relay. The first relay connects the phone line in parallel with the line running down to the Study Plot; the second sends 110 vac to the scanner solenoid, starting the scanner. The Auto-Answer will automatically hang up upon completion of an internally generated timing cycle, releasing the two mentioned relays, disconnecting the phone line, the Study Plot line, and removing power from the scanner motor solenoid, allowing the scanner to complete its cycle and stop. The unit may then be re-interrogated.

A few seconds after the scanner starts, its (1) contact goes N.C., sending a coded tone (touch-tone digit 7) from the Tone Encoder pin 3 to the AA-1 term 6, and sends it down the line to the Study Plot. This tone is on for ~~only~~ a couple seconds, and is used only to start the Study Plot Readout. (1) then goes N.O., removing this tone from the output line. After about 10 seconds (to be sure that the Weather Service Bldg. Recorder has an adequate "leader") , (2) (4) & (8) contacts are activated: (4) goes N.C. connecting the bridge circuit output to terminal 1 of the TX-1 Data Transmitter. The bridge input at this time is the Calibration resistance since (2) is N.C.. The resultant data FM signal from TX-1 term 3 is sent through (8) N.O. contact to the AA-1 term 6 and down the lines.

About 15 seconds later (2) goes N.O., removing the calibration resistance from the bridge and connects the Pass Air Temp thermistor since (3) is N.C.. About 15 seconds later (3) goes N.C., exchanging the Tower Air Temp thermistor for the Pass thermistor. After another 15 seconds (4) goes N.O. removing the bridge circuit, and (3) resets to its N.O. position.

At this time (5) goes N.C., connecting the output of the Precipitation Counter circuit to the TX-1 transmitter. In sequence, (6) and (7) representing Wind Speed and Wind Direction respectively, operate in turn. As (7) goes N.O. upon completion, (8) goes N.C. removing inputs from the TX-1 Data Transmitter. About 15 seconds later the AA-1 Auto-Answer times out and hangs up, and about 15 seconds later the scanner completes its one revolution and stops.

Sensor Notes

All sensor outputs from their respective conditioning circuits to the input of the telemetry scanner and TX-1 Data Transmitter are 0 to + 100 mv dc over the measurement range. The two thermistors (tower and pass air Temperature), and the calibration resistance are conditioned by the Bridge Circuit powered by the Floating 12 vdc Supply. This supply is to be used only for the bridge circuit. The Regular 12 vdc Supply is used for the precipitation and wind speed circuits, and to supply power to the AA-1 Auto-Answer Unit, and may be used as a source of power for subsequent additions. A floating 5 vdc is used only for the Wind Direction circuit. Refer to the attached schematics, instruction sheets and calibration procedures for more information.

Both the Stevens Pass and Hurricane Ridge anemometers are of experimental design with a disk rotor mounted over a flat heater ring providing deriming power. Heater control is provided by the Mini-Therm equipment. The precip gage is also of experimental design of the tipping bucket type, with heaters and thermoswitch in an oil bath. Drawings, wiring diagrams, and instruction sheets are attached for these units.

Study Plot Readout

This unit is located in the Study Plot at the pass, and is line connected to the Telemetry Unit. It has nothing to do with the phone line, and is designed only to provide a local recording whenever the Telemetry Unit is cycled.

This is accomplished by the Encoder Tone pulse that is generated at the beginning of the telemetry scan, and which is sent down a separate line to the Study Plot Readout. There it triggers the Tone Decoder, so that its contacts go N.O. providing a start scan AC pulse to the scanner solenoid. A second or so after the scanner starts (1) goes N.O., disconnect the decoder. A few seconds later (4) goes N.O. presenting 110 vac power to the recorder. At this point (2) is still N.C. shorting the recorder input to make an index line along the left margin of the chart. A few seconds later (2) goes N.O., and when the telemetry signal is received on the line is converted in the RX-1 Telemetry Receiver to a 0 to + 1 vdc analog and presented to the recorder. Shortly before AC power to the recorder is removed (2) goes back to N.C., shorting the input again. At this time the decoder is reset to the incoming line by

(1) going N.C., and shortly thereafter the recorder is stopped by (4) going N.C.. The scanner completes its one revolution and stops when (5) goes N.C.. Everything is now ready for the next cycle.

Note: Remember that this unit is slaved to the Telemetry Unit, and has nothing to do with the phone line or the Weather Service Bldg. Control Box.

Hurricane Ridge Telemetry

Refer to attached schematics, wiring and timing diagrams. As seen from the attached block diagram this equipment is phone line interrogated automatically from the Weather Service Bldg. Control Box. Whenever the phone number in Port Angeles is rung the AA-1 Auto-Answer answers the line, and sends 12vdc to the Tone Control Unit. This circuit produces a 12 vdc on pulse of about 2 seconds duration which is sent to and keys the Park Service owned radio transmitter, sending a tone up to the Park Service Receiver at Hurricane Ridge. This receiver then closes a set of contacts for about 2 seconds that provides the start pulse to the Telemetry Unit. The telemetry signal is fed to the Park Service transmitter, to the receiver in Port Angeles, presented to terms 6 and 7 of the Auto-Answer where it is transformer coupled to the incoming phone line and sent to Seattle.

The telemetry scanner then completes its cycle and stops, and the Auto-Answer times out and hangs up, and awaits the next phone call.

The radio equipment is owned and maintained by the Park Service, the present Communications Tech. being Dave Zibell (457-5082), who also uses local interrogation to receive Hurricane Ridge weather. Check with him on anything to do with the Port Angeles or Hurricane Ridge installations.

Returning to the Hurricane Ridge Telemetry Unit , the incoming start pulse sends a momentary 110 vac to the scanner solenoid, starting the scanner. About 4 seconds later (4) goes N.O. which provides a closed circuit which keys the radio transmitter, sending the telemetry signal to Port Angeles. Since (1) is N.C., this signal is the Full Scale Calibration . About 15 seconds later (1) goes N.O. and (2) goes N.O. sending Air Temp. At about 30 seconds (2) goes N.C. and (3) goes N.C. sending out Wind Speed. At about 55 seconds (4) goes N.C., stopping radio transmission, (3) goes N.O. ending Wind Speed, and (1) goes N.C. returning the Calibration signal. At 60 seconds (5) goes N.C., stopping the cam. The unit may now be recycled.

Operational Field Check

Ⓐ Stevens Pass Telemetry Box

1) Open box, check sensor input connections.
2) Plug in AC power, check lite.
3) Check that: Auto-Answer Timer is IN
   " Manual is OUT
   Scan Motor Switch is ON
4) Push Call UP on Auto-Answer. Small red lite should come on, Study Plot Relay, Switched 110vac Relay, and Scan Solenoid should activate, scanner should start to turn.
5) Sequence of events should be according to the Timing Diagram. Just before scanner completes one revolution, the Auto-Answer should hang up, the above relays deactivate, red lite on Auto-Answer goes out. Shortly thereafter scanner completes its revolution and stops.

Note:
Auto-Answer timer should be set to time out between end of Wind Dir (8), and end of Motor Control (9). If too soon, data is lost; if too late scanner solenoid does not release, scanner will start another scan, and output will be interrupted in mid-cycle. Reset time adj. on back of Auto-Answer if necessary. (Has not been necessary to date).

6) Now check operation in more detail. Push Timer on Auto-Answer OUT, turn Scanner Motor Switch Off.
7) Push Call Up on Auto-Answer. Relays and solenoid will activate; cam won't turn, and Auto-Answer won't time out.
8) Connect Data Precision 245 DVM, or equivalent, on the Upper Deck board to Junction Point (stepped 100 mv from scanner). Connect - to term post just above which is the -12vdc (regular) and sensor output common. Set DVM to resolve at least 1 mv.
9) Move knurled disk at the end of the camshaft (in direction of arrow) slowly until (2) is activated. Meter should read 100 mv ≠ 2 mv. Move scanner on through the rest of the sequence, noting readings for each sensor position. Scanner may be moved forward or backward as desired. Check that feadings are reasonable:

	DVM	
	0	100mv
Calib.		full scale
Temp.	-40F	≠ 60F
Precip.	(1 step per mv.)	
Wind Spd.	0	100 mph
Wind Dir.	N E S W	N

10) Before completing scan, push Reset on Auto-Answer, releasing relays and solenoid. Move scanner with knurled disk in direction of arrow until it locks at the end of its cycle.
11) Push Timer IN, turn Motor Switch ON, repeat 4) and 5) above. Close box.

Ⓑ Operational Check from any telephone

1) Call the phone number of the telemetry unit.
2) Number should ring once, then the timing sequence of events of FM tones, and hang up should be heard.
3) A strip chart recording will be made at the Study Plot Readout.

Ⓒ Check of Study Plot Readout

1) If at Telemetry Unit; perform Ⓐ 1 - 5; observe readout later.
2) If at Study Plot; perform Ⓑ 1 - 3; observe readout.
3) Compare strip chart record with DVM values taken in Ⓐ 1 - 11.

(D) Operational Check from Weather Service Bldg.

1) Open Control Box, check AC power on.
2) Move Manual toggle switch to ON. Observe events described under Weather Service Control Box, and observe the Strip Chart Recorder. When cycle in complete, move Manualtoggle switch OFF.

(E) Operational Check of Hurricane Ridge Telemetry

If at any phone:

1) Call the phone number at Port Angeles.
2) Number should ring once, then the timimg sequence of tones and hang-up should be heard.

If at Port Angeles:

3) Open box, check AC on.
4) Check Auto-Answer Timer IN, Manual OUT.
5) Turn up audio volume on the radio receiver.
6) Push Call UP on Auto-Answer, small red lite should come on. Radio transmitter should key.
7) A few seconds later the telemetry signal should be heard on the radio receiver. 1 minute later it should stop, and shortly thereafter the Auto-Answer should hang up.

If at Hurricane Ridge:

8) Open telemetry box, check AC power on.
9) Attach oscilloscope, or 600 ohm earphone to terminals 3 and 4 on TX-1 Data Transmitter. The calibration signal should be present. Alternatively, or in addition, have someone do 5) above at Port Angeles.
10) Manually start scan by depressing motor solenoid plate. Scanner should run through events on Timing Diagram; telemetry signals should be observed. After 60 seconds, one revolution, the scanner should stop.
11) Now check telemetry unit in more detail. Remove AC power, remove one wire from the scan motor terminal strip (there is no Motor ON-Off switch here). Remove one wire from the Output Control so radio transmitter won't key. Attach the Data Precision 245 DVM (or equiv.) to terminals 1 and 2 of the TX-1 Data Transmitter. Set DVM to resolve 1 mvdc.
12) Plug in Ac power. Manually depress the motor strarting solenoid lever, releasing cam. DVM should read the calib voltage of 100 mv ± 2 mv. Move the knurled disk at the end of the camshaft (in the direction of rotation of the arrow) slowly while observing the reading for air temperature and then wind speed. Scanner may be moved forward or backward. Check that readings are reasonable:

	DVM	
	0	100 mv
Calib.		full scale
Air Temp	-40F	± 60F
Wind Speed	0	100 mph

13) Move scanner until it locks at the end of cycle. Unplug AC, replace motor wire and Output Control wire. Apply AC. Repeat 8 - 10 above to check operation. Close box.

(F) Calibration of Stevens Pass Telemetry Unit

1) Perform (A) 6 - 9

2) Temperature Calib.

Remove thermistor inputs to Upper Board, and attach decade resistance box and lead resistors as shown on page . Best points are -10F and +35F (or +32F). The decade box will be used to substitute the thermistor resistance at different temperatures, and the lead resistors simulate the long wires between the sensor site and the telemetry unit. (if lead resistors are not available, set the decade box to a value representing the thermistor resistance plus the correct lead resistance.) Move scanner to Pass Temp input.

3) Set the decade box to a value of -10F (7808 ohms), adjust Bridge Zero pot for DVM reading of 30 mv.

4) Set decade box to +35F (2504 ohms), adjust Bridge Excitation Voltage pot for DVM reading of 75 mv.

5) Repeat steps 3 and 4 several times until no change is required. Check across temperature span with the decade box, comparing to previous calibration; for example that of 2 Nov 77. Note that that curve is non-linear at each end ; calibrating at the -10F and +35F points gives the best compromize over the measurement range. If desired, +32F may be used and set to 72.0 mv, so that freezing point may be accurately measured by the telemetry. Lead resistance and decade box should be set to within a few ohms (say 5) of the correct value. If desired, set DVM to resolve .1 mv; and make calibrations to within a few tenths. However,resolving 1 mv, ~~which~~ corresponding to 1 F, is adequate for this system.

6) Now move scanner to tower temp input. Adjust the Thermistor Lead Res pot ~~for same~~ for same DVM reading at some temperature as you had on the pass temp input. Both thermistor circuits now have the same total lead resistance. (The setting of this pot is the difference between the two).

7) The bridge is now calibrated. Now move scanner to the calibration resistance input. Adjust Full Scale Calib. pot for 100 mv on the DVM.

8) Move scanner to Precip. input. Push manual step button of Upper Board, noting DVM values increase 1 mv per step. At some point the counter pot "crosses over" to zero. Locate this cross-over point, and set Precip. Full Scale Calib pot so DVM reads 60 mv. Manually step across the cross-over to be sure you have it. With your fingers you may rotate the coupling between the stepping motor and the pot in either diredtion to save button pushing if you have a long way to go. 60 mv. is used (Mar 77) beaause only 60 tips can be accumulated by the stepper. This can be changed with a little redesign so 100 tips are accumulated for 100 mv full scale output - see notes in the precip. counter section of this book.

9) Move scanner to Wind Speed input , and remove both input leads from the anemometer. Move the positive lead of the DVM and connect to the - input terminal of the wind speed sensor input. (Neg. lead still on power and signal common). Adjust Wind Bias. pot on the lower deck board for +.35 v. on the DVM. This voltage corrects for the calibration curve for the anemometer not passing through the origin. (See attached plot).

Return positive lead of DVM to the Junction Point.

Substitute and input voltage source (3 or 6 v. ok) through the correct lead resistance (84 ohms) to the wind speed sensor input to the lower board. Measure voltage at the source (the battery) and calculate the equivalent wind speed from the following:

(F) 9 con't

$$\text{Wind Speed, mph} = \frac{\text{volts} + .35}{.088}$$

Example:

if source voltage measured 6.17 volts,

$$\text{wind speed} = \frac{6.17 + .35}{.088} = 74.1 \text{ mph}$$

Adjust <u>Wind Speed Full Scale Adj</u> pot to this value in mv; in this example 74.1 mv., since 0 to 100 mph equals 0 to 100 mv.

Check other points using a variable voltage source:

Voltage	Equiv. Wind Speed
8.45 v.	100 mph
6.69	80
4.93	60
3.17	40
2.29	30
1.41	20
.53	10
0	4 (bias)

10) Move scanner to <u>Wind Dir</u> input. If you have radio communication to a person on the tower calibration may be made this way. If not, disconnect Wind Direction inputs from the Lower Board, and reconnect the vane with the correct lead resistances (42 ohms each lead) to the inputs. With vane pointed toward the reference line (use the flat on the shaft if vane is removed) the internal transmitting pot is on the edge of cross-over. Move vane slightly CW, then slowly back CCW until you get the minimum DVM reading. (DVM on the Junction Point, as described above.) Adjust <u>Wind Dir. Zero</u> pot for 0 mv. Now turn the shaft and vane CW and find the highest voltage just before cross-over. Adjust <u>Wind Dir. Full Scale</u> pot for 100 mv.
(If the vane cannot be connected, calibration can be done with a 200 ohm resistance. Connect with proper lead resistances - see ~~and this sheet and short A to C for the zero adjustment above~~ the schematics - and short A to C for the zero adjustmont above, and then short A to B for the Full Scale adjustment.)
Move vane around CW, watching the DVM to be sure values increase in a linear fashion in that direction.

11) Disconnett test equipment and reattach all sensor inputs.
Perform (A) 10 and 11. Telemetry Unit is now calibrated.

12) To check the <u>TX-1 Data Transmitter</u>, connect its p terminals 3 and 4 to terminals 1 an 2 of the spare RX-1 Data Receiver. Supply 110 vac to the RX-1, and to its output terminals 3 and 4 connect the the DVM set for 1 v. full scale, or connect the Mini Servo Strip Chart Recorder. Check recorder zero and full scale as given in the Instrūction Manual for the recorder.
Perform (A) 1 - 11, Operational Field Check, or perfórm the Calibration Procedure (F) 1 - 11 above. Compare TX-1 input to RX-1 output (0 to +100 mv in produces 0 to +1 v out) and refer to the instruction sheets for these units if it is not right.

(G) Calibration of Hurricane Ridge Telemetry Unit

1) Perform (E) 8 - 12
2) Substitute a decade resistance box for the thermistor input. (No lead resistance is necessary.) Move cam to Air Temp input.
3) Set decade box for a value at - 10F (7808 ohms). Adjust Bridge Zero pot for 30 mv at the TX-1 input.
4) Set the decade box for the value at ≠35F (2504 ohms), and adjust Bridge Voltage, Vb pot for 75 mv.
5) Repeat steps 3 and 4 above several times. Compare to previous calibration, for example the calibration of 8 Nov 77.
6) Move cam back to Calibration, and check the DVM for 100 mv. If more than 2 mv off either way, adjust R cal, or if this is a fixed resistor, make very slight adjustment of the Bridge Output pot.
7) Recheck 3 - 6 until all values check. Check across the span with the decade box, comparing to previous calibrations.
8) Move scanner to Wind Speed input . Disconnect the wind speed sensor input. Calibration procedure is now the same as F 9 above.
9) Move scanner until it locks at the end of the cycle. Unplug AC power, replace Motor wire and Output Control wire, and connect Air Temp and Wind Speed sensor inputs. Reapply AC power and perform (E) 8 - 10.
10) To check the TX-1 Data Transmitter do so similar to (F) 12 above, while performing (G) 1 - 9 above.

(H) Calibration of RX-1 Data Receivers installed in Study Plot Readout and the Weather Service Bldg. Readout.

Best procedure is to remove the RX-1 unit, and connect to the spare TX-1 Data Transmitter in a bench check. Supply 110 vac to both units, attach a 0 to ≠100 mv source to the TX-1; and a 0 to ≠ 1 v dc reading DVM, or the Mini Servo Strip Chart Recorder, or both, to the output of the RX-1 Data Receiver.

Check the recorder zero and full scale as given in its Instruction Manual. Vary and measure the TX-1 input and compare to the desired RX-1 output. Refer to the Instruction Sheets for the TX-1 and the RX-1 for calibration or trouble-shooting.

Some Trouble-Shooting Suggestions

First refer to Normal Operation Check list, page . Problem sometimes is power off at the remote sites.

If remotes are missing on the readout, call them manually. Sometimes call is not completed due to phone company problem, especially to Stevens Pass.

The TX-1 and RX-1 Data unit boards sometimes act up, or go bad. Had one that was intermittent. Best thing to do is to replace with spare; if you don't see an obvious fault on the board return to factory.

90% of remaining problems have been with cables between the telemetry unit and the senfor sites (Stevens Pass) . Symptoms are: Screwy readouts for calib and temperature caused by bad connections, voltage interference picked up by cable, insulation resistance changes from wet or smashed wires. Since the tower and pass temp and calib use the same bridge circuit (at Stevens), any problem in one will probably affect the readout of the other two. Disconnect both ends of cable and "ring" out. Check series resistance (compare to cable diagram, normal lead resistances) and check insulation resistance. Also check for residual voltages,ac and dc, on the lines. Some old lines are being replaced this fall (78).

Since the Study Plot Readout is in parallel with the phone line to Seattle, a problem in the line from the Telemetry Unit down to the Study Plot could affect the quality of the signal to Seattle. Disconnect to check, xx

If you have any reason to go to Port Angeles or Hurricane Ridge, check with the Park Service Communications Tech first.

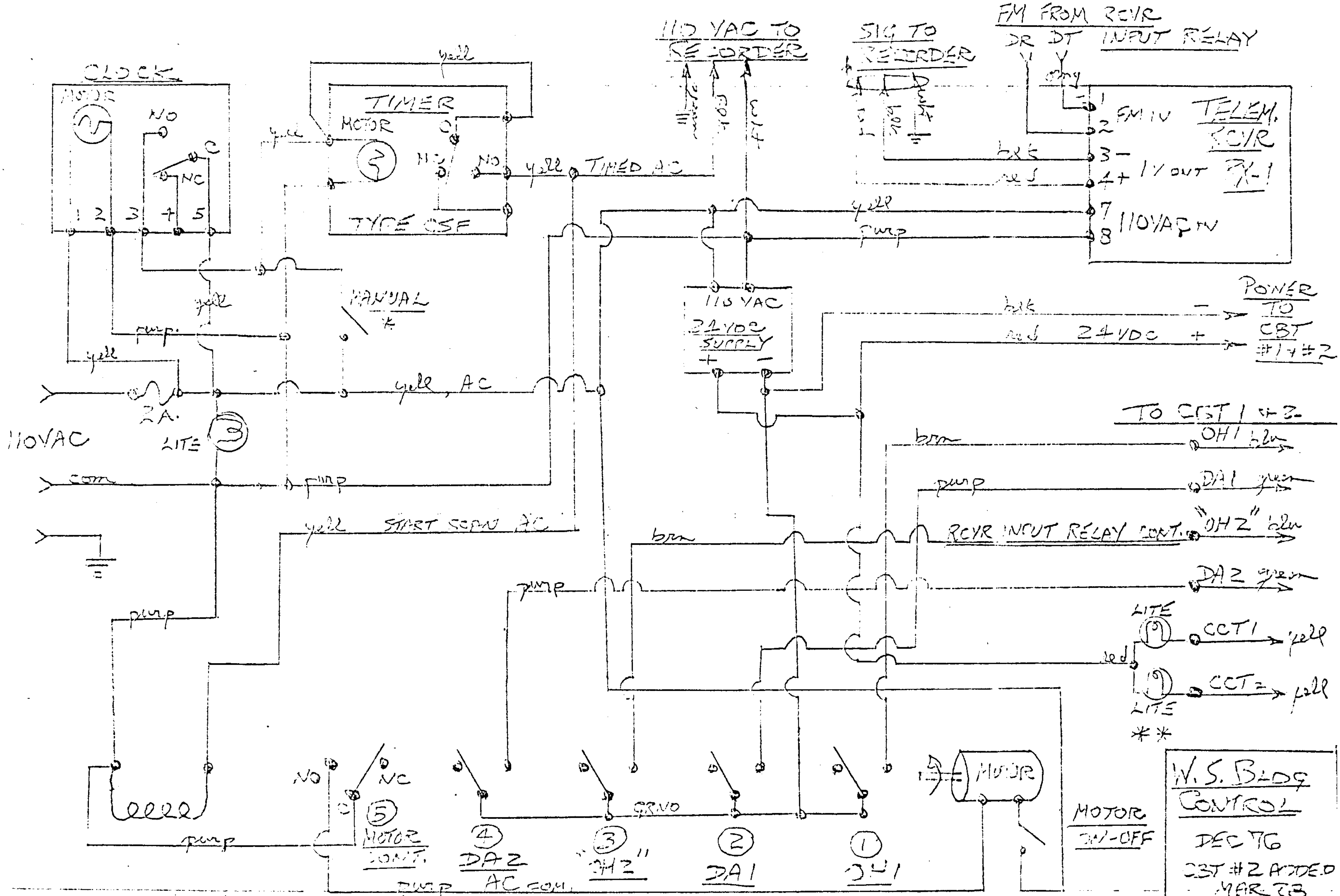
If you xx have problems with the auto dialers or data couplers call the phone company.

If sensor readouts don't seem right, don't jump to conclusions that it xxx is the electronics. Temp cans may be plugged with snow, anemometer may be rimed, vane may be rimed, precip gage may be covered with a snow cap.

Use caution when working on the sensor heater power circuit. Thxx There is 500 volts in there.

FORECASTING CENTER CONTROL

(National Weather Service, Seattle)

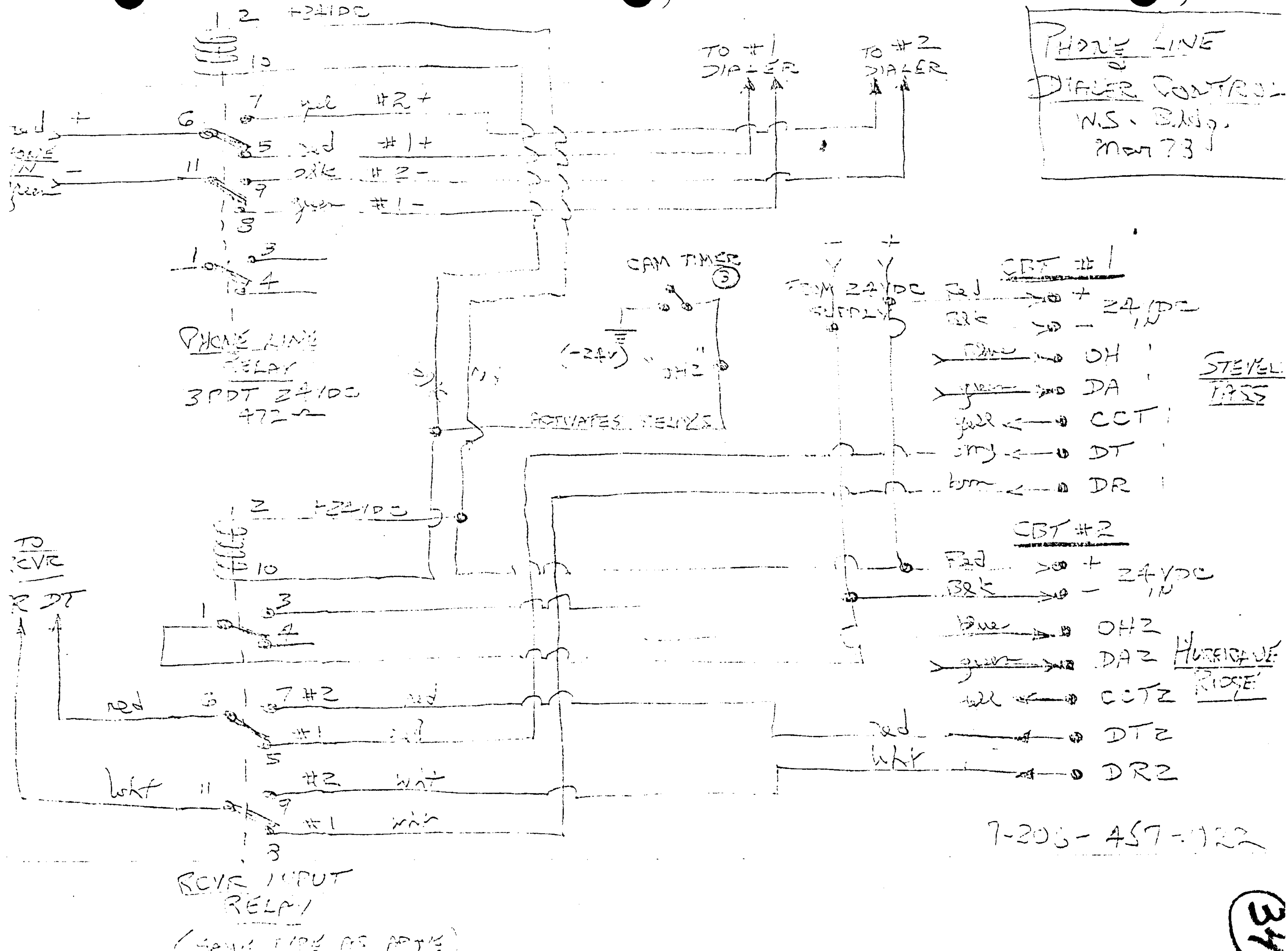


* TOGGLE - NOT MOMENTARY
LEAVE ON TIL CYCLE COMPLETE.

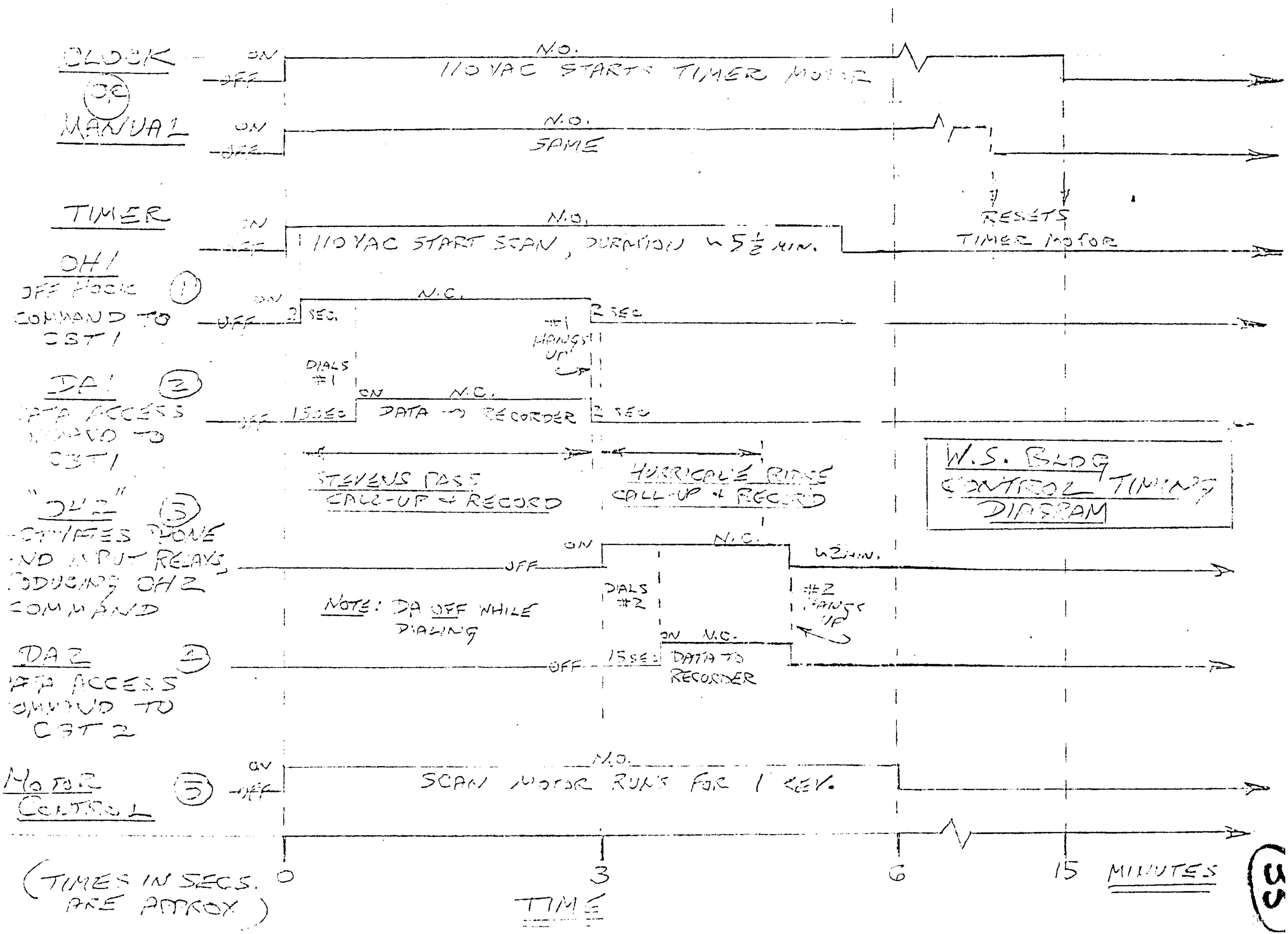
** REMOVED 3/78 TO
REDUCE LOAD ON 24VDC SUPPLY

Phone Line Dialer Control

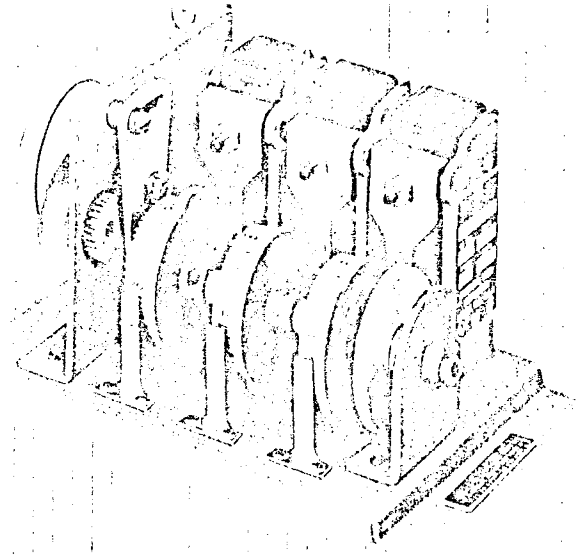
W.S. Bldg.
Mar 73



34



W.S. BLDG CONTROL TIMING DIAGRAM
CLOCK OR MANUAL
ON
OFF
N.O.
110 VAC STARTS TIMER MOTOR
N.O.
SAME
TIMER
N.O.
110 VAC START SCAN, DURATION ~5½ MIN.
RESETS TIMER MOTOR
OH1 OFF HOOK COMMAND TO CST1 ①
N.C.
2 SEC.
#1 HANGS UP
DA1 DATA ACCESS COMMAND TO CST1 ②
DIALS #1
15 SEC
ON
N.C.
DATA → RECORDER
2 SEC
STEVENS PASS CALL-UP + RECORD
HURRICANE RIDGE CALL-UP + RECORD
"OH2" ③ CTY/FES PHONE AND INPUT RELAYS, PRODUCING OH2 COMMAND
OFF
N.C.
~2 MIN.
NOTE: DA OFF WHILE DIALING
DIALS #2
#2 HANGS UP
DA2 ④ DATA ACCESS COMMAND TO CST2
15 SEC
N.C.
DATA TO RECORDER
MOTOR CONTROL ⑤
N.O.
SCAN MOTOR RUNS FOR 1 REV.
0
3
6
15
MINUTES
TIME
(TIMES IN SECS. ARE APPROX)



OPERATING INSTRUCTIONS

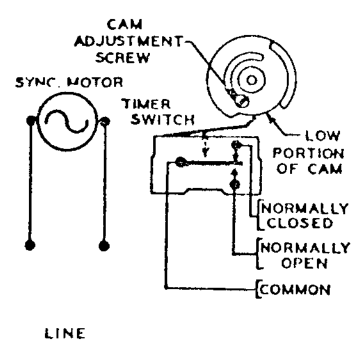
Series CM, MC, RA & RC

PROGRAMMING CAM TIMERS

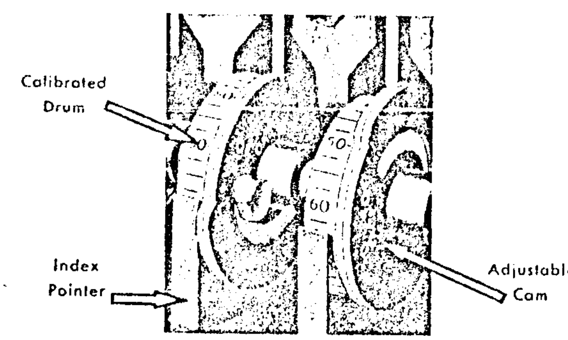
for

Catalog Bulletin #206

The switches used on the Cam Timer Series are Snap Action, Single Pole Double Throw totally enclosed micro switches, each switch is marked Normally Open (N.O.), Normally Closed (N.C.) and Common (C). These markings designate the condition of the switch in relation to the low or detent portion of the cam. A circuit is completed between the Common and the Normally Closed contact of the switch when actuator arm is in detent. Therefore, by setting the cam opening at 10%, the contacts will be closed for 10% and opened for 90% of the total time cycle. By wiring the switch to either N.O. or N.C. the load "on time" can be adjusted for a total of 2% to 98% of the total overall time cycle.



WIRING DIAGRAM ONE OR MORE CAMS



The cam opening may be adjusted by loosening the cam screw and turning the movable cam to the required degree of opening and then re-tightening the screw.

Refer to Catalog Bulletin #206 for gear rack chart and dimensions.

INDUSTRIAL TIMER
A UNIT OF ESTERLINE CORPORATION

INDUSTRIAL TIMER CORPORATION U.S. HIGHWAY 287 PARSIPPANY, N. J. 07054

TIMING SEQUENCE...MC & RC

(Multi-cam Types)

Each cam is individually mounted on the main shaft by means of a heavy duty friction which allows for easy finger adjustment of the timing sequence. The cams also incorporate a drum calibrated from 0% to 100%. Facing each calibrated drum is an index pointer for the cam sequencing.

1. Set first cam at zero on drum using index pointer as a guide.

2. Calculate the percentage of time difference when cam #2, 3, etc. should be operated. For example, if the overall time cycle is 60 seconds, the first cam is set at zero; if the next operation is to be started 15 seconds later, or 25% of the total overall time cycle, the second drum is set at 25%, against its index pointer. If the third operation is 15 seconds later, the third cam will be set at 50%, etc., additional cams are set in a like manner.

The knurled disc at the end of the camshaft should be held to prevent movement of the shaft while setting the sequence of individual cams. It may also be used to rotate the entire shaft for checking out program set-up, prior to timer operation.

CHANGING TIME CYCLE

1. Gear racks are interchanged by removing the gear rack screw. To prevent binding of gears when installing another gear rack, be certain there is a good amount of gear play. NOTE: the number and letter are stamped on the gear rack and should always face the cam shaft.

2. Additional gear rack assemblies for changing overall time cycles are listed in catalog gear rack chart.

ELECTRICAL CHARACTERISTICS

1. Cam Timers rated for 115 volt operation will operate within a range of 100 to 130 volts A.C.

2. 220 volt units will operate within a range of 205 to 240 volts A.C.

3. Switch rating 10 amps.

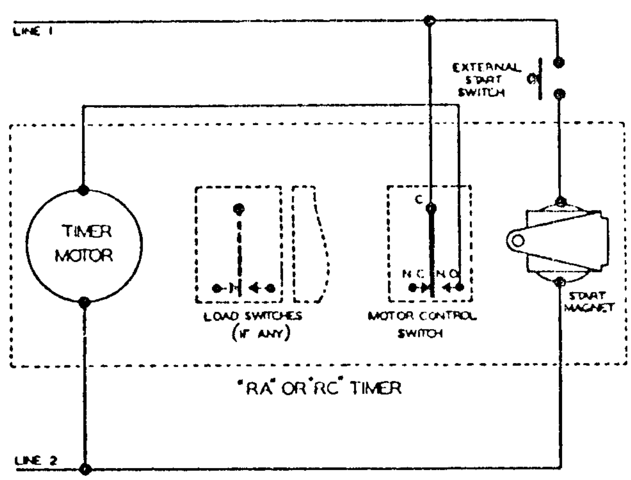
RA AND RC INSTRUCTIONS

For motor control switch and start magnet

Wire motor control switch as shown at right. Start timer by energizing the start magnet which, in turn, mechanically operates the switch.

For single cycle operation, energize the start magnet for a period which is less than the time required for the timer to complete a full cycle.

For continuous recycling the start magnet may be energized for any period of time. When released, the timer will run to the "O" position and stop.



Refer to Catalog Bulletin #206 for gear rack chart and dimensions.

programming cam timers concluded

(38)

☐ gear rack chart

MODEL	RA 0	RA 1	RA 2	RA 3	RA 4	RA 5	RA 6	RA 7	RA 8	RA 9	RA 10	RA 11	RA 12
MODEL	CM 0	CM 1	CM 2	CM 3	CM 4	CM 5	CM 6	CM 7	CM 8	CM 9	CM 10	CM 11	CM 12
MODEL	MC 0	MC 1	MC 2	MC 3	MC 4	MC 5	MC 6	MC 7	MC 8	MC 9	MC 10	MC 11	MC 12
MODEL	RC 0	RC 1	RC 2	RC 3	RC 4	RC 5	RC 6	RC 7	RC 8	RC 9	RC 10	RC 11	RC 12
GEAR RACKS	SEE NOTE 2*												
E-12	40c	4 sec	10 sec	20s	40s	2m	3m20s	10m	20m	40m	2h	3h20m	8h
E-14	46.7c	4.67s	11.67s	23.33s	46.67s	2m20s	3m53s	11m40s	23m20s	46m40s	2h20s	3h53m	9h20m
D-12	48c	4.8s	12s	24s	48s	2m24s	4m	12m	24m	48m	2h24m	4h	9h36m
E-15	50c	5 sec	12.5s	25s	50s	2m30s	4m10s	12m30s	25m	50m	2h30m	4h10m	10h
E-16	53.3c	5.33s	13.33s	26.67s	53.3s	2m40s	4m27s	13m20s	26m40s	53m20s	2h40m	4h27m	10h40m
D-14	56c	5.6s	14s	28s	56s	2m48s	4m40s	14m	28m	56m	2h48m	4h40m	11h12m
C-12	1 sec	6 sec	15s	30s	60s	3m	5m	15m	30m	60m	3h	5h	12h
D-16	64c	6.4s	16s	32s	64s	3m12s	5m20s	16m	32m	64m	3h12m	5h20m	12h48m
E-20	66.7c	6.67s	16.67s	33.33s	66.67s	3m20s	5m33s	16m40s	33m20s	66m40s	3h20m	5h33m	13h20m
C-14	70c	7s	17.5s	35s	70s	3m30s	5m50s	17m30s	35m	70m	3h30m	5h50m	14h
D-18	72c	7.2s	18s	36s	72s	3m36s	6m	18m	36m	72m	3h36m	6h	14h24m
E-22	73.3c	7.33s	18.33s	36.67s	73.33s	3m40s	6m7s	18m20s	36m40s	73m20s	3h40m	6h7m	14h40m
C-15	75c	7.5s	18.75s	37.5s	75s	3m45s	6m15s	18m45s	37m30s	75m	3h45m	6h15m	15h
B-12	80c	8 sec	20s	40s	80s	4m	6m40s	20m	40m	80m	4h	6h40m	16h
E-26	86.7c	8.67s	21.67s	43.33s	86.67s	4m20s	7m13s	21m40s	43m20s	86m40s	4h20m	7h13m	17h20m
D-22	88c	8.8s	22s	44s	88s	4m24s	7m20s	22m	44m	88m	4h24m	7h20m	17h36m
C-18	90c	9 sec	22.5s	45s	90s	4m30s	7m30s	22m30s	45m	90m	4h30m	7h30m	18h
B-14	93.3c	9.33s	23.33s	46.67s	93.33s	4m40s	7m47s	23m20s	46m40s	93m20s	4h40m	7h47m	18h40m
D-24	96c	9.6s	24s	48s	96s	4m48s	8m	24m	48m	96m	4h48m	8h	19h12m
B-15	100c	10 sec	25s	50s	100s	5m	8m20s	25m	50m	100m	5h	8h20m	20h
D-26	104c	10.4s	26s	52s	104s	5m12s	8m40s	26m	52m	104m	5h12m	8h40m	20h48m
B-16	106.7c	10.67s	26.67s	53.33s	106.7s	5m20s	8m54s	26m40s	53m20s	106m40s	5h20m	8h54m	21h20m
C-22	110c	11 sec	27.5s	55s	100s	5m30s	9m10s	27m30s	55m	110m	5h30m	9h10m	22h
D-28	112c	11.2s	28s	56s	112s	5m36s	9m20s	28m	56m	112m	5h36m	9h20m	22h24m
E-34	113.3c	11.33s	28.33s	56.67s	113.3s	5m40s	9m27s	28m20s	56m40s	113m20s	5h40m	9h27m	22h40m
A-12	2 sec	12 sec	30s	60s	2m	6m	10m	30m	60m	2h	6h	10h	24h
D-32	2s8c	12.78s	32s	64s	128s	6m24s	10m40s	32m	64m	2h8m	6h24m	10h40m	25h36m
C-26	2s10c	13 sec	32.5s	65s	130s	6m30s	10m50s	32m30s	65m	2h10m	6h30m	10h50m	26h
B-20	2s12c	13.2s	33.33s	66.67s	133.3s	6m40s	11m7s	33m20s	66m40s	2h13m	6h40m	11h7m	26h40m
D-34	2s16c	13.56s	34s	68s	136s	6m48s	11m20s	34m	68m	2h16m	6h48m	11h20m	27h12m
A-14	2s20c	14 sec	35s	70s	140s	7m	11m40s	35m	70m	2h20m	7h	11h40m	28h
D-36	2s24c	14.4s	36s	72s	144s	7m12s	12m	36m	72m	2h24m	7h12m	12h	28h48m
B-22	2s27c	14.7s	36.67s	73.33s	146.7s	7m20s	12m13s	36m40s	73m20s	2h27m	7h20m	12h13m	29h20m
A-15	2s30c	15 sec	37.5s	75s	150s	7m30s	12m30s	37m30s	75m	2h30m	7h30m	12h30m	30h
A-16	2s40c	16 sec	40s	80s	160s	8m	13m20s	40m	80m	2h40m	8h	13h20m	32h
C-34	2s50c	17 sec	42.5s	85s	170s	8m30s	14m10s	42m30s	85m	2h50m	8h30m	14h10m	34h
B-26	2s52c	17.2s	43.33s	86.67s	173.3s	8m40s	14m27s	43m20s	86m40s	2h53m	8h40m	14h27m	34h40m
A-18	3 sec	18 sec	45s	90s	3m	9m	15m	45m	90m	3h	9h	15h	36h
B-28	3s7c	18.7s	46.67s	93.33s	186.7s	9m20s	15m33s	46m40s	93m20s	3h7m	9h20m	15h33m	37h20m
A-20	3s20c	20 sec	50s	100s	200s	10m	16m40s	50m	100m	3h20m	10h	16h40m	40h
B-32	3s33c	21.3s	53.33s	106.7s	213.4s	10m40s	17m47s	53m20s	106m40s	3h33m	10h40m	17h47m	42h40m
A-22	3s40c	22 sec	55s	110s	220s	11m	18m20s	55m	110m	3h40m	11h	18h20m	44h
B-34	3s47c	22.7s	56.67s	113.3s	226.7s	11m20s	18m53s	56m40s	113m20s	3h47m	11h20m	18h54m	45h20m
A-24	4 sec	24 sec	60s	2m	4m	12m	20m	60m	2h	4h	12h	20h	48h
A-26	4s20c	26 sec	65s	130s	260s	13m	21m40s	65m	2h10m	4h20m	13h	21h40m	52h
A-28	4s40c	28 sec	70s	140s	280s	14m	23m20s	70m	2h20m	4h40m	14h	23h20m	56h
A-30	5 sec	30 sec	75s	150s	5m	15m	25m	75m	2h30m	5h	15h	25h	60h
A-32	5s20c	32 sec	80s	160s	320s	16m	26m40s	80m	2h40m	5h20m	16h	26h40m	64h
A-34	5s40c	34 sec	85s	170s	340s	17m	28m20s	85m	2h50m	5h40m	17h	28h20m	68h
A-36	6 sec	36 sec	90s	3m	6m	18m	30m	90m	3h	6h	18h	30h	72h

c-cycles s-seconds m-minutes h-hours

1. ORDERING INFORMATION--Model number selected from top of gear rack chart, gear rack, number of load switches, voltage and frequency.

ALTERNATE ORDERING INFORMATION—Required time cycle (one complete rotation of cam shaft), number of load switches, voltage and frequency. Since some time cycles are available in 3 model numbers, the use of the ALTERNATIVE ordering information may expedite delivery by allowing us to ship model in stock with required time cycle.

Multi-switch cam timers requiring time cycles in shaded area may require high torque timing motor. This is due to increased torque encountered in rapid time cycles. To determine need of larger motor; multiply required time cycle in seconds by 2/3, the answer will be the maximum number of switches that can be operated with a standard timing motor. EXAMPLE: Time cycle 15 seconds. 2/3 x 15s = 10. 10 switches can be operated at 15 seconds with a standard timing motor, more than 10 load switches requires the use of a high torque timing motor.

Price added for Hi-Torque motors:

Series	Motor Speed	120/60 Hz
MC-0 RC-0	1 RPS	$45.00
MC-1 RC-1	1/6 RPS	45.00

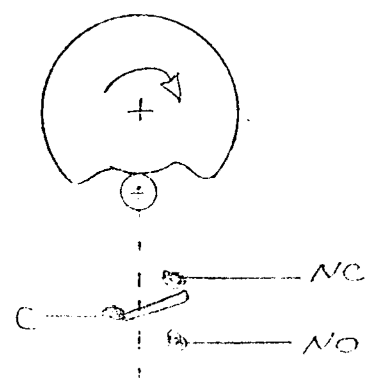
NOTES ON SCANNER CAMS

(REFER TO INDUSTRIAL TIMER OPERATING INSTRUCTIONS FOR PROGRAMMING TYPE RC CAM TIMER.)

- CYCLE TIME DEPENDS ON GEAR RACK

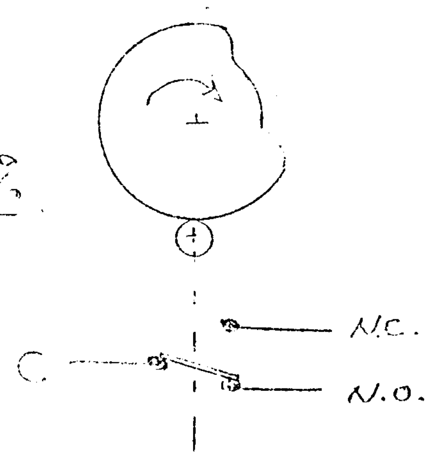
- IF AN ON TIME OF LESS THAN 50% OF THE CYCLE TIME IS DESIRED, USE THE N.C. CONTACT:

ON < 50%



- IF AN ON TIME OF MORE THAN 50% IS DESIRED, USE THE N.O. CONTACT:

ON > 50%



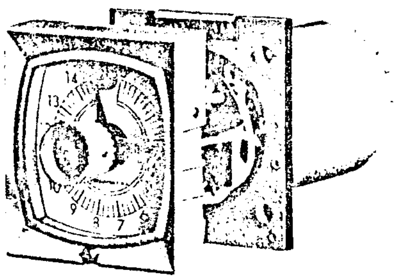
SEE INSTRUCTION SHEET FOR SETTING AND INDEXING CAMS

(40)

time delay timers

motor driven

The following series timers generate the delay function from a synchronous motor. This delay is created by applying power to the timer motor/clutch circuit with a sustained switch closure (sustained is interpreted as simply being longer in length than the desired delay). When the timer receives power it begins a delay period, at the end of which a switch operation occurs. The load switch remains in the operated condition until power is removed from the timer, at which time, the timer automatically resets.



SERIES GP

plug-in interval/delay timer

An automatic reset, synchronous motor driven timing control with two sets of instantaneous contacts and two sets of delayed contacts.

A unique concept in instrument clutching called Spider Clutch* provides repeat accuracy of ± 1/4 of 1% of overall time cycle. Reset is less than 1/2 second for full scale.

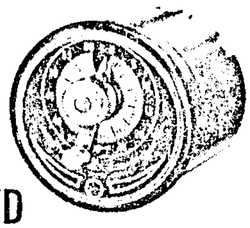
Load switches are rated at 10 amp non-inductive at 125/250 VAC.

Motor voltages 120 or 240 VAC, 50 or 60 Hz.

Model	Minimum Setting	Maximum Setting
GP-6S	1/10 sec.	6 sec.
GP-15S	1/4 sec.	15 sec.
GP-30S	1/2 sec.	30 sec.
GP-60S	1 sec.	60 sec.
GP-3M	3 sec.	3 min.
GP-5M	5 sec.	5 min.
GP-15M	15 sec.	15 min.
GP-30M	30 sec.	30 min.
GP-60M	60 sec.	60 min.
GP-3H	180 sec.	3 hour

*Patent No. 3,378,123
UL Component Recognition

SERIES TD/CTD

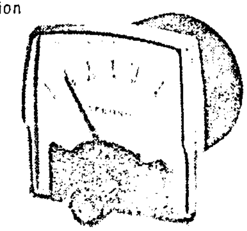


Incased, panel mounted, SPDT snap action contacts rated 10 amp non-inductive at 120 VAC.

Motor voltages 120 or 240 VAC, 50 or 60 Hz.

Model	Minimum Setting	Maximum Setting
TD-6S	1/10 sec.	6 sec.
TD-15S	1/4 sec.	15 sec.
TD-30S	1/2 sec.	30 sec.
†CTD-1M	1 sec.	60 sec.
†CTD-3M	3 sec.	3 min.
†CTD-5M	5 sec.	5 min.

†Clutch external to synchronous motor
UL Component Recognition



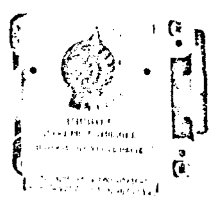
SERIES MTD

Meter face, panel mounted, SPDT snap action contacts rated 10 amp non-inductive at 120 VAC.

Motor voltages 120 or 240 VAC, 50 or 60 Hz.

Model	Minimum Setting	Maximum Setting
MTD-6S	1/10 sec.	6 sec.
MTD 15S	1/4 sec.	15 sec.
MTD-30S	1/2 sec.	30 sec.
†MTD-60S	1 sec.	60 sec.
†MTD-3M	3 sec.	3 min.
†MTD-5M	5 sec.	5 min.
†MTD-15M	15 sec.	15 min.
†MTD-30M	30 sec.	30 min.
†MTD-60M	60 sec.	60 min.
†MTD-3H	3 min.	3 hour

†Clutch external to synchronous motor
UL Component Recognition



SERIES RB

Molded case of Noryl SE-1*, panel or back mounted, SPDT snap action contacts rated 15 amp non-inductive at 120 VAC.

Motor voltages 120 or 240 VAC, 50 or 60 Hz.

Model	Minimum Setting	Maximum Setting
RB-5.6S	.2 sec.	5.5 sec.
RB-14S	.5 sec.	13.5 sec.
RB-28S	1 sec.	27 sec.
RB-56S	2 sec.	54 sec.
RB-84S	3 sec.	82 sec.
RB-168S	6 sec.	164 sec.
RB-4.5M	10 sec.	4 min. 24 sec.

*Trademark GE Co.
UL Component Recognition

SERIES H/CH

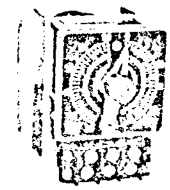
Panel mounted, wiring to terminal strip, SPDT snap action contacts rated 10 amp non-inductive at 120 VAC.

Motor voltages 120 or 240 VAC, 50 or 60 Hz.

Model	Minimum Setting	Maximum Setting
H-6S	1/10 sec.	6 sec.
H-15S	1/4 sec.	15 sec.
H-30S	1/2 sec.	30 sec.
†CH-1M	1 sec.	60 sec.
†CH-3M	3 sec.	3 min.
†CH-5M	5 sec.	5 min.

†Clutch external to synchronous motor
UL Component Recognition

SERIES TDAB (F)



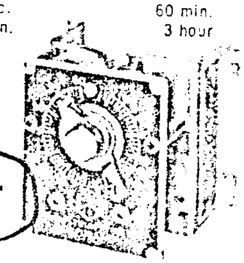
Automatic reset, back mounted. SPDT snap action contacts rated 10 amp non-inductive at 120 VAC. Motor voltage 120 or 240 VAC, 50 or 60 Hz. Optional knockout housing available.

TDAF panel mounted version.

Model	Minimum Setting	Maximum Setting
TDAB-1S	1/60 sec.	1 sec.
TDAB-3S	1/20 sec.	3 sec.
TDAB-6S	1/10 sec.	6 sec.
TDAB-15S	1/4 sec.	15 sec.
TDAB-30S	1/2 sec.	30 sec.
TDAB-60S	1 sec.	60 sec.
TDAB-3M	3 sec.	3 min.
TDAB-5M	5 sec.	5 min.
TDAB 15M	15 sec.	15 min.
TDAB-30M	30 sec.	30 min.
TDAB-60M	60 sec.	60 min.
TDAB-3H	3 min.	3 hour

UL Component Recognition

SERIES SF(CSF)



Automatic reset, back mounted, SPDT snap action contacts rated 10 amp non-inductive at 120 VAC.

Motor voltages 120 or 240 VAC, 50 or 60 Hz.

Model	Minimum Setting	Maximum Setting
SF-6S	1/10 sec.	6 sec.
SF-15S	1/4 sec.	15 sec.
SF-30S	1/2 sec.	30 sec.
†CSF-1M	1 sec.	60 sec.
†CSF-3M	3 sec.	3 min.
†CSF-5M	5 sec.	5 min.

†Clutch external to synchronous motor
UL Component Recognition

SERIES SF & CSF TIME DELAY TIMERS

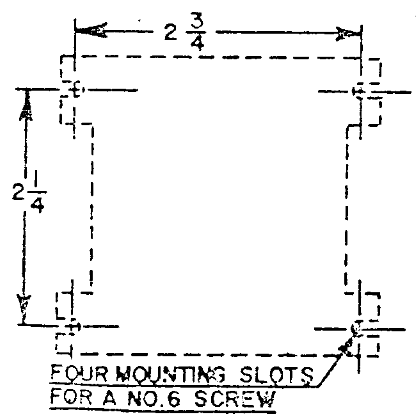


Fig. 1

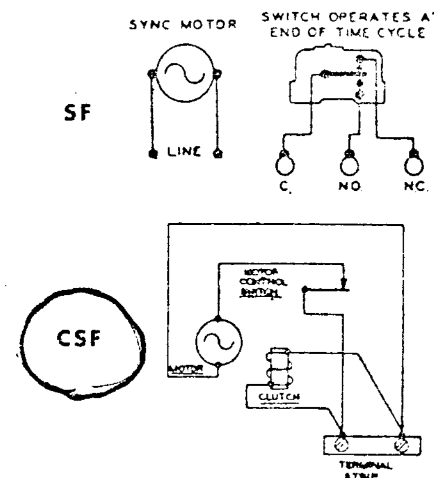


Fig. 2

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RX-1 Data Receiver schematics and instructions under

Stevens Pass Telemetry Unit

(43)

STANDARD POWER SUPPLIES

INSTRUCTION SHEET
SPS/CPS SERIES

FEATURES

- Voltage adjustment potentiometer
- Foldback current limiting
- 115/230 Vac, 47-440 Hz input
- 0.1% line/load regulation
- Temperature compensated circuitry
- 0.1% ripple
- Optional overvoltage protection
- Optional square current limiting
- Optional logic inhibit

DESCRIPTION

The SPS and CPS Series are series regulated, solid state power supplies designed to provide closely regulated DC voltages in all popular voltage and current levels. The output is floating, hence any voltage may be plus or minus or referenced to another voltage.

OPERATING PROCEDURE

For 115 Vac, 47-440Hz connect input leads to terminals 1 and 4 of transformer or input terminal block, terminals 1 & 3 and 2 & 4 will be jumpered. (Factory connection)

For 230 Vac input, remove jumpers between 1 & 3 and 2 & 4. Then jumper terminals 2 and 3 together and connect 230 Vac to terminals 1 and 4. Suggest twisted AC input wires if electrical noise reduction is prime concern.

Output terminals identified in figures on back of this sheet are marked + and -. Load should be connected to these terminals with due care to proper wire size and solid electrical connection for best results. Output voltages may be adjusted with the potentiometers identified in the figures located on the back of this sheet

SUGGESTED TEST PROCEDURE

Connect AC input power as outlined in operating procedure. Place a variac between Vac source and input to transformer. Place an AC voltmeter across transformer input terminals 1 and 4. Set input voltage for nominal 115 Vac with variac.

Place resistive load across output, check Vdc output specifications. DC voltmeter should be connected directly across output terminals. Greatest test errors are made at this point.

LINE REGULATION

With output adjusted to rated voltage, reduce input Vac to 104 volts and record or note output voltage. Then increase input Vac. to 126 Vac and note output voltage. Total output voltage change should not exceed .2% or ± .1%.

LOAD REGULATION

Set AC input voltage to 115 Vac. Place DC voltmeter across output terminals and record or note output voltage. A load resistor, equal to the rated load of the supply at selected DC voltage setting, is then applied to output terminals. The voltage change should be noted. This differential change should not exceed .2% or ± .1% of DC output voltage.

Output current adjust is accomplished by placing a load resistor of the desired value across output terminal; adjust current limit potentiometer identified in figures on back of this sheet until voltage starts to drop. This is the fold back point of current limiting, this control is factory set to 120% of rated output and sealed.

RIPPLE

With voltage set at 115 volts and full load across DC output terminals, the measurable AC voltage on output should not exceed 0.1% RMS.

OVERVOLTAGE PROTECTION

Optional overvoltage protection is available on most models. Consult the catalog selection guide or the listing on the next page for appropriate models or contact the factory for application note.

Loads generating high back EMF voltages should be checked with parallel diode, zener, or series diode to reduce detrimental effects on pass elements. It is recommended that the AC input circuit be fused. A suggested fuse rating is listed on the reverse side of this sheet.

SUGGESTED PRACTICES

Moving air is desireable when mounting in a confined area. Chassis may be attached to other heat dissipating surfaces to improve cooling characteristic at maximum ratings.

STANDARD POWER, INCORPORATED ■ 1400 South Village Way ■ Santa Ana, Calif. 92705 ■ phone (714) 558 8512

SPS / CPS 15 SERIES
SPS / CPS 30 SERIES

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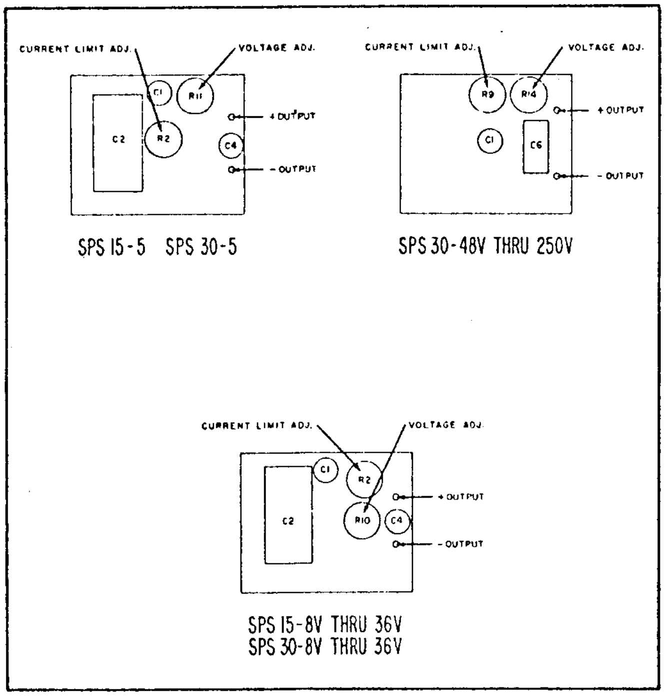
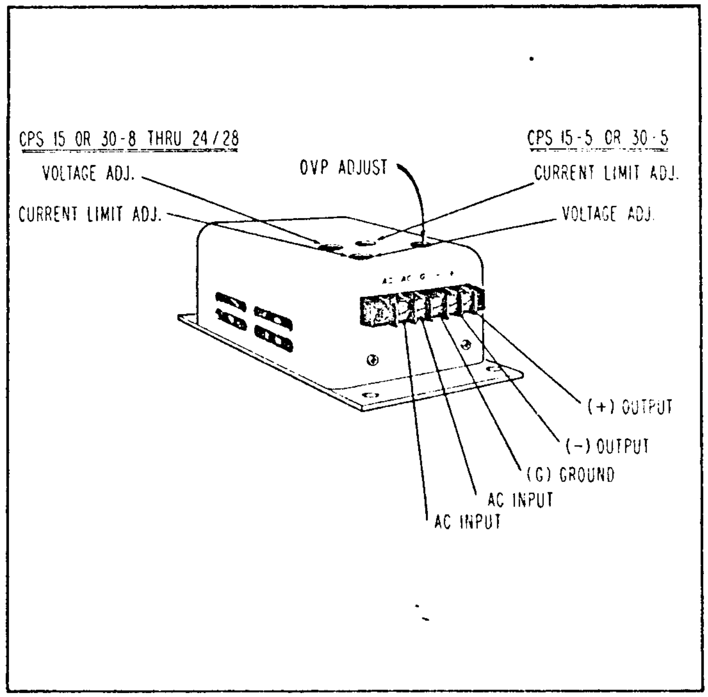
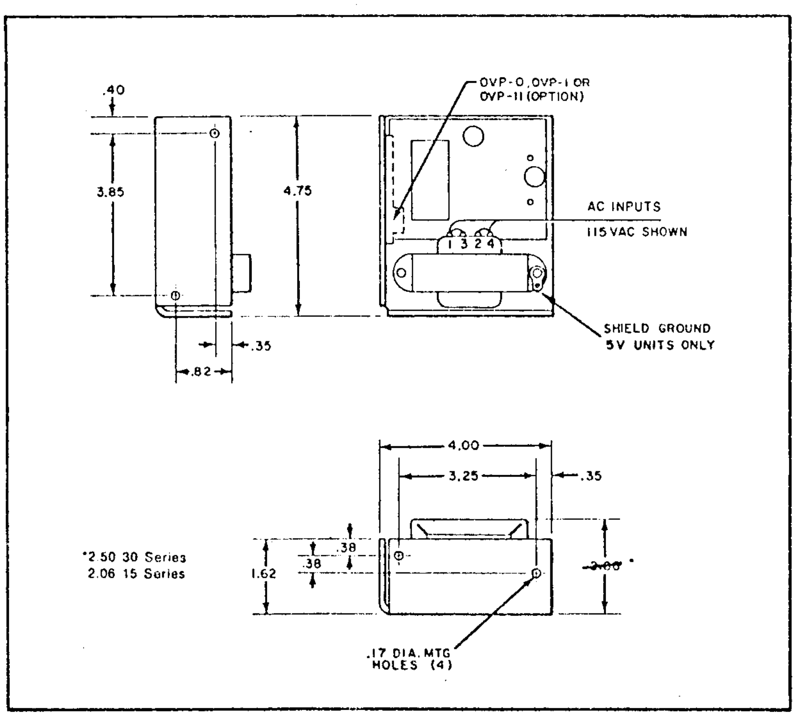
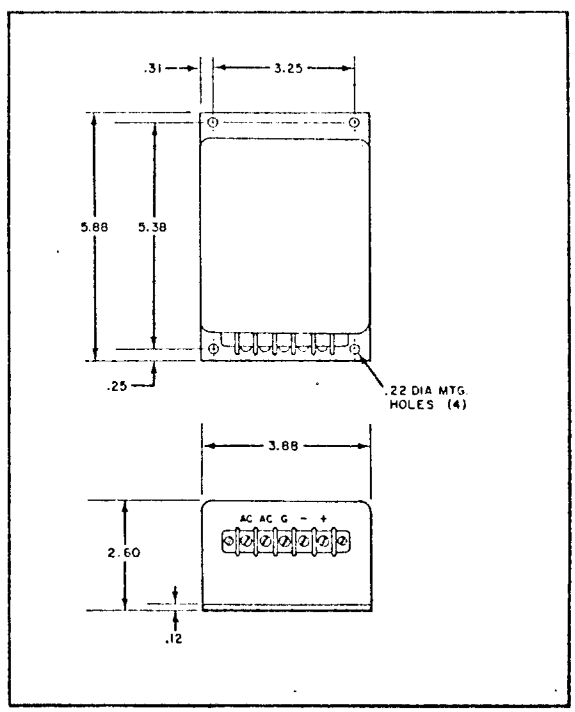
NOTES:

1. Recommended input fuse 1A, Type 3 AG.
2. OVP-1 is compatible with 5V through 28V models.
3. OVP-0 or OVP-11 may be used on 5V models.
4. If problems are encountered in series operation of two power supplies due to a common load connected across the two supplies, contact the factory for application note, AN 101.









Bp: Al Smith Co.

CARITRONICS INC.

Oct 97 (45)

Encapsulated Power Supplies

FEATURES:

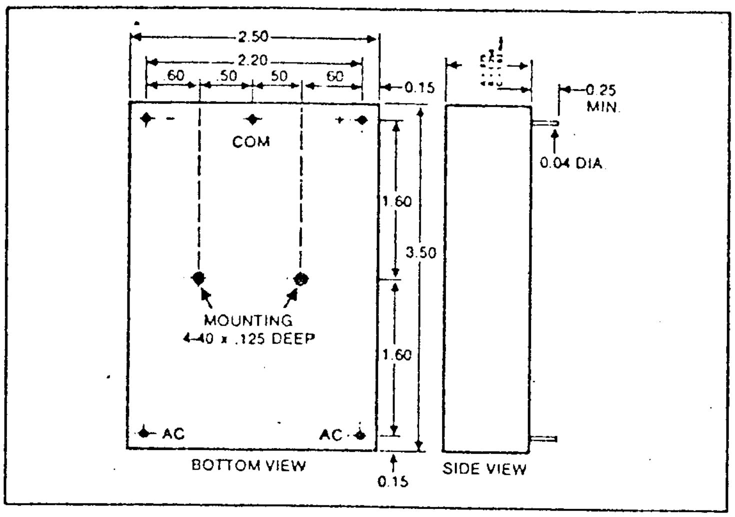
- LOW COST
- RUGGED ENCAPSULATION
- SHORT CIRCUIT PROTECTION

SPECIFICATIONS:

INPUT VOLTAGE: 115 ± 10 vac.
OUTPUT VOLTAGE: See ratings chart.
OUTPUT CURRENT: See ratings chart.
OUTPUT SET: ±2%.
OPERATING TEMPERATURE: −25°C to 71°C
FREQUENCY: 50 to 400 Hz.
TEMPERATURE COEFFICIENT: 0.02% / °C.
INPUT ISOLATION: 50 Megohms.
OUTPUT IMPEDANCE @ 10 KHz: 200 Milliohms.
STORAGE TEMPERATURE: −25°C to 85°C.

RIPPLE: 1.0mV RMS

MODEL SINGLES	OUTPUT VOLTAGE Vdc	OUTPUT CURRENT mA	REGULATION LINE	REGULATION LOAD	CASE SIZE	1-9
S-5-250	5	250	0.05%	0.1%	A	37.00
S-5-500	5	500	0.05%	0.1%	A	43.00
S-5-1000	5	1000	0.05%	0.1%	B	53.00
S-5-2000	5	2000	0.05%	0.1%	C	73.00
DUALS						
D-12-100	±12	±100	0.05%	0.05%	A	43.00
D-15-100	±15	±100	0.05%	0.05%	A	43.00
D-12-200	±12	±200	0.05%	0.05%	B	53.00
D-15-200	±15	±200	0.05%	0.05%	B	53.00
D-12-300	±12	±300	0.05%	0.05%	C	73.00
D-15-300	±15	±300	0.05%	0.05%	C	73.00



Bell System

TECHNICAL REFERENCE

DATA COUPLERS CBS AND CBT FOR AUTOMATIC TERMINALS

MAY 1974

Function Telephone (USOC-CBY) may be provided, at the customer's option, instead of the standard telephone.

The CBY telephone provides aural monitoring of data signals and an indication of whether the ADAA is in the Talk or Data mode.

Arrangements are available for associating a multibutton telephone with six, ten, eighteen, or thirty data couplers. Each telephone line must have its own ADAA, and the ADAAs are not switchable between lines. In these multiline arrangements, the couplers are the primary line termination (see Sections 5.1.1 and 5.1.3) and data calls may be originated and answered without interference from the telephone set. Data coupler activity is indicated by a winking light under the associated telephone pushbutton.

An optional line current status indicator (USOC-CBW) is available for detecting and indicating the presence or absence of telephone line supervisory loop current through the coupler. An optional dc power supply (USOC-CBV) is available to power data coupler CBT.

2. DESCRIPTION OF THE AUTOMATIC DATA ACCESS ARRANGEMENTS

2.1 Physical

A photo of an installation of a single protective Automatic Data Access Arrangement is shown in Figure 1. Shown are the wires that lead to the telephone line, the wires that connect to the customer-provided data modem and automatic call originating or answering equipment (for data signals and control signals), and wires that connect to the telephone set with which an attendant can place calls manually on the telephone line associated with the ADAA.

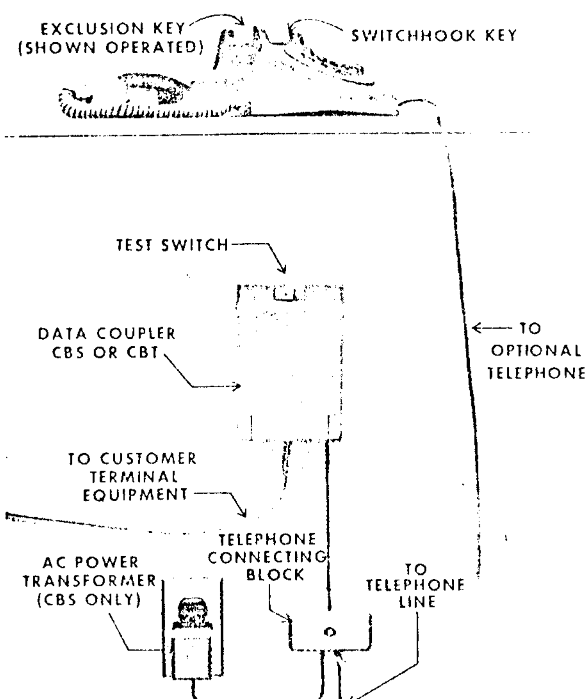


FIGURE 1

Both the CBS and the CBT of current manufacture use the same physical housing, which is 5 inches wide, 7 inches high, and 1-3/4 inches deep. CBS and CBT units of earlier manufacture use a housing which measures 9 inches wide, 11 inches high, and 2-1/4 inches deep. These housings are shown in Figure 2. The ADAAs weigh about 1-3/4 pounds (2-1/2 pounds for couplers of earlier manufacture) and are designed to operate over an ambient temperature range from 0° to 120°F, with relative humidity up to 95 percent. The ADAA must be mounted vertically in a fixed orientation, due to the use of a long-life mercury wetted dial pulse relay. Customer interface connections (see Figures 3A and 3B) are made to No. 4 screw terminals which are located under a protective "flip-up" cover on the bottom of the couplers.

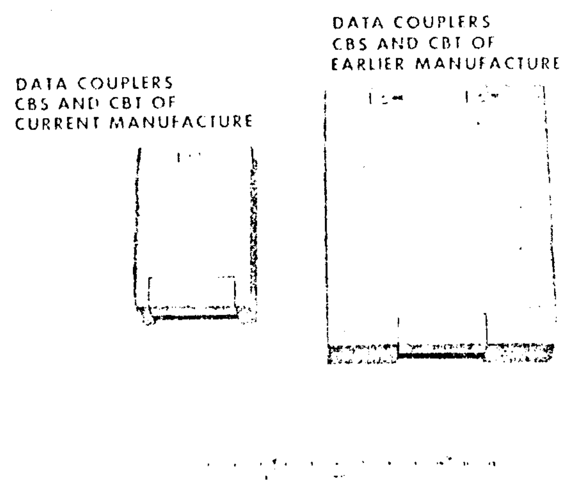


FIGURE 2

A switch, located in a recessed area near the top of the data couplers of current manufacture, permits remote testing from a Telephone Company test center. Couplers of earlier manufacture have two switches in the recessed area for this function. Operation of these switches is described in Section 5.3.

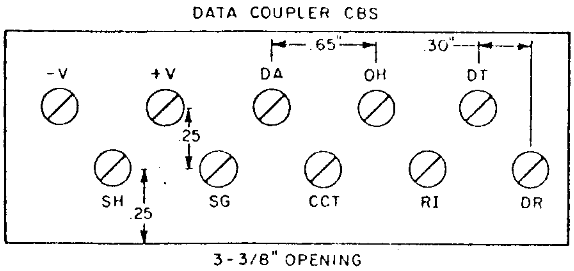
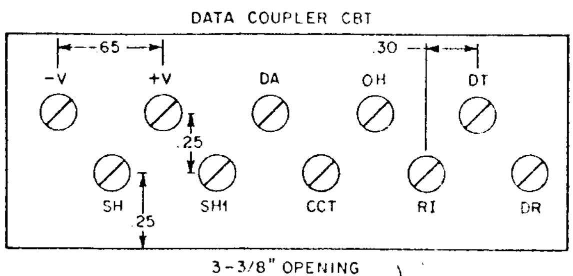


FIGURE 3A



INTERFACE SCREW TERMINAL ARRANGEMENTS

FIGURE 3B

A typical multiple-mounting arrangement for ADAAs is shown in Figure 4. Up to 54 small ADAAs or up to 16 large ADAAs can be housed in the cabinet, which measures 30 inches high, 24 inches wide, and 17 inches deep. Smaller cabinets are also available. One customer-provided ac electrical outlet is required per cabinet.

CABINET FOR MULTIPLE ADAA INSTALLATION

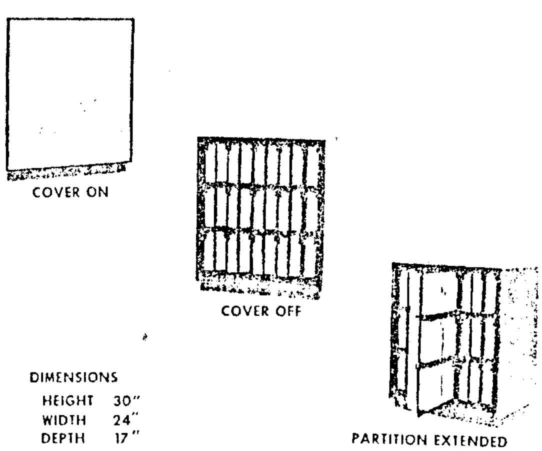


FIGURE 4

2.2 Functions

2.2.1 Data Couplers (CBS and CBT)

The major functions of data couplers CBS and CBT are:

a. To provide a transmission path for customer-provided data modems to the telecommunications network.

b. To protect Telephone Company personnel and equipment from any accidentally applied hazardous voltages from customer-provided data modems.

c. To protect telephone lines from longitudinal imbalance.

d. To limit data modem signal power to a specified value (if the customer's signal power is too high) in order to prevent interference with other telephone services.

e. To provide the following network control signaling functions:

   1. To provide a loop holding path for dc supervision.
   2. To detect ringing and to alert the customer's terminal on an incoming call.
   3. To originate on-hook and off-hook signals and to generate dial pulsing in response to signals received from the customer via the interface control leads.
   4. To provide a delay of from one to three seconds after an incoming call is answered, in order to prevent data signals from interfering with automatic message accounting equipment.

f. To provide for remote testing of the data coupler.

g. To provide an indication of the status of the switchhook of the associated telephone.

2.2.2 Standard Telephone (CBS and CBT)

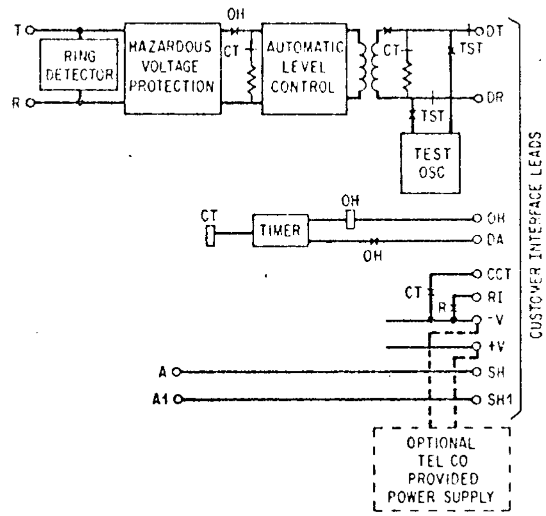
A telephone with exclusion key and with either a rotary dial or a Touch-Tone dial is normally associated with the CBS and CBT ADAAs. If desired, the telephone set may be omitted and should be so specified by the customer when an

Specification RS-232-B (couplers of both earlier and current manufacture) and RS-232-C (couplers of current manufacture only). The essential differences of these two specifications as they relate to data couplers are as follows: RS-232-C requires that the interface driver output voltage traverse the transition voltage region between ON and OFF or between OFF and ON without any voltage reversals and without reentering the transition region until the next significant change in signal condition. The time required to traverse the transition region is between 200 nanoseconds and one millisecond for RS-232-C. RS-232-B has no such transition region requirements for control-type interface leads.

All control leads are referenced to signal ground (SG) with positive EIA voltages indicating an ON state and negative EIA voltages indicating an OFF state. The OH and DA control lead terminators have a nominal 3-kilohm resistance to signal ground in the ON and OFF states. The CCT, RI, and SH control lead drivers are capable of providing a nominal 5-volt output when loaded by a 3-kilohm resistance to signal ground.

3.2 Contact Interface Circuits — Coupler CBT (See Figure 5B)

Coupler CBT accepts contact closures between the OH and the DA interface control leads and the -V interface lead. The coupler presents contact closures to the customer's equipment between the CCT, RI, and -V interface leads. A closed contact to -V indicates an ON state, and an open contact to -V indicates an OFF state. The SH lead is referenced to SH1. Contact restrictions are covered in Section 4.3.2.



NOTE
IF POWER IS SUPPLIED BY TELCO, CUSTOMER USES -V FOR COMMON BUT MUST NOT CONNECT TO +V

BLOCK DIAGRAM OF DATA COUPLER CBT
FIGURE 5B

Through the customer's contact closures, the OH lead will draw less than ten milliamperes dc, and the DA lead will draw less than 35 milliamperes dc. The contact closure resistance, including the resistance of any wiring between the coupler and the customer terminal, must be less than 100 ohms for the OH lead and less than 50 ohms for the DA lead. The impedance when open (OFF) should be more than 100,000 ohms, referenced to the common return lead (-V).

Momentary contact bounce associated with relays in the data coupler and the CCT and RI interface leads may be observed. This is most likely to occur during the first five milliseconds of closure and should be ignored.

TABLE I

LEAD DESIGNATION		DIRECTION	FUNCTION
Voltage	Contact		
(CBS)	(CBT)		
DT DR	DT DR	Both	600-ohm transmission leads for data signals.
OH	OH	To coupler	To control OFF-HOOK relay.
DA	DA	To coupler	To request data transmission path cut-through.
CCT	CCT	To customer	Coupler transmission path cut-through indication.
RI	RI	To customer	Ringing signal present indication.
SH*		To customer	Status of telephone set switchhook in coupler CBS.
SG	†	Both	Signal ground in coupler CBS.
	SH*	To customer	Status of telephone set switchhook in coupler CBT.
	SH1*	To customer	Return for SH lead in coupler CBT.
+V‡	+V	To coupler	Positive dc power.
-V‡	-V	To coupler	Negative dc power.

*Designations will change to MI and MI1 if customer implements multiple-function telephone (CBY) and/or Line Current Status Indicator (CBW).

† Not used in coupler CBT.

‡Not used in coupler CBS of earlier manufacture.
See Section 2.3.1 for coupler CBS of current manufacture and Section 2.3.2 for coupler CBT.

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3.3 Detailed Description of Interface Circuits (Table I)

DT and DR (Data Tip and Data Ring) are used to provide an analog data signal transmission path between the customer's modem and the telephone line. Transformer coupling to the telephone line in ADAAs provides an isolated termination to the customer-provided modem on the transmission leads DT and DR.

OH (Off-Hook) provides control of off-hook and on-hook supervisory signals to the telephone line and associated central office equipment. Applying an ON signal (off-hook) to this lead operates a relay which completes a dc path to the serving central office and causes loop current to flow. When originating a call, an ON signal applied to the OH lead is used to request dial tone. Pulses on the OH lead may then be used to generate dial pulses (see Section 6.1). On incoming calls, an ON signal applied to the OH interface lead answers the call and trips ringing. The OH circuit both operates and releases in about two milliseconds.

DA (Data Transmission) is used to request that the data transmission path through the coupler be cut through to the telephone channel. DA must be OFF during dial pulsing but ON for tone address signaling. It may be ON at all other times. DA operates only if OH is ON.

CCT (Coupler Cut-Through) indicates to the customer, by an ON signal, that the transmission path is connected through the coupler to the telephone line. The ON condition indicates the state of the coupler and should not be interpreted as an indication of the status of the associated telephone line or connection.

Coupler CBS: In the Originate mode the CCT interface lead changes state within three milliseconds after the state of the DA input has been changed. The actual time to cut through the transmission path is between ten and 20 milliseconds, and the release time is between 15 and 30 milliseconds. In the Answer mode, the operate time is extended to include the accounting time interval of one to three seconds. The CCT lead output voltage, on CBS couplers of earlier manufacture, may exhibit a voltage reversal within the first ten milliseconds when switching from OFF to ON. This reversal is typically four volts and can occur at any time during the rise of the interface lead voltage. Voltage reversals do not occur in couplers of current manufacture.

Coupler CBT: In the Originate and Answer modes, the operate time of the CCT interface lead and the time to actual cut-through of the transmisssion path are both equal to the accounting time interval (one to three seconds). In the Answer mode, the release time of the CCT circuit is about 20 milliseconds.

RI (Ring Indicator) indicates to the customer by ON signals that the coupler is being rung. In coupler CBT, the RI contact operates at a 40 Hz rate during the two seconds that ringing is on the line. These closures should be integrated by the customer's data terminal for at least 100 milliseconds (two cycles, or more) before reacting to the ringing signal. This integration will help protect against false ring detection on transients such as may occur during dial pulsing or when switching transients or impulse noise occurs on the loop.

In coupler CBS, the RI indications are the result of rectifying and integrating the 20 Hz ringing signals received from the line. The ringing indication consists of regular transitions which follow the ringing cycle (normally two seconds on and four seconds off) and will not normally be actuated by transients associated with dialing or switching.

SG (Signal Ground) in coupler CBS is the common reference for all interface control signals. SG is not provided in coupler CBT.

SH (Switchhook) indicates to the customer the state of the indicator contacts connected to the coupler telephone interface leads A and A1 (see Section 5.6). An ON state (with SH1 as the return lead for coupler CBT) indicates a contact closure between A and A1.

In coupler CBS, the voltage appearing on the SH lead is a direct indication of the contact closure of whichever indicator is connected to the coupler — eg, the switchhook contact — and is subject to any transition irregularities that might be produced by the indicator. The rise or fall time of the SH lead is about two milliseconds for couplers of earlier manufacture and about six microseconds for couplers of current manufacture.

a contact closure or an EIA ON voltage to indicate that the line is connected to the telephone.

There are several alternate arrangements. The first is to use a series combination of the exclusion key break contact and the switchhook make contact to indicate the Voice mode. The Voice mode indicates that the telephone line is connected to the telephone and that the handset has been lifted off-hook for normal voice communication. A second alternate arrangement is to use the exclusion key make contact as a Data Coupler mode indication. Namely, when the exclusion key is operated, the customer is given either a contact closure or an EIA ON voltage to indicate that the line has been transferred to the data coupler. A third alternate arrangement is to use the switchhook make contact as a switchhook mode indication.

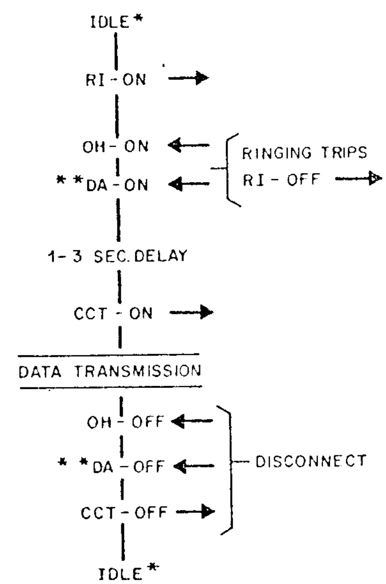
5.2 Data Coupler Operating Procedures

Data couplers CBS and CBT are designed to work with data terminal equipments (which can automatically control the origination, answering, and termination of data calls). Automatic operation is described in Sections 5.2.1 through 5.2.5 wherein the assumption is made that the data coupler is connected to the telephone line. This assumption implies that if a telephone set is included as part of the ADAA, then the exclusion key is positioned so that the telephone line is connected to the ADAA. Manual operation is described in Section 5.2.6, wherein it is assumed that the exclusion key is positioned for the telephone line to be connected to the associated telephone.

5.2.1 Automatic Answer

In the Automatic Answer mode (see Figure 9), the customer's data terminal provides the logic necessary to answer a call. The coupler detects the incoming ringing signal and indicates this to the terminal on the Ring Indicator (RI) interface lead. To answer the call and to trip ringing, the customer's terminal turns ON the coupler off-hook (OH) lead. If not already turned ON, the customer's terminal must then turn ON the Data mode (DA) lead. After a 1- to 3-second interval to allow for proper registration of the call by automatic message accounting equipment at the central office, the transmission path (DT and DR) is cut through, the CCT interface lead turns ON, and data transmission may begin.

ANSWERING SEQUENCE FOR DATA COUPLERS CBS AND CBT



→ TO CUSTOMER
← TO TELCO
* IDLE ALL CONTROL LEADS "OFF" (NEG. OR OPEN)
** IF DESIRED, DA MAY BE PERMANENTLY "ON" FOR AUTO. ANSWER

FIGURE 9

5.2.2 Dial Pulse Origination

To originate a call automatically (see Figure 10), the customer's data terminal must supply the logic to request service (go off-hook), detect dial tone (see Reference a), and generate the dial pulses corresponding to the number of the called station. From the idle condition with all control leads OFF, the terminal must first turn ON the OH lead and the DA lead (DA may be left ON from the previous call) and then wait for the CCT lead to turn ON. In the contact interface coupler CBT, there will be a 1- to 3-second delay between OH plus DA going ON and CCT coming ON. In the voltage interface coupler CBS, CCT will turn ON in less than three milliseconds. When dial tone is detected, the DA lead must be turned OFF, and after CCT goes OFF, the OH lead may be pulsed with the desired called number (see Section 6.1). At the end of dialing, DA is turned ON and when CCT comes ON (with the same delays as given above), the originating station can monitor for a response from the called station to initiate data transmission.

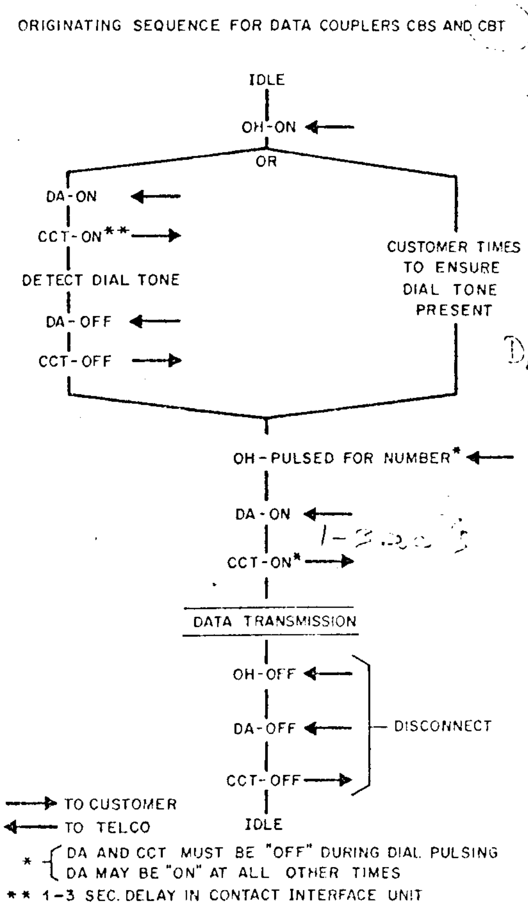


FIGURE 10

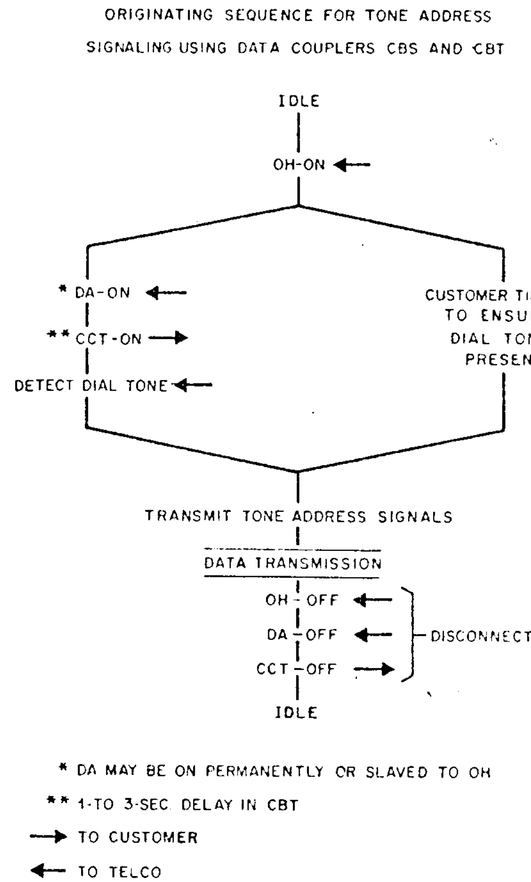


FIGURE 11

5.2.3 Origination With Customer-Provided Tone Address Signaling

For installations where the customer has ordered Touch-Tone calling service in order to originate a call address signals using customer generated tone differ from those prescribed for dial pulsing. Tone address origination (see Section 6.2) is diagrammed in Figure 11.

The customer's terminal requests service by turning ON the OH lead. The DA lead, if not ON previously, must be turned ON. (If all addressing is to be done by tone signals, DA may be strapped ON permanently or slaved to the OH lead signals, providing that the EIA voltage specifications or contact current requirements are met.) When CCT comes ON and dial tone is detected, the network may be addressed, subject to the tone address signaling requirements given in Section 6.2. Monitoring for call progress indications (dial tone, busy reorder, answer tone, and call intercept) is the customer's responsibility.

5.2.4 Call Progress Tones

A brief description of the call progress signals mentioned above is given here for general information about the telecommunications network. The frequency content of dial tone has not been standardized throughout the network; however, precise dial tone is available in all offices equipped for Touch-Tone calling. This precise dial tone is a pair of equal-level tones at 350 and 440 Hz and is suitable for machine recognition.

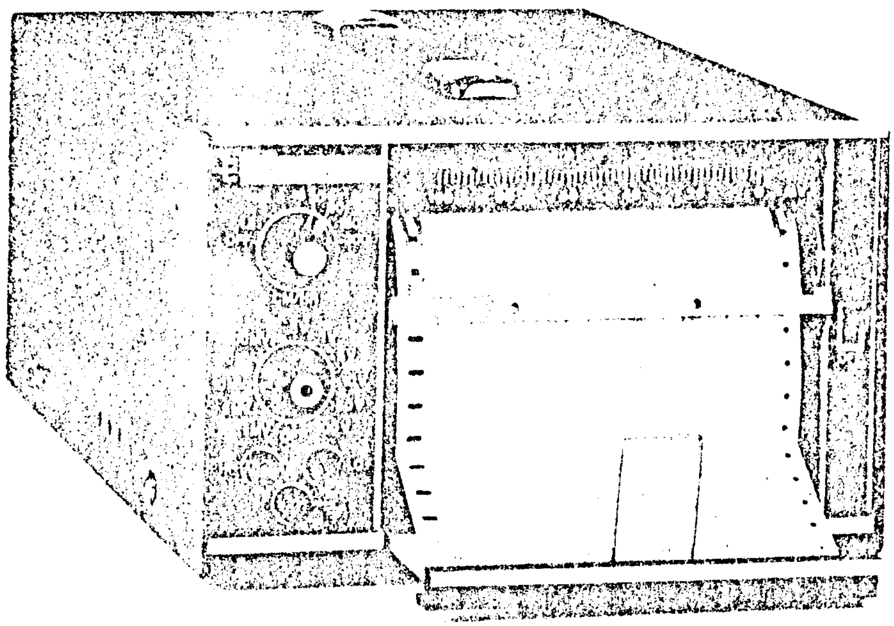
Busy or reorder tones are call progress tones which indicate either station busy or trunk equipment busy. Reorder tone is a fast (120

INSTRUCTION MANUAL

FOR MODEL MS401BB

MINISERVO

STRIP-CHART RECORDER



ESTERLINE ANGUS

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MS723-BB XM0175

ADDENDUM
Changing Manual No. MS723-BB to No. MS723-1BB.

This supplemental addendum describes the latest design changes now in production to improve the quality or extend the usefulness of the Model MS401BB Miniservo recorder. The following instruction changes will supersede information found in this manual:

(I) General:

a. The major difference of the recorder described in the standard instructions and the one now supplied is in the chart drive system. A new stepper-motor drive is now incorporated which has increased chart speeds four times the speeds originally offered (see II below).

b. To prevent breakage during recorder scaleplate removal, grasp scaleplate at both ends, carefully swing bottom of scaleplate upward, and lift out of instrument with both hands.

c. Parts for the new stepper chart drive as well as miscellaneous part changes are listed in the tables of VI and VII below.

(II) Technical Specifications:

Make the following changes in Table 1-1 under CHART DRIVE SYSTEM --

Feed Rates ------------------------ 6, 12, 24 cm/hr; 1, 2, 4, 10, 20 cm/min.

Stepper Motor ----------------------------12 VDC (4 4/9 RPM, 40 Hz maximum).

(III) Theory of Operation:

The following changes should be made under paragraph 1.3.5 --

Change basic timing frequency from "200 Hz" to "600 Hz."

Change references to 20, 2 and 0.2 Hz to 60, 6 and .6 Hz respectively.

Change Table 1-2 as shown below:

TABLE 1-2. TIMING RELATIONSHIPS

CHART SPEED	DIVISION RATIO	INPUT TO Z6
20 cm/min.	1:1	60 Hz (16.67 ms)
10 cm/min.	1:2	30 Hz (33.33 ms)
4 cm/min.	1:5	12 Hz (83.33 ms)
2 cm/min.	1:10	6 Hz (166.67 ms)
1 cm/min.	1:20	3 Hz (333.33 ms)
24 cm/hr.	1:50	1.2 Hz (.8333 s)
12 cm/hr.	1:100	.6 Hz (1.667 s)
6 cm/hr.	1:200	.3 Hz (3.333 s)

Change maximum stepping times per second from 20 to 40.

(IV) Calibration:

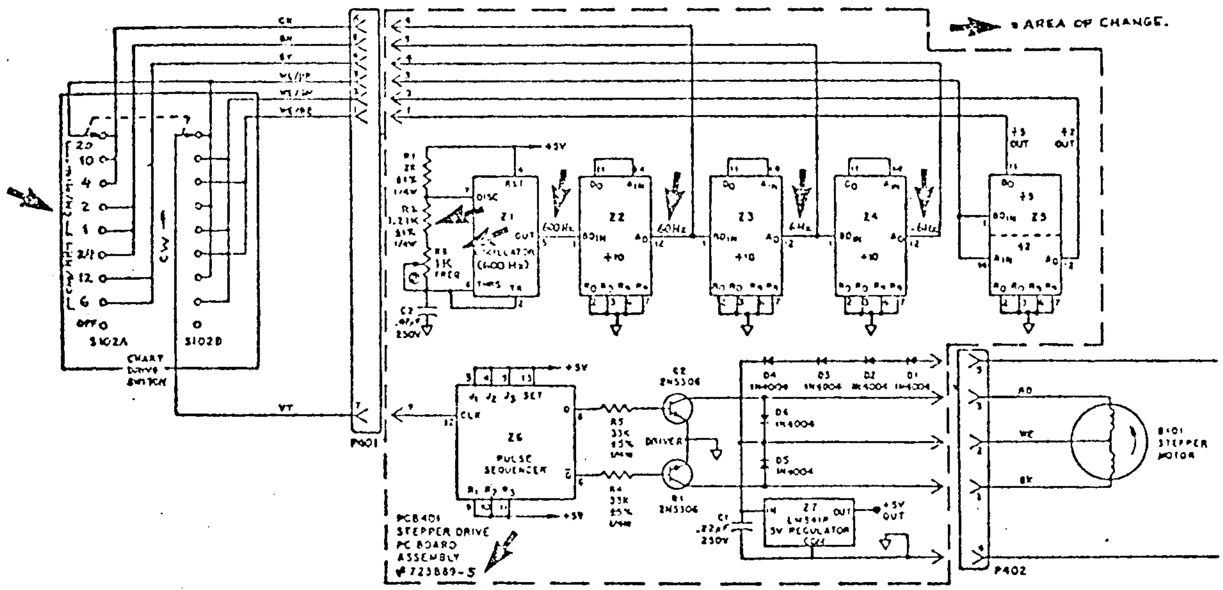
The "STEPPER FREQUENCY ADJUST" procedures (¶4.4.4) should be changed as follows --

In step (2), change "300 cm/hr." to "20 cm/min.."

In step (5), change references of "20 Hz" to "60 Hz", and "50 ms" to "16.667 ms."

(V) Schematic Diagram:

The stepper drive schematic in Figure 4-2 changes as follows --



(VI) Table 5-1. Replacement Parts List Changes:

Fig. 5-1 Item No.	Part No.	Description	Qt.
–	723D22-1	MS401BB Recorder W/Integral Battery (Complete)	1
13	723A134	. Trim, Front (Right)	1
15	723A133	. Trim, Front (Left)	1
New	723B100-2	. Strip, Trim (Alum. Finishing Strip)	3
22	723D4-7	. Chassis Assy. (Table 5-2)	1
24 ∇	ND40213-22	. Screw (#4-40 x 1/2")	1
32	723B103	. Escutcheon, Left	1
36	43302-9	. Screw (1/4" Type B)	4
CR102	723A146	. Diode, Dual-Zener (2SZ7.4, ±1%)	1

∇ Quantity change only.

(VII) Table 5-2. Replacement Parts List Changes:

Fig. 5-2 Item No.	Part No.	Description	Qt.
–	723D4-7	Chassis Assy., 12 V, W/Stepper Drive (Complete)	1
3	723B25	. Top Mounting Plate Assy.	1
▲	ND40213-19	. Screw (#4-40 x 1/4")	1
B101	723A128-1	. Stepper Motor Assy. W/Connector (Complete)	1
New	723A3	. Pulley, Motor	1
PCB401	723B89-5	. Stepper Drive PC Board Assy. (Complete)	1

▲ Replaces Item 33 in Figure 5-2, View B-B.

(57)

CONTENTS

FOR A COMPLETE TECHNICAL DESCRIPTION OF YOUR SPECIFIC INSTRUMENT, SEE THE DATA SHEET WHICH IS SUPPLIED IN A SEPARATE ENVELOPE AT THE BACK OF THIS MANUAL. SPECIAL DRAWINGS AND SUPPLEMENTARY INSTRUCTIONS THAT MAY BE REQUIRED WILL BE LISTED ON THE DATA SHEET AND WILL BE FOUND IN THE APPENDIX OF THIS MANUAL.

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SECTION 1—INSTRUMENT DESCRIPTION

1.1 INTRODUCTION

a. The Esterline Angus Model MS401BB Miniservo is a compact, portable bench-top, strip-chart recorder with self-contained battery supply. These adaptable instruments may also be powered by external AC or DC sources, thereby making them well suited for all laboratory, industrial, and mobile field applications. Operating on a null-balance potentiometeric principle, they offer the sensitivity, response, and reliability of much more sophisticated servo recorders. The writing system features a single disposable ink cartridge that snaps easily into position at the front of the instrument.

b. Eleven switch-selectable recording spans are provided, ranging from 1 mV to 100 V full scale. An eight-speed stepper chart drive permits the selection of chart speeds from 1.5 to 300 cm/hr., and the Z-fold strip chart has a full 10 cm calibrated span.

c. The unit may be powered by one of three different sources: (1) from the internal battery; (2) from the AC line by means of the battery charger/AC adapter; or (3) from an external DC supply connected to the battery charger jack. Note that the battery charger CANNOT be used to power the recorder and charge the internal battery simultaneously. Physical dimensions for the recorder and its external plug-in battery charger are given in Figure 1-1.

1.2 SPECIFICATIONS

All electrical and mechanical characteristics of the standard Model MS401BB Miniservo recorder are listed in Table 1-1.

> NOTE: Refer to supplemental instructions if special options or customized modifications are supplied.

1.3 THEORY OF OPERATION

All principal electronic circuits of the Model MS401BB Miniservo recorder are constructed on modular printed-circuit boards. The complete measuring system is illustrated in the simplified block diagram of Figure 1-2. Analog signals to be recorded are first applied to span switch S101A. This switch section then routes the signals to switch section S101B; either directly (for spans of 1V or less), or through a voltage divider consisting of resistors R101 and R102 (for spans of 5V or more). From switch section S101B, analog signals are applied to an input filter/limiter network on preamp board PCB201. This network rejects stray interference and includes a pair of zener diodes (CR203 and CR204) for input overload protection. To eliminate long input leads, PCB201 is physically positioned directly behind the front-panel span switch.

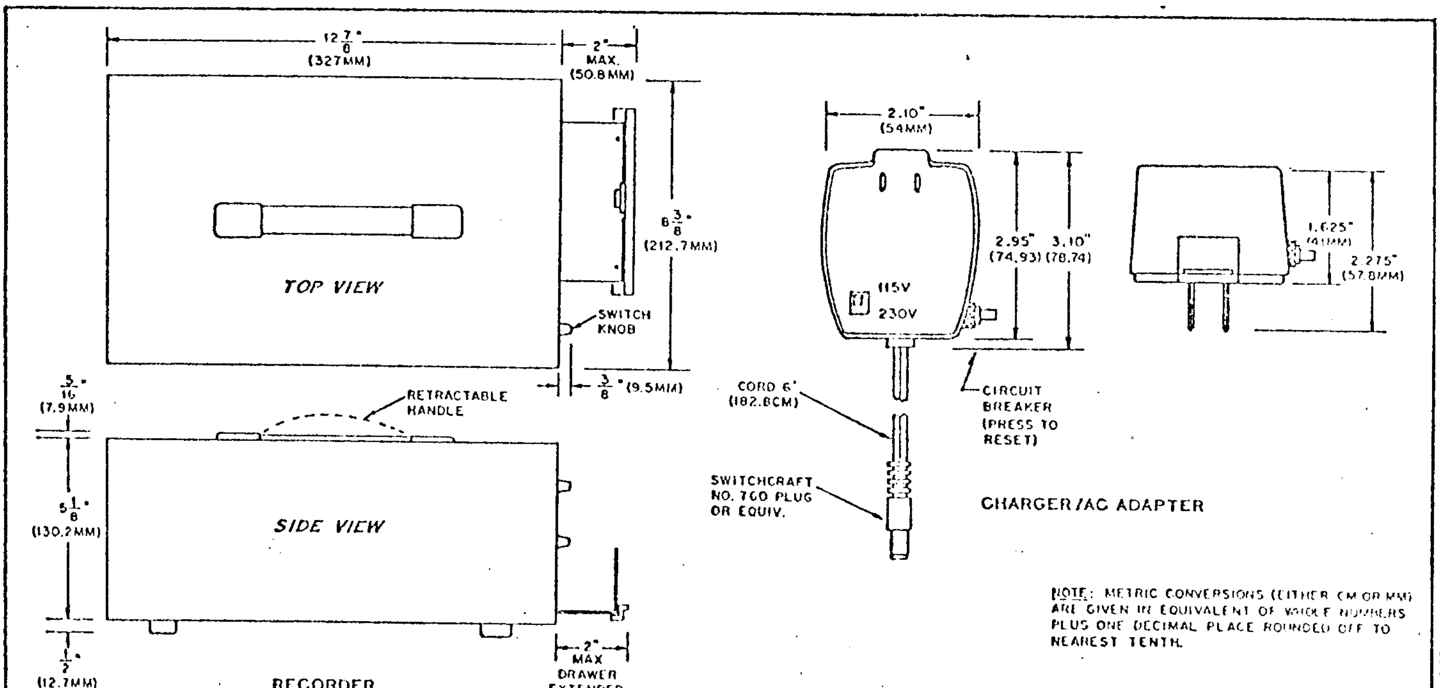


Figure 1-1. Instrument Dimensional Diagram.

TABLE 1-1. TECHNICAL SPECIFICATIONS

INSTRUMENT TYPE	Portable, single-channel, strip-chart recorder.
RECORDING SYSTEM	Servo-actuated inking pen on chart paper.
Method of Writing	Cable-driven disposable cartridge with self-contained stylus and ink supply.
Charts	Z-fold, rectilinear, with 10 cm active span width; 20 m long with 5 cm folds; right-hand zero and metric calibration.
Step Response Time	1.0 second full scale.
Pen Lifter	Manual front-panel lever provided.
MEASURING SYSTEM	Null-balance DC servo with potentiometric input.
Amplifier	All solid-state design with IC preamp eliminating troublesome chopper; ±100 VDC overload without damage.
Source Impedance	10 KΩ (maximum).
Input Sensitivity	11 selectable spans: 1, 5, 10, 50, 100 and 500 mV; 1, 5, 10, 50 and 100 V.▲
Input Impedance	Potentiometric to 1 V; 1 megohm above 1 V. Front panel input jacks provided.
Common Mode Potential	±150 VDC (maximum).
DC Mode Rejection	120 dB down @ 100 VDC (maximim).
Accuracy	1.0 % of span, with maximum offset drift of 2.0 μV/°C.
Ambient Temperature Range	0 to 50 °C.
Amplifier Controls	Front panel: multi-span selector switch includes "OFF" position, and electrical zero adjustable over ±100 % of span.▲ Side panel: Span calib. and gain with approx. ±10 % span adjust.
Feedback Potentiometer	Conductive plastic with minimum life of 10^7 (up- and down-scale) cycles.
Servo Motor	Permanent-magnet, DC rotary type.
CHART DRIVE SYSTEM	Electronic controlled, multi-speed stepper drive.
Feed Rates	1.5, 3, 6, 15, 30, 60, 150 and 300 cm/hr.
Rate Accuracy	Within 1.0 % @ 23 °C (±10 °C); and within 2.0 % from 0 to 50 °C.
Speed Control	Front panel switch provides 8 feed-rate selections and drive "OFF" position.
Stepper Motor	12 VDC (1 RPM, 10 Hz maximum).
Transport Features	Front loading, dual-ended sprocket drive, slide-out chart accumulator, thumbwheel advance, and chart tear-off bar.

TABLE 1-1. TECHNICAL SPECIFICATIONS (CONT'D)

POWER REQUIREMENTS (selectable)	Self-contained or external 12 V battery @ 6 VA; 115/230 V, 50/60 Hz @ approx. 12 VA*.
Internal DC Source	12 V, 4.5 Ah, rechargeable gelled lead-acid battery. 8-hour operation with full charge.* Battery check feature provided.
External AC Source	AC-to-DC adapter (charger) supplied for operation from 50- or 60-Hz power line. Adapter plugs into wall receptacle and its cord attaches to rear-panel jack.
External DC Source	Requires 12 VDC supply. Current drain is approx. 0.5 A*. Source connects to rear-panel jack.
Mode Selector	3-position slide switch on rear panel selects power source or charging function for internal battery.
Battery Charger	Charger (AC adapter) supplied for recharging internal battery with approx. 12 VDC @ 500 mA. Charger plugs into AC wall receptacle and its cord attaches to rear-panel jack. Power switch and reset provided.†
INSTRUMENT SIZE	See dimensions in Figure 1-1.
INSTRUMENT WEIGHT	Approx. 12.5 lbs. (5.6 kg) with battery.

▲ Signal input must not exceed ±100 V (regardless of offset adjustment).
* Without overload (instrument stalled off scale in either direction).
† Instrument is inoperative during charge period. Maximum charge time 24 hours.

1.3.1 PREAMP

a. After the signal leaves the input network, it is next amplified by preamp IC202--an integrated-circuit opamp. Gain of this stage is regulated by a closed feedback loop, consisting of resistor R206 and voltage divider resistors R103 - R109. Span switch section S101C is used to select a precision feedback network for each of the eleven spans provided. Offset potentiometer R209 is adjusted for optimum offset drift over normal operating temperature limits of IC202.

b. From the output of IC202, the amplified signal Es is fed through the battery-check switch to a voltage-summing network. This network is located on PCB101--a servo amp board mounted within the inner-chassis assembly. In addition to E_s, the summing network also receives two other voltages--gain regulating voltage e_g from a feedback circuit in the servo amplifier loop, and zeroing voltage E_z that is established by zero-adjust R110 and its accompanying regulator IC201. This system provides a zero adjustment over ±100% of the chart span. E_z, like E_s, is fed to the summing network through the battery-check switch.

c. At the output of the summing network, zeroing voltage E_z and gain-regulating voltage e_g are combined with the amplified analog signal E_s to form a conditioned signal voltage e_c. This resultant signal is then applied to the first stage of the basic servo-measuring loop.

1.3.2 SERVO AMP

a. Signal voltage e_c from the summing circuit is connected to the inverting input of differential amplifier IC1. The non-inverting input of this opamp receives a composite feedback signal E_r, which is made up of voltages E_p and e_v. Voltage E_p is directly proportional to the position of the wiper arm on feedback pot R501 (equivalent to pen position). Damping rate voltage e_v is also picked off at the arm of the feedback pot through differentiating capacitor C2. This dynamic voltage depends upon velocity of the servo motor; and it is therefore effective only when the system is approaching balance, thus helping the motor to anticipate the correct stopping point. The value of C2 has been selected for optimum response characteristics.

b. The differential amplifier compares the analog signal e_c with the feedback signal E_r and, under "off-null" conditions, an error signal voltage e_r is developed at the differential input of IC1.

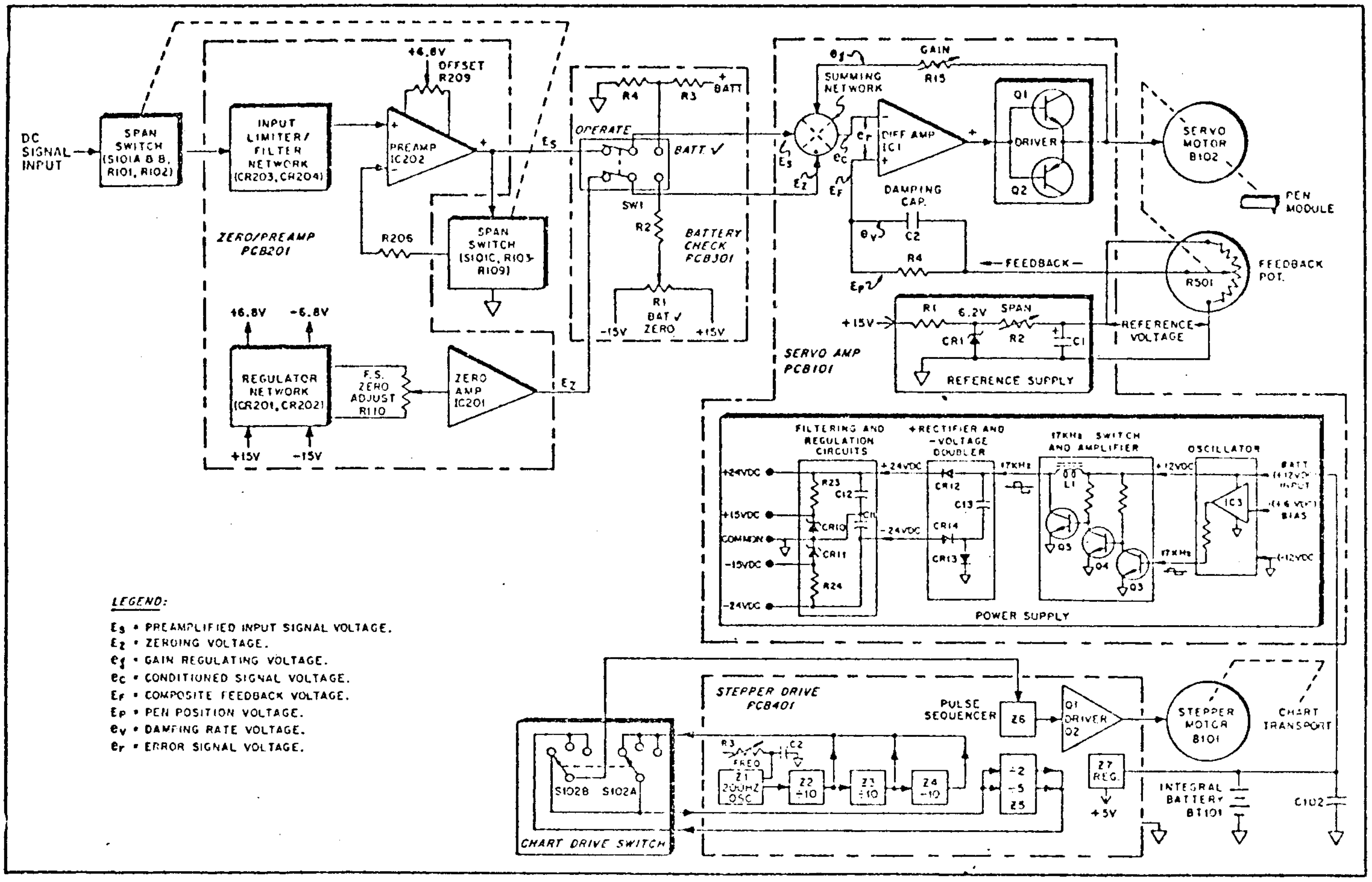


Figure 1-2. Functional Block Diagram.

This signal is amplified and then fed to an output driver stage. The driver makes use of complimentary power transistors Q1 and Q2 which, in turn, deliver a DC voltage to the armature of servo motor B102. Drive voltage is applied until the "follow-up" feedback pot reaches a voltage position equal to e_c. At this point the system is "balanced," and the recording pen will come to rest at a new position on the chart. The error signal voltage, which is generated within the measuring system, may be expressed in simplified form as follows:

$$e_r = E_S \pm (E_Z + e_g) \pm E_P + e_v$$

or:

$$e_r = e_c \pm E_F$$

c. Reference voltage for feedback pot R501 is derived from an adjustable temperature-compensated circuit on the servo amplifier board. In this auxiliary supply, R1 reduces the +15 V source to +6.2 V which, in turn, is regulated by zener diode CR1. Span control R2 is provided for calibration while C1 serves as a filter capacitor.

1.3.3 BATTERY CHECK CIRCUIT

a. A separate test circuit has been designed into the recorder which offers the operator a convenient method for checking the charged condition of the internal battery. As shown in Figure 1-2, all components of the battery check circuit are grouped on PCB301--a miniature PC board attached to the rear panel of the instrument.

b. When momentary slide switch SW1 is not actuated, it will remain in its "OPERATE" position and couple preamp signals E_S and E_Z to the servo amplifier for analog recording. When this double-pole switch is held in its "BATT. √" position, however, one pole selects plus battery potential from voltage dividers R3 and R4, while the other pole receives an offset potential from R1 and R2 for zero elevation. These potentials now represent signals E_S and E_Z at the input to the servo amplifier.

c. The servo system measures and indicates the relative battery voltage as it would an analog input signal. If the battery is charged, the pointer on the recording pen will register in the upper 30% of the scale, which is denoted by a green colored area on the scaleplate.

1.3.4 POWER SUPPLY

a. The main power supply circuitry is located on the servo amplifier board; here, a +12 VDC input and a +6 VDC bias potential are applied to integrated-circuit IC3. This opamp functions as a 17 kHz square-wave oscillator, which is then used to drive an inductive DC converter.

b. The AC signal generated by IC3 is amplified by transistors Q3 and Q4; then, it is applied to the base of switching transistor Q5. Transistor Q5 is alternately driven from cutoff to saturation at a 17 kHz rate. When Q5 is saturated, one end of choke L1 is effectively grounded; and a large charging current flows into the choke at this time. As Q5 cuts off, the field around L1 collapses and induces a voltage in L1 of such polarity that it adds to the +12 V input supply and provides a positive peak of approximately 24 V with respect to common. The 24 V pulses are then rectified by diode CR12. At the same time, capacitor C13 is being charged through diode CR13. As Q5 again saturates, capacitors C11 and C13 along with diodes CR13 and CR14 act as a negative voltage-doubler circuit to provide a rectified DC of approximately -24 V at the output of CR14.

c. Capacitor C12 filters and smooths the +24 VDC supply, while C11 performs the same function for the -24 VDC supply. Both 24 V supplies are dropped down to produce a +15 V source and a -15 V source by resistors R23 and R24. These sources are zener regulated by CR10 and CR11 and supply the operating voltages for all stages in the servo measuring system except the servo motor drivers. Drivers Q1 and Q2 are operated from the 24 V supplies.

1.3.5 CHART-STEPPER DRIVE

a. The Miniservo chart-drive system consists of chart-drive switch S102, stepper drive board PCB401, and stepper motor B101. Switch S102 is mounted on the front panel, while the PC board and motor are located within the inner-chassis assembly. Stepper motor B101 advances the chart at a rate determined by the pulse frequency selected when the chart-drive switch is placed in one of its eight operating positions.

b. As illustrated in Figure 1-2, a basic timing frequency of 200 Hz is generated by integrated-circuit oscillator Z1 and its associated RC network; potentiometer R3 is used to adjust this frequency. The 200 Hz pulses are then applied to a ÷ 10 integrated-circuit Z2. The 20 Hz output of Z2 is connected through chart-drive switch S102 to pulse sequencer Z6 and drivers Q1 and Q2. In this mode of operation, the stepper motor advances the chart at a rate of 300 cm/hr. Integrated-circuit Z6 serves as a flip-flop that triggers switching transistors Q1 and Q2 alternately to pulse the motor.

c. The 20 Hz pulses from Z2 are also applied to another ÷ 10 integrated-circuit Z3. The 2 Hz output of Z3 is connected to a ÷ 10 integrated-circuit Z4 to give a 0.2 Hz output. The 20 Hz-, 2 Hz-, or 0.2 Hz-pulses are further divided by 2 or 5 in integrated-circuit Z5. The chart-drive switch inter-connects combinations of these frequency-divider circuits to product the specified chart speeds shown in Table 1-2.

TABLE 1-2. TIMING RELATIONSHIPS

CHART SPEED cm/hr	DIVISION RATIO	INPUT TO Z6
300	1:1	20 Hz (50 ms)
150	1:2	10 Hz (100 ms)
60	1:5	4 Hz (250 ms)
30	1:10	2 Hz (500 ms)
15	1:20	1 Hz (1 s)
6	1:50	.4 Hz (2.5 s)
3	1:100	.2 Hz (5 s)
1.5	1:200	.1 Hz (10 s)

d. DC output pulses from the driver circuitry are applied in sequence to the two windings of stepper motor B101. This 12 V motor is designed with a permanent-magnet rotor and an electro-magnetic stator. It rotates in discrete angular steps of 15 degrees and is capable of stepping a maximum of 20 times per second. Regulator Z7 (on PCB401) receives +12 V from the power input circuit of the recorder and provides a regulated +5 V supply for all IC's in the stepper-drive circuitry. The collectors of driver transistors Q1 and Q2 are connected to the +12 V source through the stepper-motor windings.

1.3.6 POWER MODES

a. Input power circuitry of the Miniservo has been designed for the utmost in versatility. Operating power is made selectable through the use of a mode switch and input jack that are conveniently located on the rear panel of the recorder. Mode selector S104 is a 3-position, slide-type switch and jack J104 is a miniature AC/DC power receptacle.

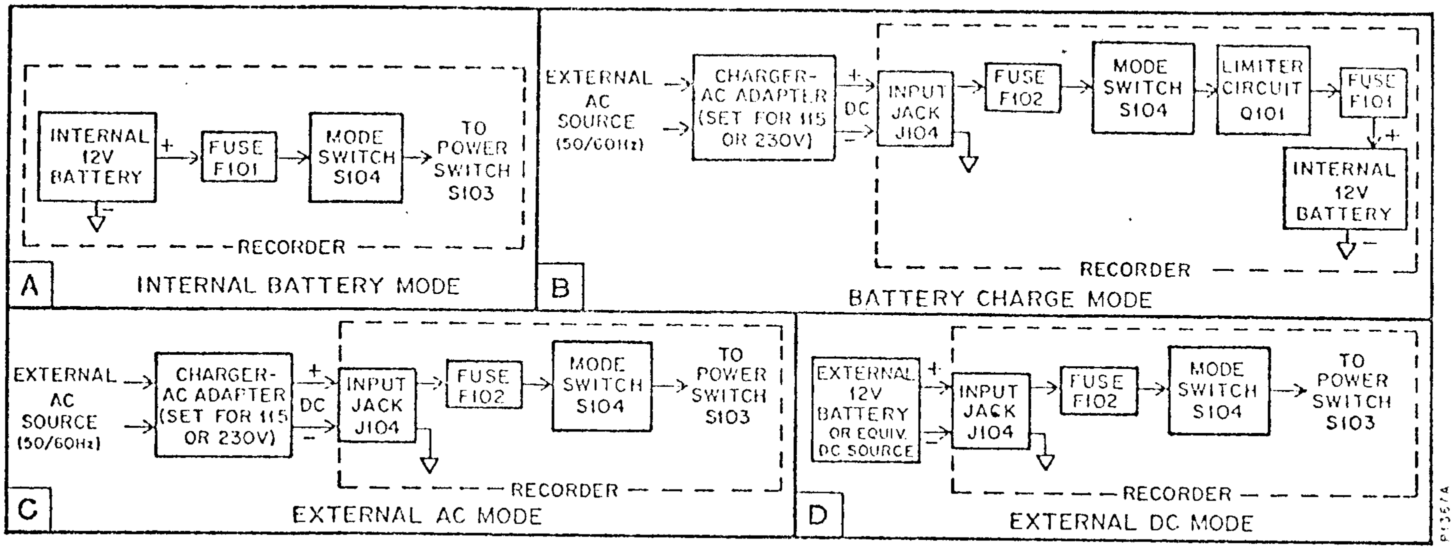


Figure 1-3. Simplified Power Mode Diagrams Showing Internal and External Connections.

b. When the mode switch is placed in its "BATT." position, the instrument is powered by a self-contained battery, as illustrated in Figure 1-3A. With the switch in its "CHG." position, the internal battery is charged by an external source (Figure 1-3B). In its "AC/EXT. BATT." position, however, the mode-switch circuitry permits the unit to be operated from either an external-AC or an external-DC source, as shown in diagrams C and D of Figure 1-3. Two separate fuses are employed to protect the instrument during either internal or external modes of operation.

c. The charger/AC adapter furnished with the recorder has an internal thermal type of circuit breaker for overload protection. If the adapter fails to function, press reset button on side of unit to restore circuit continuity.

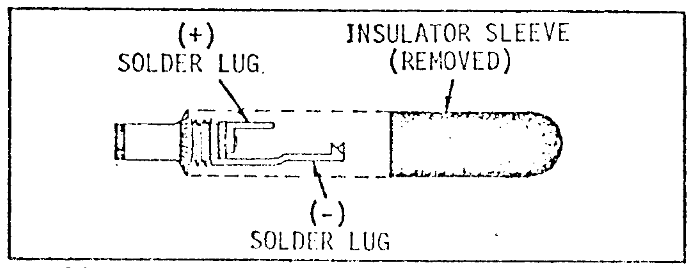


Figure 1-4. Optional DC Power Connector.

NOTE: To check charger/AC adapter, place mode switch in its "AC/EXT. BATT." position, insert plug into rear-panel jack, and connect adapter card to appropriate AC source. Normal operation of recorder will indicate that the charger is functioning properly.

SECTION 2—INSTALLATION

2.1 UNPACKING INSTRUCTIONS

a. Carriers are responsible for damage in transit. If the packing case shows damage, make a notation to that effect on the express receipt or freight bill. If the shipment within is damaged, notify the carrier and your Esterline Angus representative immediately. The following standard items have been inspected and carefully packed in the Miniservo shipping carton:

ITEM	QTY.
Recording Instrument	1
Service Kit (Inking Accessories)	1
Instruction Manual	1
Recording Chart (Blank)	1
Battery	1
Battery Charger/AC Adapter	1

b. Remove the packing material from the carton carefully and check off all items listed on the packing slip as they are unpacked. Inspect all contents for damage.

CAUTION: Do not attempt to operate a damaged instrument.

c. The Model MS401BB Miniservo recorder was inspected and properly calibrated at the factory prior to shipping, and should be ready for operation as soon as it is unpacked and set up.

d. Setting up the instrument for operation basically consists of the following procedures:

(1) Install battery in recorder, and charge battery.

(2) Note mounting considerations.

(3) Install chart paper.

(4) Install pen module.

(5) Connect analog input signal.

2.2 BATTERY INSTALLATION

The sealed 12 V battery is installed in the recorder by performing the following steps:

(1) Remove top cover from instrument by removing two screws on each side of recorder base, then lift cover straight upward.

(2) Remove two battery bolts and battery strap from rear of recorder base (items 18 and 19, Figure 5-1).

(3) Install battery between battery brackets with terminals toward right-hand side of instrument (as shown in Figure 5-1).

(4) Place battery strap over top of battery and secure with two bolts removed in step 2.

(5) Insert battery plug into its mating connector.

(6) Replace instrument cover, and charge battery as follows:

CAUTION: Use only charger/AC adapter unit supplied with recorder.

(7) Plug battery charger into rear panel CHG. CONN jack, and place mode switch in CHG. (bottom) position (Figure 2-2). Set charger switch to applicabl source voltage, then plug charger into AC line.

(8) Permit battery to charge for 14 to 16 hours, or as required.

CAUTION: DO NOT exceed 24 hours.

(9) Check battery charge by following procedures in step (1) under paragraph 3.3.

NOTE: If charger operation is doubtful, refer to paragraph 1.3.6c.

2.3 INSTRUMENT MOUNTING

a. The Model MS401BB, with its internal power and case carrying handle, has been designed primarily for portable and bench-top applications and therefore no special installation procedures are requi Four rubber feet are adhesively-attached to the bo tom of the instrument to protect supporting surfa The unit should normally be operated in a horizont plane, however, it may be tilted backward up to 2 degrees without hindering the automatic function c refolding used chart.

b. Preferably, the recorder should be positioned in a clean well-lighted location that affords convenient access to the operator. It should not be subjected to excessive vibration or extreme tempe ature and humidity conditions. If excessive dust moisture or corrosive fumes are present, a proper vented enclosure should be used to protect the in strument. If signal interference is encountered, refer to signal Shielding and Grounding techniqu in paragraph 2.6.3.

2.4 CHARTING PROCEDURES

(1) To install chart in recorder, turn off recorder power switch, swing scaleplate upward and

remove. Raise pen lifter lever located at left end of chart-drive roller. Pull front drawer assembly forward against its stops (Figure 2-1).

(2) Squeeze retaining bail to disengage it from drawer slots; then lift bail out. Grasp center wedge attached to hinged baffle, and pivot baffle downward.

(3) Place chart supply in paper-supply compartment so that elongated drive holes are toward left side of recorder, and printed side of chart is toward rear of recorder.

(4) Pull up a few inches of chart from supply and insert end of chart between loading chute and drive roller as shown in Figure 2-1.

(5) Thread chart over top of drive roller and under tear-off bar by rotating thumbwheel on right end of drive roller until leading edge of chart is just behind bar. See that roller pins engage the perforations in chart paper at both edges.

> NOTE: If any chart paper is protruding from supply compartment, carefully fold it back into its original configuration.

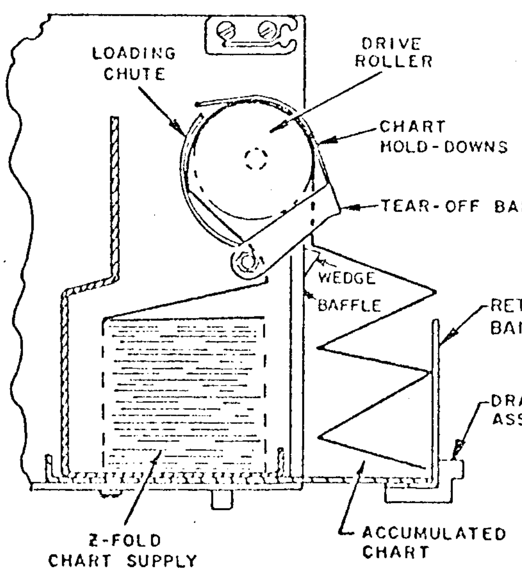


CHART TRANSPORT (SIDE VIEW)

P-1362

Figure 2-1. Chart Installation Diagram.

(6) Pivot baffle upward, and snap into position by pressing on both top-front corners. Replace wire bail.

(7) Rotate thumbwheel downward until chart enters drawer assembly and begins to fold as shown in Figure 2-1. If chart does not automatically start to refold properly at first, manually position first fold to ensure correct folding. Allow at least three folds to accumulate in drawer.

(8) Lower pen lifter lever and replace scaleplate by inserting top edge in first; then, swing plate downward until it snaps into position. To check operation, turn on power switch and select chart speed desired.

> NOTE: A 1/8" wide, blue line starting approximately one metter (36") from end of chart in left-hand margin will give operator warning that end of chart is near.

2.5 INKING PROCEDURES

A disposable pen cartridge and scaleplate pointer are supplied in the service kit. If desired, slide pointer over pen staff before installing cartridge. To install a cartridge, proceed as follows:

(1) Turn off power switch, raise pen lifter lever, and swing scaleplate upward and remove.

(2) Remove red protective cap from pen tip and, with pen tip facing down, insert module straight back into cartridge holder. Priming of pen is not necessary.

(3) Lower pen lifter lever and replace scaleplate by inserting top edge in first, then swing plate downward until it snaps into position. With chart installed, select a chart speed, turn on power switch, and check operation.

2.6 ELECTRICAL CONNECTIONS

The composite wiring diagram (Figure 4-2) furnished in this manual identifies all external terminal connections for signal input, as well as switches and jack used for external power to the recorder and for charging the internal battery. Input power ratings will be specified on a nameplate located on the rear panel, and are also listed on the Data Sheet.

2.6.1 POWER CONNECTIONS

a. The Model MS401BB Miniservo is normally powered by its own internal battery; thus, for this operational mode, external power connections are not required. The recorder can be powered,

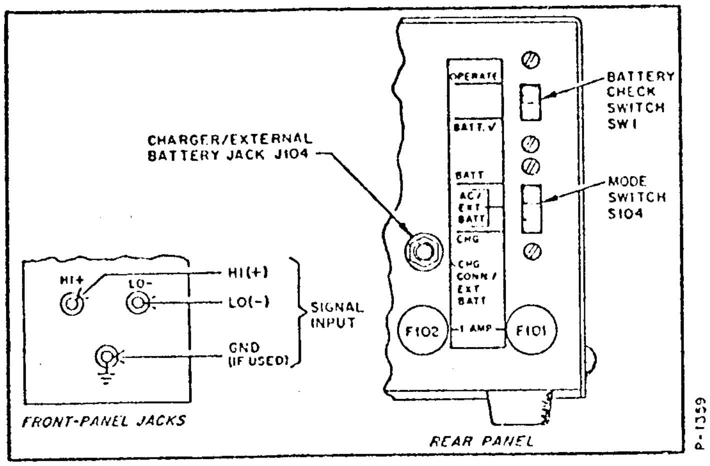


Figure 2-2. Power and Signal Connection Points.

however, from either of two external-power sources: (1) a 50- or 60-Hz AC line by means of the charger/AC adapter supplied; or (2) an external 12 VDC supply. To use the external power mode, plug either the charger or an external DC source into rear-panel connector jack J104, and place mode switch S104 in its AC/EXT. BATT. (center) position (see Figure 2-2). To charge the internal battery, plug charger into rear-panel connector jack J104, and place mode switch S104 in the CHG. (bottom) position. It is recommended that the internal battery not be left on charge more than 24 hours.

> NOTE: Charger/AC adapter CANNOT be used to power recorder and charge battery simultaneously.

b. It is recommended that an external ground connection be made to the instrument--preferably through the ground-input jack (⏚) on the front panel. This jack is connected internally to the recorder chassis.

c. If recorder is to be operated from an external DC source, a mating power plug for input jack J104 is available from Esterline Angus under part no. JAC-17. This optional two-conductor plug is shown in Figure 1-4.

2.6.2 ANALOG SIGNAL CONNECTIONS

Analog signal sources are connected to the front-panel input jacks as shown in Figure 2-2. For an up-scale deflection, the positive signal is connected to the "HI+" jack and the negative signal to the "LO-" jack. Refer to paragraph 2.6.3 for suggested input-signal shielding and grounding techniques.

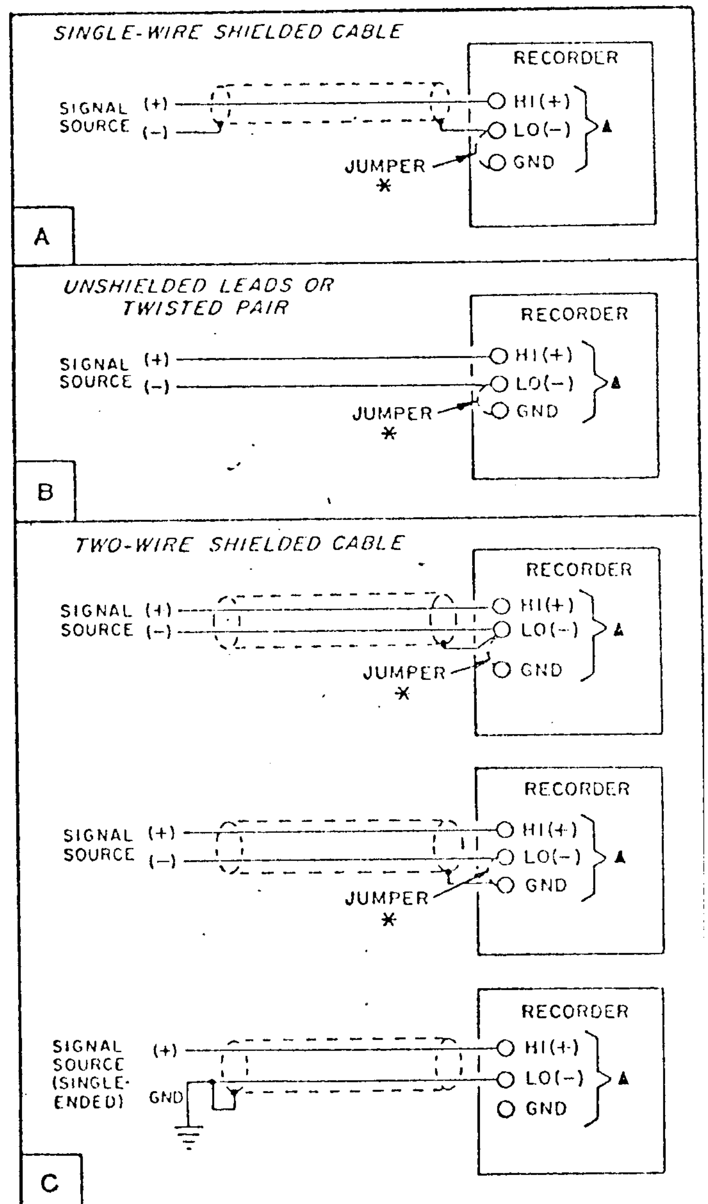
> CAUTION: Common mode voltage must NOT exceed a maximum of 150 VDC.

2.6.3 SHIELDING AND GROUNDING

a. For most applications, signal input connections may be made with a single-wire shielded cable or unshielded leads as shown in Figure 2-3A & B. For low-level signals in "noisy" areas, however, a two-wire shielded cable is recommended (see wiring examples in Figure 2-3C).

b. The presence of external interference (or stray pickup) may be indicated by a slight vibration of the pen, zero shifting, excessive deadband, or any combination of these effects. Such conditions can usually be eliminated by use of proper shielding and grounding techniques.

c. In applications where the source of stray pickup is unknown, the ideal operating condition may best be found by experimenting with the different connection configurations shown in Figure 2-3. If unsatisfactory operation still exists and it is established that relatively high AC signals are present, it may be necessary to insert a low-pass RC filter across the output of the signal source.



* ALTERNATE CONNECTION. DO NOT USE IF (-)SIGNAL IS AT "OFF-GROUND" POTENTIAL.
▲ SEE FIGURE 2-2 FOR RECORDER SIGNAL-CONNECTION POINTS

Figure 2-3. Signal Shielding and Grounding.

SECTION 3—OPERATION

3.1 OPERATING CONTROLS

Operating controls for internal-battery powered Miniservo recorders are illustrated in Figure 2-2 (rear-panel controls) and in Figure 3-1 (front-panel controls). Basic control functions are delineated in the following paragraphs.

3.1.1 REAR PANEL CONTROLS

a. BATTERY CHECK SWITCH (SW1): This is a two-position slide switch having an OPERATE position and a momentary press-to-test BATT✓ position. In the battery-check position, the internal battery is connected through SW1 circuitry to the servo measuring system to indicate the charged condition of the internal battery. If the recording pen moves into the green area on the scaleplate, the battery voltage is sufficient for normal operation; however, if the pen is near the right-hand side of the green area, the battery is nearing the point at which it should be recharged.

b. MODE SWITCH (S104): This three-position slide switch permits the operator to select the input-power mode for the instrument. In its BATT. (top) position, the recorder operates from the internal battery; in the AC/EXT. BATT. (center) position, the instrument is powered by an external source connected to J104 (AC adapter or external 12 V source); but, in the CHG. (bottom) position, the internal battery will be charged when the charger is connected to J104. The recorder will remain inoperative during battery recharging periods.

c. CHG. CONN./EXT. BATT. JACK (J104): This jack provides a convenient means for connecting the charger/AC adapter or external DC source to the recorder, using a Switchcraft No. 760 plug or equivalent.

d. POWER FUSES: Two separate fuses are provided on the rear panel of the instrument. Fuse F101 protects the internal battery circuit, while fuse F102 is used only with external power sources. Replace these fuses with only the exact types recommended.

3.1.2 FRONT PANEL CONTROLS

a. CHART ADVANCE (THUMBWHEEL): This mechanical adjustment is provided so that the operator can advance the chart paper manually. Rotating the wheel downward over-rides the internal drive system and propells the chart forward. This control should always be used when charting the instrument.

b. PEN LIFT (LEVER): The small metal arm located at the left end of the scaleplate is a pen lifter lever. This device permits the operator to raise or lower the recording pen as desired. To raise the pen from the chart, merely move the lever arm upward. The pen can be lowered to its recording position by moving the lever downward.

c. POWER SWITCH (S103): This is a two-position slide switch that controls DC power to both serv and chart-drive systems. To energize the record move the switch to its "ON" position. Always pl

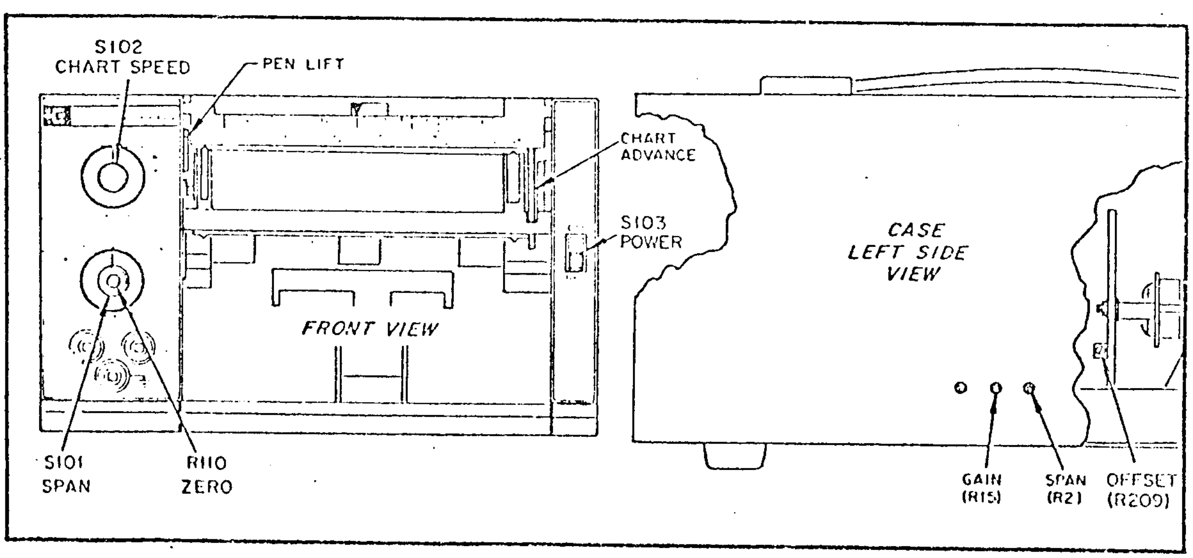


Figure 3-1. Location of Controls and Adjustments.

the switch in its "OFF" position when recorder is not in use, or when charting, inking or servicing the unit.

d. CHART SPEED SWITCH (S102): This nine-position rotary switch offers the operator a selection of eight (CM/HR) chart speeds, and it may be rotated in either direction with power on or off. To stop the chart paper, place the switch in its "OFF" position (fully counterclockwise).

e. SPAN SWITCH (S101): A twelve-position rotary switch used to select any one of 11 different measuring and recording spans. In its OFF position, the signal source connection is broken and the preamp input is effectively shorted. The switch assembly also includes an inner concentric zero control (R110). This screwdriver adjustment provides a zero pen positioning over ±100% of the chart span.

3.2 SERVO ADJUSTMENTS

a. All Miniservo recorders are carefully set up for normal operating standards before leaving the factory; however, certain servo system adjustments are provided to satisfy various field applications and for calibration purposes. These adjustments include Gain and Span, which are miniature potentiometers that mount on an internal PC board. The controls are adjustable with a small screwdriver through access holes on the side of the case--as illustrated in Figure 3-1.

b. GAIN ADJUST (R15): Servo "stiffness" (deadband) is determined by the setting of this control. It establishes overall amplification through a signal feedback loop in the servo system. For maximum stability, the control should be adjusted for only maximum specified deadband.

c. SPAN ADJUST (R2): The Span control regulates the precise amount of reference supply voltage that is applied across the feedback pot. It determines the accuracy of full-span deflection, and should therefore be adjusted only during calibration procedures. This adjustment provides a shift at F.S. of approximately 10% of chart span.

> NOTE: No damping adjustment is required. A dynamic damping circuit has been built into the servo amplifier for optimum response characteristics.

3.3 OPERATING PROCEDURES

The following instructions assume that either internal or external power is connected to the instrument, chart paper is installed, and that the inking system is ready for operation.

> CAUTION: Internal servo adjustments are pre-set and should not be disturbed unless otherwise specified.

(1) If operating from internal battery, turn on power switch S103, hold battery-check switch SW-1 in its BATT.✓ position, and note charged condition of battery (as indicated by pen pointer on scaleplate). Recharge battery if necessary.

(2) Swing scaleplate upward and remove; then, lower recording pen onto chart by moving pen lift lever down.

(3) With power switch on and chart speed switch S102 off, permit instrument to warm up for approximately 10 minutes without signal applied.

(4) Connect shorting jumper across "HI" & "LO" signal input jacks, place span switch S101 in appropriate position for intended measurement, and set chart speed switch to an operating position.

> NOTE: To conserve chart paper during initial adjustments, place chart speed switch in its slowest rate position.

(5) Recording pen should come to rest on zero reference line of chart. If it does not, carefully adjust zero potentiometer R110, which is accessible through center of span switch knob.

> NOTE: If zero suppression or elevation is desired, refer to zero offset adjustments in paragraph 3.4.

(6) Place span and chart-speed switches in appropriate positions for the desired recording application. Remove shorting jumper and connect analog source to signal-input jacks.

> CAUTION: Maximum common-mode potential is limited to 150 VDC.

(7) Recorder is now operational. Replace scaleplate by inserting top edge in first; then swing plate downward until it snaps into position.

> NOTE: If recording accuracy is not within acceptable tolerance, refer to calibration instructions.

3.4 ZERO OFFSET

a. Zero control R110, which is a screwdriver adjustment accessible through the center of the span switch knob, not only affords the operator conventional zero pen positioning but also provides a means for offsetting electrical zero. With this feature, the operator may shift a selected measurement span so that a more detailed record of a specific analog variable is obtained with maximum resolution.

b. If negative or both positive and negative signal excursions are to be recorded, electrical zero may be shifted up-scale (elevated) from 0 to +100% of the selected chart span. If the input signal range is greater than the upper limit of the span selected, electrical zero may be shifted down-scale (suppressed) from 0 to -100% of the chart span.

3.4.1 ZERO ELEVATION

a. Electrical zero can be shifted up-scale (elevated) from chart or scale "0" to full scale for any selected recording span; therefore, the Miniservo can be adjusted to record negative or both positive and negative input signals. Zero may be elevated by the following procedure:

> CAUTION: Signal input must not exceed ±100V, regardless of offset adjustment.

(1) Remove analog source and connect shorting jumper across "HI" and "LO" signal input jacks.

(2) Place span switch (S101) in desired span position, turn on power switch (S103), and permit instrument to warm up for ten minutes.

(3) Determine desired zero pen position on chart or scale. Lower-end value of input signal range equals minimum amount of zero elevation required--disregarding negative sign of input signal voltage.

> NOTE: If scale calibrations are not directly proportional to selected span, calculate equivalent percentage point on scale.

(4) Using small screwdriver, carefully adjust zero (R110) until recording pen moves up-scale to point determined in step (3). Adjustment is accessible through hole in center of span knob.

(5) Remove shorting jumper and connect signal source to be measured. Instrument will now record analog inputs over offset range selected.

b. EXAMPLE: Assume an analog source having maximum signal deviations of from -13 mV to +65 mV. The total desired measurement range is thus 78 mV. To encompass this signal range, an available recorder span of 100 mV is selected. Since the selected span is 22 mV greater than the anticipated signal range, 11 mV may be added to each end of the range so that all measurements will be centered within the given chart span. Adding 11 mV to the lower-end value of the signal range (-13 mV), results in a total required elevation of 24 mV (disregarding sign). Zero pot (R110) is then adjusted for an elevated pen position equivalent to 24 mV on the chart or scale. The recorder will now operate over the desired input signal range with a full-span calibration of from -24 mV to +76 mV.

3.4.2 ZERO SUPPRESSION

a. When source signals are to be recorded that are above the upper limit of an available span, electrical zero may be shifted down-scale (suppressed) as much as one full span from chart or scale "0". Zero may be suppressed by the following procedure:

> CAUTION: Signal input must not exceed ±100 V, regardless of offset adjustment.

(1) Disconnect analog source, place span switch (S101) in desired span position, turn on power switch (S103), and permit instrument to warm up for ten minutes.

(2) Using known-accurate voltage standard, apply input signal to recorder that equals low-end value of desired measurement range. Recording pen will deflect to equivalent position on chart span.

> NOTE: If scale calibrations are not directly proportional to selected span, calculate equivalent percentage point on scale.

(3) Using a small screwdriver, carefully adjus zero (R110) until recording pen moves down-scal and comes to rest precisely on "0" reference li of chart. Adjustment is accessible through hol in center of span knob.

> NOTE: Scale "0" now electrically represents low end of desired measurement range

(4) Disconnect voltage standard from recorder' put and connect signal source to be measured. I strument will now record analog inputs over of range selected.

b. EXAMPLE: Assume an analog source having maximum signal deviations of from +15 V to +55 The total signal range is thus 40 V. To encom pass this measurement range, an available spar of 50 V is selected. Since the recorder span' 10 V greater than the anticipated range, each end of the signal range may be shifted 5 V to center all measurements on the chart span. S tracting 5 V from the lower-end value of the signal range (+15 V), results in a required z suppression of 10 V. A reference source of p cisely +10 V is applied to the recorder input and zero pot R110 is then adjusted until the recording pen comes to rest on chart "0". Th reference source is removed and the recorder now set up to operate over the desired input signal range with a span calibration of from to +60 V.

SECTION 4—MAINTENANCE

4.1 GENERAL

The Model MS401BB battery-powered Miniservo, designed for long trouble-free operation, should require little attention in the field, other than periodic recharging of the internal battery. Battery voltage should be checked regularly, and periodic maintenance schedules for the instrument should be established and followed to ensure optimum performance. Where extreme temperatures or contaminated atmospheres prevail, maintenance should be performed more often. Since frequency of use and environmental conditions may vary with each application, maintenance scheduling is left to the discretion of the user. Routine maintenance procedures will primarily entail a complete visual inspection and cleaning. Keeping a simple written record of component replacements will be a handy reference during inspection, and will help ensure that a ready reserve of expendable items is maintained--such as chart paper and pen modules.

> WARNING: Prior to servicing or cleaning activities, always remove external-power sources and any other wiring that is potentially dangerous. If the instrument cover is removed, it is recommended that the internal battery be disconnected--use care NOT to short the battery terminals.

4.2 INSPECTION

A complete visual inspection of the instrument should be made at each scheduled maintenance period to detect the possible onset of a malfunction. At that time, check for low chart supply, accumulation of dirt, damaged or loose hardware, shorted or broken wiring, and loose connections. Also check the reserve of charts and pen modules to assure that an adequate supply is on hand.

4.3 CLEANING

a. Regardless of the precautions taken, dirt and dust will enter the recorder chassis area; therefore, periodic cleaning of exposed components within the instrument will be necessary. Always keep the pen tip free of lint and dried ink. To prevent dry-out, replace red cap on pen tip if recorder will remain inactive for more than 24 hours.

b. Light dirt marks can be removed from case surfaces, scaleplate, and front control panel with a damp, lint-free cloth or sponge. Esterline Angus recording ink is water based and can be removed with a wet cloth. Heavier dirt smudges can be removed with any commercially-available liquid detergent; however, DO NOT use harsh solvents as they may damage certain finishes. Dust and other dry accumulations can be removed from within the recorder with a soft-bristled brush or low-vacuum system. Under normal operating conditions, recorder lubrication will not be necessary in the field. DO NOT lubricate the pen module bearing or its guide rod, under any circumstance.

> CAUTION: Exercise care when cleaning to avoid disturbing electrical wiring and alignment of mechanical parts.

4.4 CALIBRATION

Recorder calibration can be checked by a direct comparison with a known-accurate standard. The validity of such a test, however, depends upon the accuracy of the reference source--which should be considerably better than accuracy requirements of the recorder. To calibrate the Miniservo, refer to Figure 3-1 for location of adjustments and proceed with the following instructions:

> NOTE: If operating from internal battery, test battery condition before attempting calibration.

4.4.1 ZERO ADJUST

(1) Turn off Power switch S103 and remove cover from instrument (see Disassembly instructions).

(2) Disconnect analog source and connect shorting jumper across "HI" and "LO" signal-input jacks.

(3) Turn on Power switch S103 and permit recorder to warm up for at least ten minutes.

(4) Place Span switch S101 in its OFF position, and select mid-range feed rate on Chart Speed switch S102.

(5) Adjust Zero pot R110 until pen point moves up scale and is positioned exactly on a vertical graduation line at mid-chart.

NOTE: Chart paper should be in motion for all adjustments.

(6) Set Span switch S101 to its 1 MV position. Recording pen should remain on reference line of chart. If it does not, use small screwdriver and carefully adjust Offset pot R209 until pen point is positioned precisely on reference line selected in step (5).

(7) Place Span switch S101 in its OFF position. Pen should not move from chart reference line. If it does, repeat steps (5) and (6).

(8) Disconnect shorting jumper from front-panel input jacks, and proceed with span adjustments.

4.4.2 SPAN ADJUST

(1) Place Span switch S101 in its 50 MV position.

NOTE: Any available span may be selected for dedicated applications.

(2) Connect output of precision voltage standard (Esterline Angus Model V-2000 or equivalent) to recorder input jacks, and adjust standard for zero voltage output.

(3) Adjust Zero pot R110 until recording pen point comes to rest precisely on zero reference line of chart.

NOTE: Chart paper should be in motion for all adjustments.

(4) Set standard for a DC voltage output equal to full-span calibration as selected by span switch in step (1). Recording pen should deflect upscale.

(5) Carefully adjust Span pot R2 until pen point comes to rest precisely on full-scale reference line of chart.

(6) Adjust Gain pot R15 to a minimum clockwise setting that produces a deadband within 0.2% of span.

(7) Recheck zero pen position and, if necessary, repeat steps (3) through (5). Disconnect voltage standard from recorder.

4.4.3 BATTERY CHECK ADJUST

(1) Pull red wire, terminated with removal connector, from terminal #2 on terminal board TB101 (Figure 5-1).

(2) Hold Battery-Check switch SW1 (Figure 2-2) in its BATT.✓ position. Recording pen point should come to rest precisely on right-hand "0" reference line of chart. If it does not, use small screwdriver and carefully adjust Battery-Check Zero (R1 in Figure 5-1) until accurate reference is obtained. Release Battery-Check switch.

(3) Reinstall red wire on terminal #2 of TB101. BATT.✓ position of switch should now cause recording pen to accurately indicate charged condition of internal battery.

NOTE: Servo system calibration is now complete and recorder may be restored to operation; however, if chart-drive calibration is deemed necessary, proceed with paragraph 4.4.4.

4.4.4 STEPPER FREQUENCY ADJUST

Electronic control circuits of the chart-drive system have been accurately adjusted at the factory and will not normally require field recalibration. If, however, components of the stepper-drive circuitry have been replaced or chart speeds appear incorrect, proceed with the following instructions:

<u>CAUTION</u>: Inspect all mechanical and electrical modules for proper operation before attempting recalibration.

(1) Using precision frequency counter, apply power to counter and permit it to warm up as recommended in instrument instructions.

(2) Place recorder Chart Speed switch S102 in its 300 CM/HR position, and Span switch S101 in its OFF position.

(3) Turn on Power switch S103 and permit recorder to warm up for at least 10 minutes.

(4) Connect "low" input lead of frequency counter to -12 VDC point (recorder common), and connect "high" input lead to violet wire terminal on Chart Speed switch S102 (refer to schematic in Figure 4-2).

(5) Adjust frequency counter for measurement. If counter readout is not 20 Hz (50 ms time period), use small screwdriver and carefully set Frequency Adjust R3 for 20 Hz readout. Pot R3 is located on PCB401 (see Figure 4-1).

NOTE: It may be necessary to loosen battery mounting to make this adjustment.

(6) Rotate Chart Speed switch S102 through each of its feed-rate positions. Counter should indicate frequency (or time) listed in Table 1-2 for each speed selected.

(7) This completes chart-drive calibration. Disconnect frequency counter and restore recorder to operation.

> CAUTION: Make sure internal battery is securely fastened in its operating position.

4.5 DISASSEMBLY

a. Most of the components and modular assemblies in the recorder are accessible for inspection and servicing by simply removing the instrument cover; however, certain adjustments and repairs in some areas will be facilitated by removing the internal battery (see Figure 5-1). Servicing of a few components, such as the servo motor and feedback potentiometer, may also require removal of the inner chassis assembly from the instrument base pan.

b. Basic chassis assembly construction and the location of functional parts are shown in Figures 4-1 and 5-2. Servo-amplifier board (PCB101), the stepper-drive board (PCB401), and the preamp switch assembly (including PCB201) are replaceable as complete subassemblies. Other components such as the servo motor, feedback potentiometer, and chart-drive stepper motor are also replaceable in the field.

4.5.1 COVER REMOVAL

To remove the instrument cover, proceed with the following steps:

(1) Place Power switch in its OFF position. Disconnect external-power source from recorder (if used) and remove signal wiring from front-panel jacks.

(2) Remove two screws securing cover on each side of recorder base pan.

(3) Lift cover straight up and off from instrument.

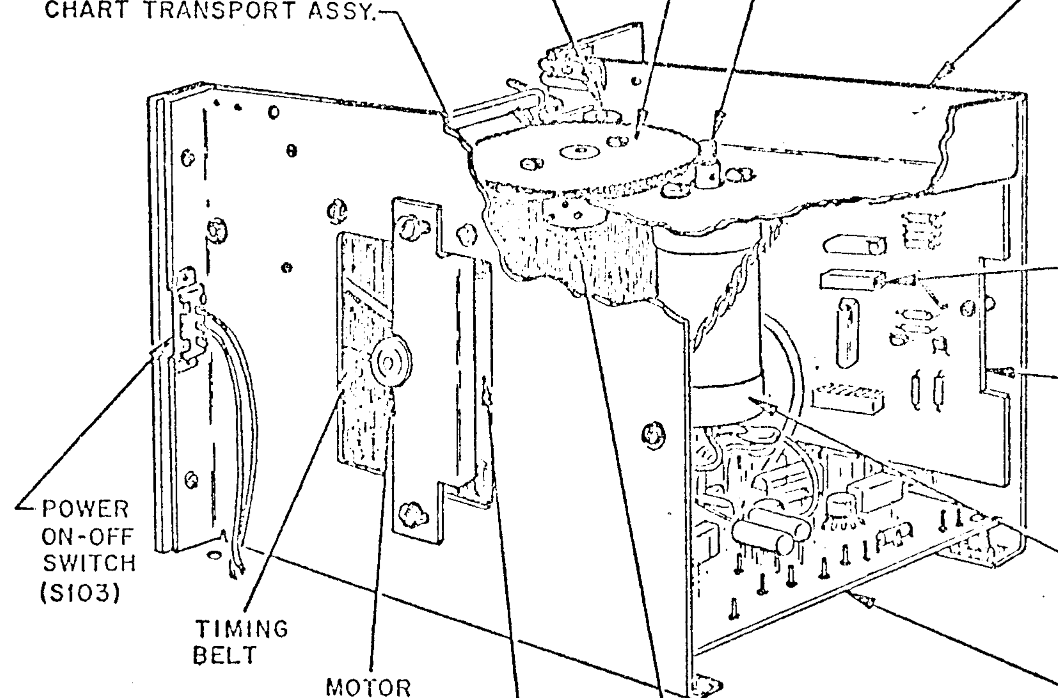


Figure 4-1. Major Components of Inner Chassis Assembly.

4.5.2 BATTERY REMOVAL

To remove the internal battery, proceed as follows:

(1) Remove instrument cover as described in paragraph 4.5.1.

(2) Disconnect battery plug from its mating connector.

> CAUTION: DO NOT short battery terminals.

(3) Remove two bolts and strap securing battery to recorder base pan (see Figure 5-1).

(4) Lift battery up and out of instrument.

4.5.3 CHASSIS ASSEMBLY REMOVAL

To remove the inner chassis assembly, proceed with the following steps:

(1) Remove instrument cover and internal battery as previously described.

(2) Unsolder both red (RD) and orange (OE) wires from Power switch S103.

(3) Disconnect two cable connectors at rear edge of stepper-drive board (PCB401) by pulling connectors straight back from board.

(4) Disconnect only required wiring from servo-amplifier board as specified in Table 4-1A. Carefully pull each removable connector straight up from its mating pin on board. Use extreme care NOT to break connector pins.

> CAUTION: DO NOT disturb adjustments or other wiring.

(5) From underside of recorder, remove four screws securing chassis assembly to base pan; then, pull chassis straight up and out top of instrument.

> NOTE: When reinstalling chassis, refer to Table 4-1A and to diagram in Figure 4-2 for location of connection points.

4.5.4 PREAMP MODULE REMOVAL

To remove the preamp switch and PC-board assembly, proceed with the following steps:

(1) Remove instrument cover and internal battery as previously described.

(2) Disconnect wiring from battery-check and servo-amp boards as directed in Table 4-1C. Carefully pull each removable connector straight out from its mating pin on PC board. Use extreme care NOT to break connector pins.

> CAUTION: DO NOT disturb adjustments or other wiring.

(3) Using .050" Allen wrench, loosen setscrew in Span switch knob and remove knob.

(4) Remove nut securing switch shaft bushing to front panel.

> CAUTION: DO NOT stress switch or board wiring.

TABLE 4-1. WIRE DISCONNECT GUIDE FOR ELECTRONIC MODULES

Ⓐ TO REMOVE CHASSIS MODULE DISCONNECT WIRE:*

COLORED:	FROM COMPONENT:	TERM. 0
BK	Servo Amp Board PCB101	2
WE/BE		3
WE/RD		4
BK		7
BE		18
BK		19
WE/GN		20
RD		+12 V IN
YW		POINT "A"

Ⓑ TO REMOVE SERVO AMP BOARD DISCONNECT WIRE:*

COLORED:	FROM COMPONENT:	TERM. 0
BK	Servo Amp Board PCB101	2
WE/BE		3
WE/RD		4
BK		7
RD		10
OE		12
RD		13
BE		14
OE		15
BE		18
BK		19
WE/GN		20
RD		+12 V IN
YW		POINT "A"

Ⓒ TO REMOVE PREAMP MODULE DISCONNECT WIRE:*

COLORED:	FROM COMPONENT:	TERM. 0
BE	Battery Check Board PCB301	1
WE/GN		4
WE/RD		7
WE/BE		9
BK	Servo Amp Board PCB101	2

* CAUTION: Remove wires carefully; DO NOT break board connector pins.
0 Refer to schematic diagram for location of board terminals.

(5) Carefully move entire module to one side and unsolder both red (RD) and black (BK) wires leading to front-panel input jacks.

(6) Free all connecting wires and carefully withdraw switch assembly from front panel. Remove entire preamp module from instrument.

> NOTE: When reinstalling module, refer to Table 4-1C and to diagram in Figure 4-2 for location of connection points.

4.5.5 SERVO BOARD REMOVAL

To remove the servo amplifier board (PCB101), proceed with the following steps:

(1) Remove instrument cover and internal battery as previously described.

(2) Disconnect wiring from servo amp board as directed in Table 4-1B. Carefully pull each removable connector straight up from its mating pin on PC board. Use extreme care NOT to break connector pins.

> CAUTION: DO NOT disturb adjustments or other wiring.

(3) From underside of recorder, remove four screws securing PC board to inner chassis.

> NOTE: Mounting screws are accessible through holes in instrument base pan.

(4) Clear all wiring and carefully remove servo amp board through rear of inner chassis assembly.

> NOTE: When reinstalling board, refer to Table 4-1B and to diagram in Figure 4-2 for location of connection points.

4.5.6 STEPPER BOARD REMOVAL

To remove the stepper drive board (PCB401), proceed with the following steps:

(1) Remove instrument cover and internal battery as previously described.

(2) Disconnect two cable connectors at rear edge of PC board by pulling connectors straight back from board.

> CAUTION: DO NOT disturb adjustments or other wiring.

(3) Remove three screws securing board to left-hand side of inner chassis assembly.

(4) Carefully slide stepper board out through rear of chassis and remove from instrument.

> NOTE: When reinstalling board, make sure cable plugs seat firmly on edge-board connectors.

4.6 SHUTDOWN

If the recorder is to remain inactive for more than 30 days, disconnect external-power source (if used) and remove pen cartridge module. If cartridge is to be retained, place red protectiv cap over pen tip. Place Power switch in its OFF position and Mode switch in its CHG. position. If instrument is to be transported for a long distance, follow factory packing procedures.

> NOTE: DO NOT store recorder for extended periods with the internal battery in a discharged state. Always fully charge battery before removing recorder from service and recharge at least every six months.

4.7 SCHEMATIC DIAGRAM

a. A complete electrical schematic and wiring diagram is furnished in Figure 4-2 of this manu This composite diagram provides all necessary i formation for tracing wiring and troubleshootir the instrument.

b. If trouble is indicated in the electrical measuring system, the most logical troubleshoot ing approach is to isolate the fault to one ele trical module or component--such as a servo am board or feedback pot. Voltage and current measurements, continuity checks, and DC resist measurements may be necessary to pin-point the trouble.

> CAUTION: Always turn off power before making DC continuity checks or resistance measurements.

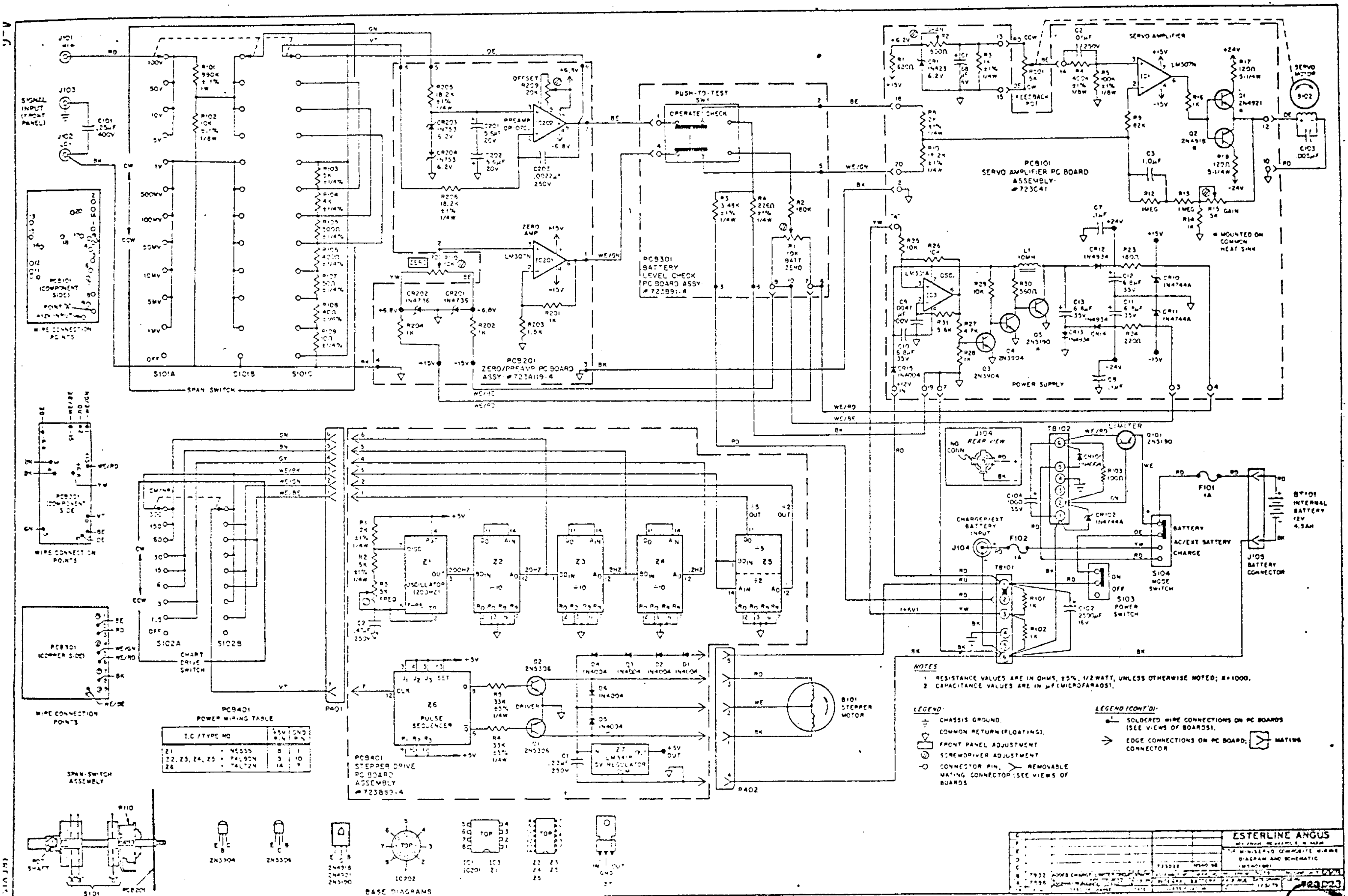


Figure 4-2. Composite Schematic and Wiring Diagram for Model MS401BB Recorder.

(REVISED 8/75)

SECTION 5—ILLUSTRATED PARTS BREAKDOWN

5.1 PARTS TABLES

a. Each parts table in the following section covers a major assembly or group of related components used in the construction of MINISERVO recorders. Illustrations accompany each parts list to assist the user in obtaining a correct replacement part.

b. The first column in each parts table contains identifying numbers for assemblies, subassemblies, or parts that are pointed out in the accompanying parts location illustration. Esterline Angus part numbers for all replaceable items appear in the Part Number column, while a nomenclature for each part is found in the Description column. The number represented in the Qty. column refers to the quantity used in the assembly covered under the title of each particular list.

5.2 ORDERING INFORMATION

All parts and recording supplies are available through Esterline Angus Sales Offices. To insure prompt delivery and receipt of parts that are compatible with your specific instrument, always mention the recorder Model Number and Serial Number--as well as the part number and description of all items requested.

WARRANTY—Only the products manufactured by the Seller and sold hereunder are warranted as free from defects of materials and workmanship and in conformance with specifications. There are no other oral, statutory, or implied warranties. Seller's obligation hereunder shall be and is limited to servicing or replacing f.o.b. its plant in Indianapolis, Indiana or such other point as Seller may designate, or refunding the purchase price of any such product manufactured by the Seller which proves to be defective in material or workmanship or which fails to conform to specifications therefor, provided that (1) written notice of such defect or failure is received by Seller from Purchaser within one year after the date of shipment of such products manufactured by the Seller, and (2) such defects, in the opinion of Seller, shall not have arisen from improper use. The absence of such written notice of defect, or failure, or lack of conformance to specifications within the specified time shall constitute a waiver of any claim. Seller may, after receipt of notice, require purchaser to send said products, transportation prepaid, to Seller for its examination and inspection.*

** Batteries supplied with instrument are warranted for 60-days only.*

TABLE 5-1. INSTRUMENT MAIN ASSEMBLY REPLACEMENT PARTS LIST.

Fig. 5-1 Item No.	Part No.	Description	Qty.
-	723D22	MS401BB Recorder W/Integral Battery (Complete)	1
1	723A53	.Decal, Information	1
2	723D20	.Cover	1
3	723D21	.Pan, Base	1
4	723A123	.Decal, Rear-Panel	1
5	ND40103-59	.Screw (#4-40 x 1/8")	4
6	723A122	.Washer, Shouldered	2
7	NX90604	.Screw (6-32 x 1/4")	4
8	SP1906	.Washer (#6)	6
9	X2106	.Nut (#6-32)	6
10	ND40210-5	.Screw, Flat Head (#4-40 x 1/4")	2
11	723A61	.Escutcheon, Right	1
12	723B29	.Plate, Escutcheon Mounting (Right)	1
13	723A52	.Trim, Front (Right)	1
14	723B36	.Drawer Assembly	1
15	723A51	.Trim, Front (Left)	1
16	43118	.Nut (3/8")	4

TABLE 5-1. INSTRUMENT MAIN ASSEMBLY REPLACEMENT PARTS LIST (CON'T).

Fig. 5-1 Item No.	Part No.	Description	Qty.
17	NX91104	.Screw (#10-32 x 1/4")	4
18	A1032K64B1	.Bolt, Battery	2
19	723A125	.Strap, Battery	1
20	723A126	.Bracket, Battery	2
21	43140-4	.Screw (#4-40 x 1/4")	9
22	723D4-6	.Chassis Assembly (See Table 5-2)	1
23	723A124	.Stop, Rear-Panel	1
24	ND40213-22	.Screw (#4-40 x 1/2")	2
25	SP1904	.Washer (#4)	10
26	43141	.Nut (#4-40)	7
27	723A64	.Handle & Hardware	1
28	NX10605	.Screw, Flat Head (#6-32 x 5/16")	4
29	723A49	.Trim, Cover	1
30	723A66	.Decal, Logo	1
31	723A63	.Knob, Chart Drive	1
32	723B90	.Escutcheon, Left	1
33	723A121	.Knob, Range (Span)	1
34	723B28	.Bracket, Mounting	1
35	723A54	.Foot, Rubber	4
36	NX90203	.Screw (#2-56 x 3/16")	4
37	14358	.Fuseholder	2
38	723B51	.Hold-Down, Chart	1
39	723A55-1B	.Scaleplate; 100 to 0	1
40	723A77	.Standoff	2
41	723A73	.Chute, Loading	1
42	723A76	.Wedge	3
43	STC4C21B	.Screw, Self-Tapping (#4 x 1/8")	3
44	723B50	.Baffle	1
45	723A81	.Bail, Wire Retaining	1
46	SP1920	.Lockwasher (3/8")	2
47	723B30	.Bracket, Escutcheon Mounting (Left)	1
48	723A131	.Battery Charger/AC Adapter (Complete)	1
BT101	723B95	.Battery Assembly W/Connector	1
C101	45304	.Capacitor; 0.25 µF, 400 V	1
C102	CEL148	.Capacitor, Electrolytic; 2500 µF, 16 V	1
C104	CEL120	.Capacitor; 1000 µF, 35 V	1
CR101	43421	.Diode, Silicon; 1N4004	1
CR102	67A15	.Diode, Zener; 1N4744A (Selected)	1
F101, F102	14359-1	.Fuse, 1-amp, Slow-Blow	2
J101-J103	JAC12	.Terminal, Front Input (Jack)	3
J104	JAC16	.Connector, Rear Power (Jack)	1
PCB101	723C41	.Servo Amplifier PC Board Assy. (Complete)	1
PCB301	723B91-4	.Battery Check PC Board Assy. (Complete)	1
Q101	TRA5190	.Transistor; 2N5190	1
S101	723C42	.Span Switch Assy. W/S101, R110, PCB201 (Complete)	1
PCB201	723A119-4	..Board Assy., Preamp	1
R103	RCC1-101	.Resistor; 100 Ω, ±5%, ½ W	1
S102	723B94	.Chart Speed Switch Assy. W/Connector (Complete)	1
S103	51166	.Switch, Power (ON-OFF)	1
S104	51164	.Switch, Mode (BATTERY-AC-CHARGE)	1
TB101,TB102	ND40074-19	.Terminal Strip	2
R101, R102	RCC1-102	.Resistor, Carbon; 1K, ±5%, 1/2W	2
-	723A68-1	.Accessory Kit (W/Cartridge, Chart, Pointer, Screwdriver)	1
-	*	Chart Paper, Z-fold	A/R
-	*	Cartridge, Ink (6 per pack)	A/R
-	723B97	Carrying Case, Vinyl (optional)	A/R

* See Catalog Listing. A/R: As Required.

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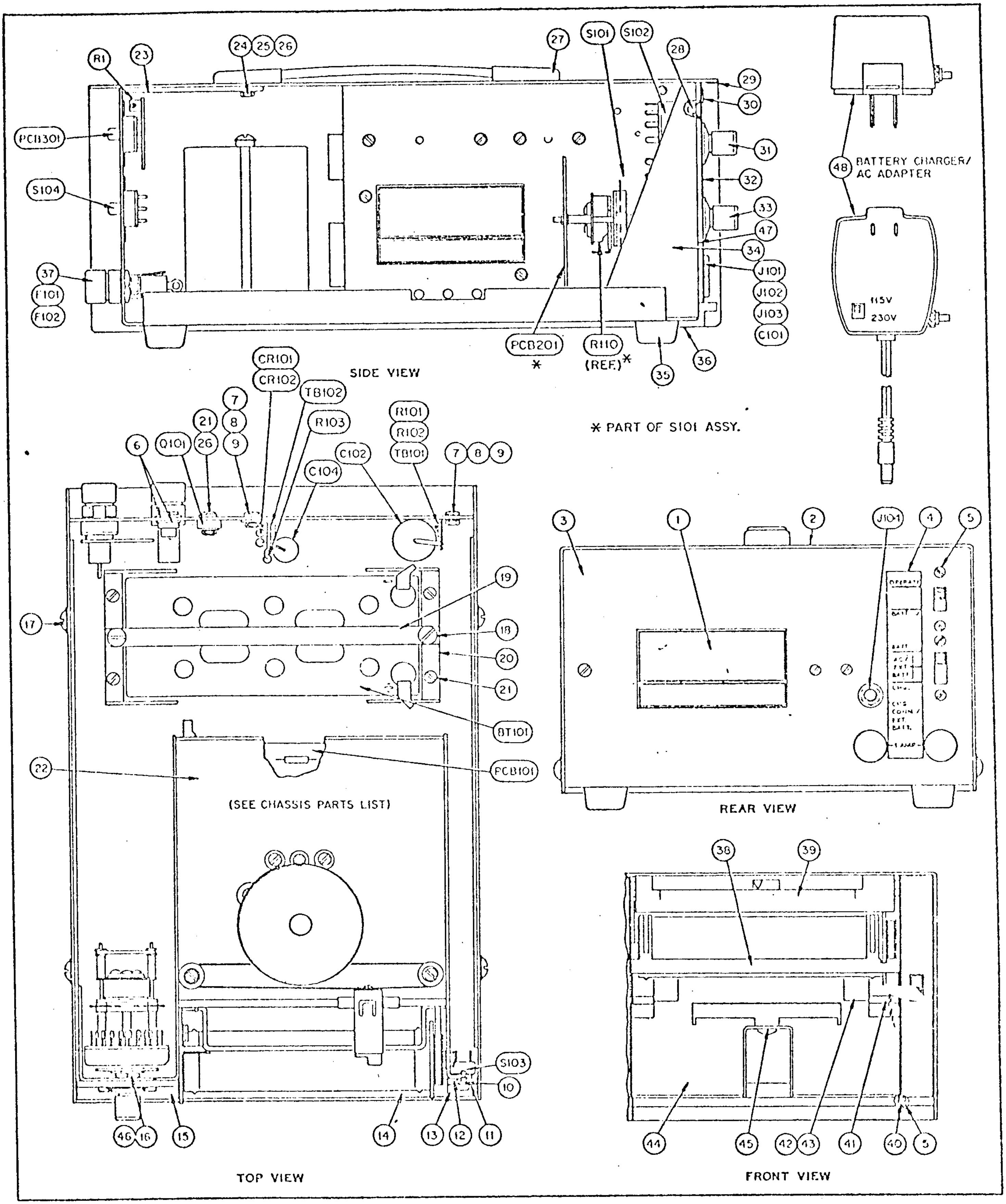

Figure 5-1. Instrument Main Assembly Parts Location.

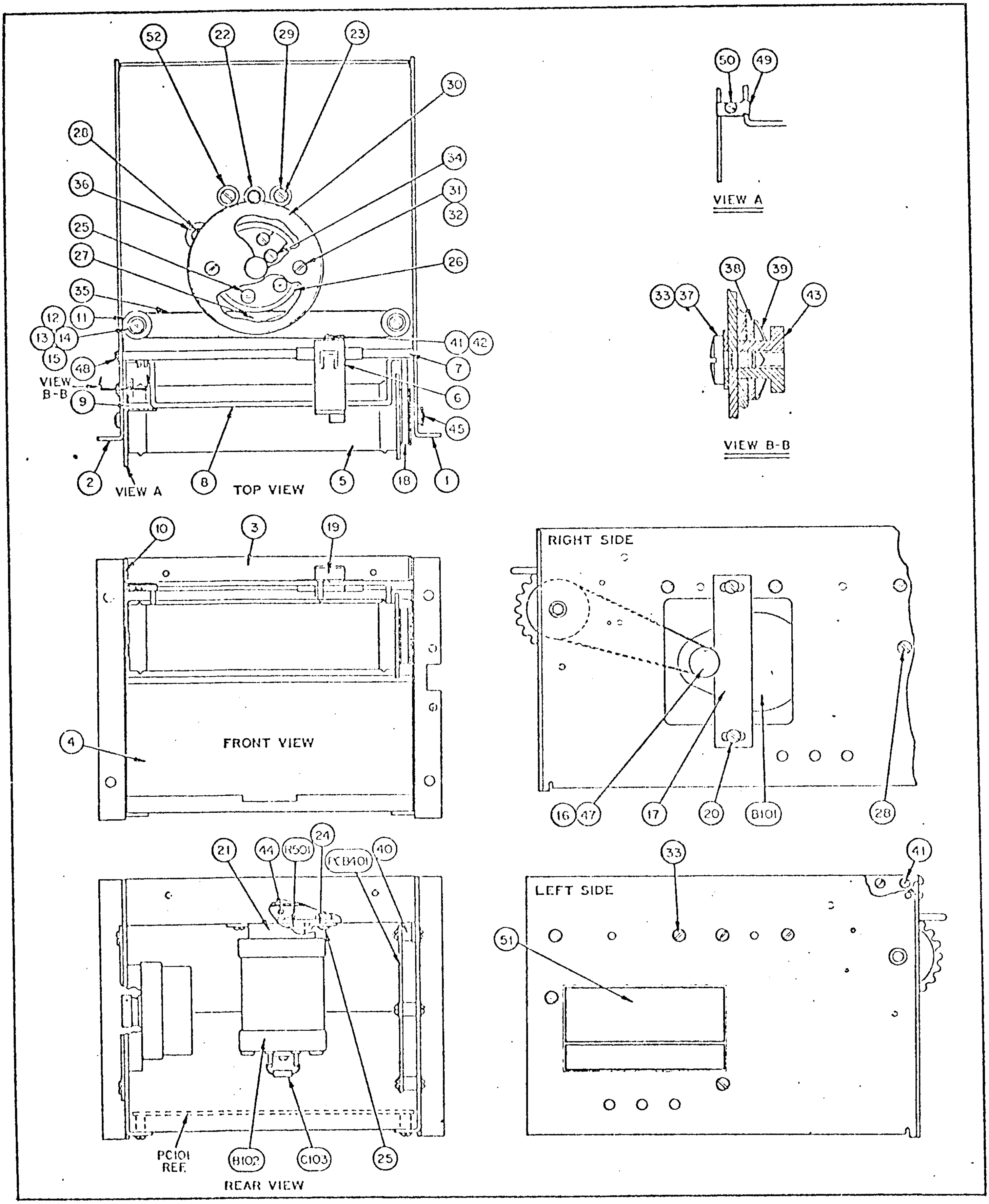

Figure 5-2. Chassis Assembly Parts Location.

TABLE 5-2. CHASSIS ASSEMBLY REPLACEMENT PARTS LIST.

Fig. 5-2 Item No.	Part No.	Description	Qty.
-	723D4-6	Chassis Assy., 12 V, W/Stepper Drive (Complete)	1
1	723B6	.Sideplate Assy. (Right-Hand)	1
2	723B7	.Sideplate Assy. (Left-Hand)	1
3	723B25-1	.Top Mounting Plate Assy.	1
4	723C10	.Plate, Paper Supply and Guide	1
5	723B24	.Drive Roll Assy. (Transport)	1
6	723A42	.Cartridge Holder Assy.	1
7	723A22	.Rod, Guide	1
8	723A37	.Bail, Pen Lift	1
9	723A32	.Arm, Pen Lift	1
10	723B35	.Clip, Scale Mounting	1
11	723A18	.Pulley, Servo Cable	2
12	723A24	.Spacer, Pulley Mounting	2
13	ND40213-24	.Screw (#5-40 x 5/8")	2
14	ND40203-4	.Nut (#5-40)	2
15	ND40221-10	.Lockwasher (#5)	2
16	723A2	.Pulley, Motor	1
17	723B52	.Bracket, Motor Mounting	1
18	70A199-3	.Belt, Timing	1
19	▲	.Cartridge, Ink (Red) *	1
-	▲	.Pointer, Scale	1
20	NX90603	.Screw (#6-32 x 3/16")	2
21	723A135	.Adapter, Motor	1
22	723A40	.Pinion Assembly	1
23	HX38021	.Screw (#6-32 x 1/2")	2
24	723A5	.Clamp	2
25	ND40213-38	.Screw (#6-32 x 3/16")	4
26	723B17	.Pulley, Servo Motor	1
27	723A21	.Stop, Servo Pulley	1
28	HX38017	.Screw (#6-32 x 1/4")	1
29	SP1906	.Lockwasher (#6)	8
30	723A79	.Gear, 180-Tooth	1
31	HX38034	.Screw (#8-32 x 3/8")	2
32	SP1908	.Lockwasher (#8)	2
33	HX38001	.Screw (#4-40 x 3/16")	21
34	NX1004	.Washer, Flat (#4)	2
35	01523	.Cable, Servo Drive	A/R
36	69140	.Bumper, Pulley Stop	1
37	ND40221-4	.Lockwasher (#4)	22
38	723A56	.Washer, Flat	1
39	723A58	.Washer, Spring (Pen Lift)	1
40	723A17	.Standoff, PC Board	3
41	NX30202	.Screw (#2-56 x 1/8")	5
42	NX1002	.Washer, Flat (#2)	2
43	723A57	.Washer, Hat-Type (Pen Lift)	1
44	HX20591	.Setscrew	2
45	43006	."E" Ring, Retaining	1
46	NX2006	.Nut (#6)	1
47	HX20593	.Setscrew, Cup-Point (#4-40 x 5/16")	1
48	ND40143-1	."E" Ring, Bowed	1
49	70A137	.Clamp, Pen Lift	1
50	ND40213-69	.Screw (#4-40 x 1/8")	1
51	723A53	.Decal	1
52	723A136	.Washer, Shoulder	2
B101	723A128	.Stepper Motor Assy. W/Connector (Complete)	1
B102	723A118-1	.Servo Motor Assembly (Complete)	1
C103	40763-2	..Capacitor, Ceramic Disc; .005 µF, 1000 V	1
PCB401	723B89-4	.Stepper Driver PC Board Assy. (Complete)	1
R501	723B88	.Feedback Potentiometer Assy; 5 K (Complete)	1

* See Catalog Listing. ▲ Part of Accessory Kit No. 723A68-1 A/R: As Required.

IMPORTANT

TECHNICAL DATA

ENCLOSED

SPECIFICATIONS FOR STOCK RECORDER

JUN 28 1976

CASE--Style: Bench (DC) COLOR: Standard Nextel Blue

ACCESSORIES -- Service Kit. No.: 723A68-1 Battery No.: 723B95 Charger/AC Adapter No.: 723A131

Manual No.: MS723-1BB

POWER REQUIREMENTS -- 12V DC @ 6VA; or 120/240V, 50/60 Hz @ 12VA Max. (with adapter)

MEASURING CIRCUIT -- Actuation: Millivolts/Volts Span: Multi-span Ranges: 1, 5, 10, 50, 100, 500 MV;
1, 5, 10, 50, 100 V

Zero: Right-hand with ±100% span adjustment

Scaleplate No.: 723A55-1B Scale Graduation: 100-0

Servo Amplifier PC Board Assy. No.: 723C41 Step Response Time: 1.0 Second

Preamp Switch/Board Assy. No.: 723C42 Battery Check PC Board Assy. No.: 723B91-4

CHART DRIVE -- Style: Multi-speed stepper drive with Z-fold charting

Feed Rates: 6, 12, 24, cm/hr; 1, 2, 4, 10, 20 cm/min.

Stepper Motor Assy. No.: 723A128-1 Pulley No.: 723A3 Drive PC Board Assy. No.: 723B89-5

NOTE: Instruction manual includes one copy of this Data Sheet drawing.

*User to specify this stock number when ordering replacement parts.

LET	CHANGE	DATE
E		
D		
C		
B		
A	RELEASED EPR 5200	11-24-75

UNLESS OTHERWISE SPECIFIED
1. TOLERANCE ON FRACTIONAL DIM. LENGTH DIAMETER
2. ECCENTRICITY—NOT TO EXCEED .010 INDICATOR READING.
3. PLATED PARTS MUST FIT GAUGES AFTER BEING PLATED.

NOTES

FACTORY REFERENCE ONLY:

Drawings - not supplied:

Assy.No.- 723D22-1
ChassisNo. 723D4-7
SchematicNo. 723D23-1

NO. REQ.	DWG. NO.	STYLE NO.

CLASSIFICATION

ESTERLINE ANGUS INSTRUMENT CO., INC.
INDIANAPOLIS, IND., U.S.A.

NAME	DATA SHEET FOR STOCKED
XXXX	MINISERVO Recorder
XXXXX	Model: MS401BB-80-830-12-06-27

DR. JWS | SCALE
CH. | 11/24/75
AP. | S-22243-1A*

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STEVENS PASS TELEMETRY UNIT

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98105

Department of Atmospheric Sciences

(84)

July 22, 1976

Mr. William L. Anderson
Manager of Forest Lands
Burlington-Northern
Palmer, WA 98048

Reference: University of Washington Research Project Central Avalanche Hazard Forecasting, 63-1174
Washington State Department of Highways Agreement Y-1700

Subject: Land Use, Section 15, T26N, R14E

Dear Mr. Anderson:

The Washington State Highway Commission, Department of Highways, has funded a second year of research under the above-referenced research project. (A report covering the first year of this project is enclosed for your information.)

As a portion of the second year of research, we propose to install a Stevens Pass Telemetry System which will provide the avalanche forecaster with meteorological feed-back from Stevens Pass (see page 5 of the enclosed research proposal). Such a telemetry system would require a precipitation measurement instrumentation package on a 10 foot tower to be located at site A on the enclosed map; a windspeed and direction measurement equipment package on a 30 foot tower to be located at site B on the enclosed map; and cables of 1/2" diameter to be laid on the aurface of the ground, as indicated, to support the equipment packages.

We request permission from Burlington-Northern to use the southeastern corner of Section 15, T26N, R14E, for the purpose of installing and maintaining the above-described Stevens Pass Telemetry System.

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No permanent improvements on the site are planned and all materials will be removed at the end of the research contract period (September 30, 1977) with minimal disturbance to the area. No timber or reproduction will be cut or destroyed by reason of our activities.

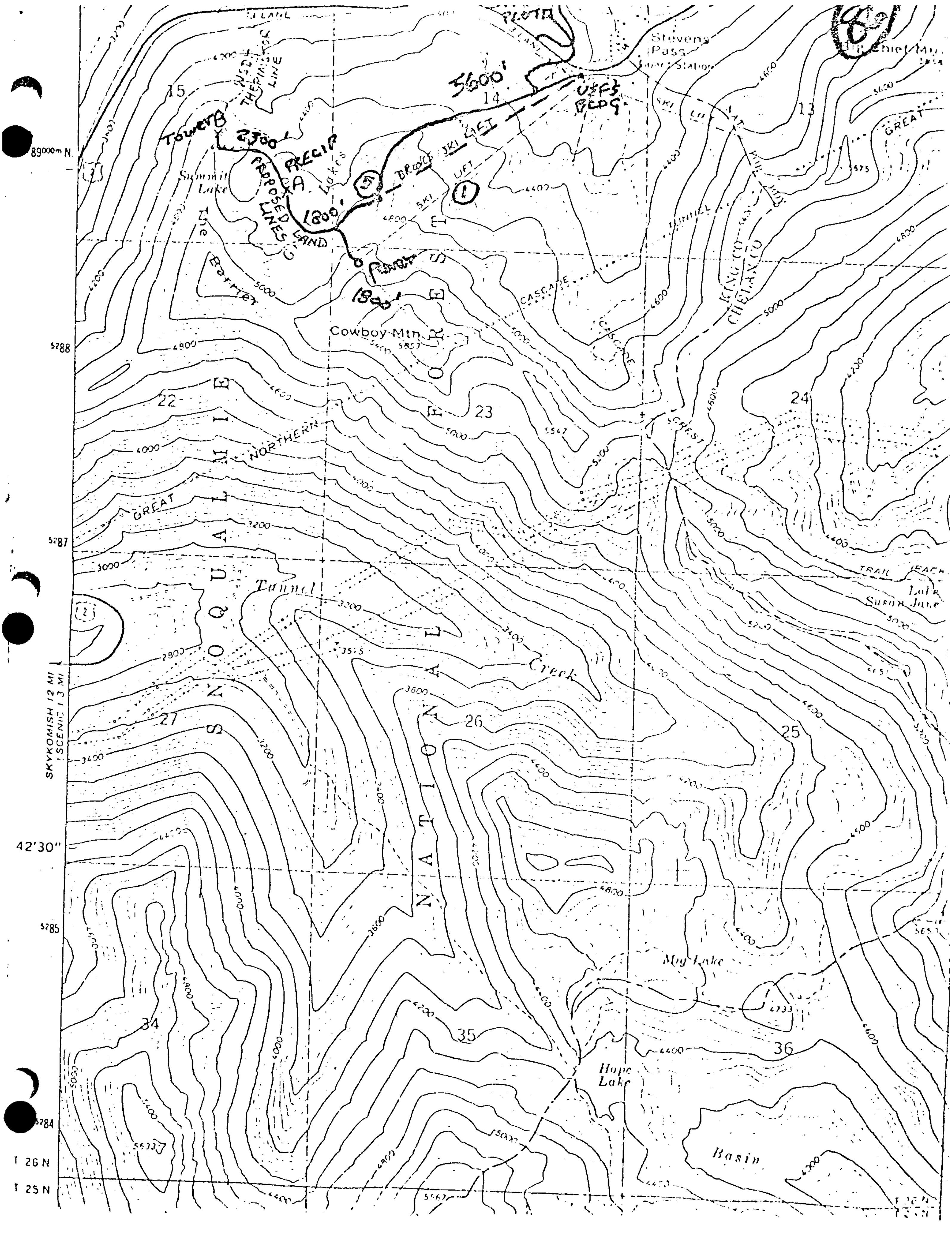
We are anxious to install our equipment at the subject site in August, and we would appreciate your early review of this matter.

Sincerely,

E. R. LaChapelle
Principal Investigator
Professor of Atmospheric Sciences and Geophysics

by E. M. Sackett
Program Assistant, Atmospheric Sciences AK-40
(206) 543-7180
cc: Mr. Carl Morig
Mr. Al Bennett, WSDH Liaison
Mr. Carl A. Toney

Enclosures: Site Location Map
Draft Interim Report, June 1976
Research Proposal, May 1, 1976


Stevens Pass
Big Chief Mtn
5600'
USFS BLDG
TOWER
2300'
PRECIP
Summit Lake
Lakes
PROPOSED LINES
1800'
SKI LIFT
The Barrier
1800'
Cowboy Mtn
5857
CASCADE
TUNNEL
KING CO
CHELAN CO
GREAT NORTHERN
SNOQUALMIE NATIONAL FOREST
Tunnel Creek
Susan Jane
Lake
Mig Lake
Hope Lake
Basin
SKYKOMISH 12 MI
SCENIC 1.3 MI
89000m N.
5288
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42'30"
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T 25 N
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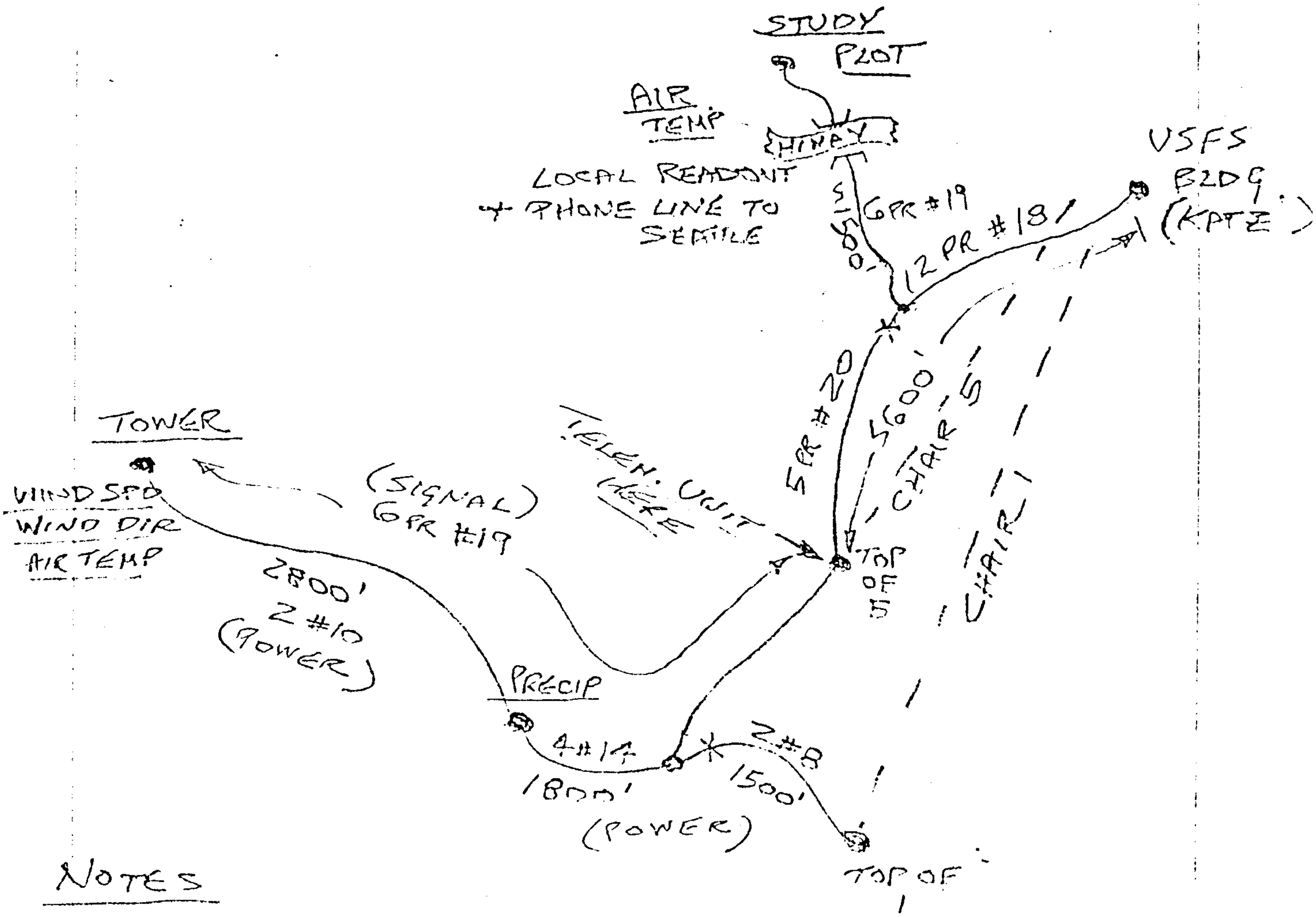
STEVENS PAS. INST. CABLE LAYOUT

87

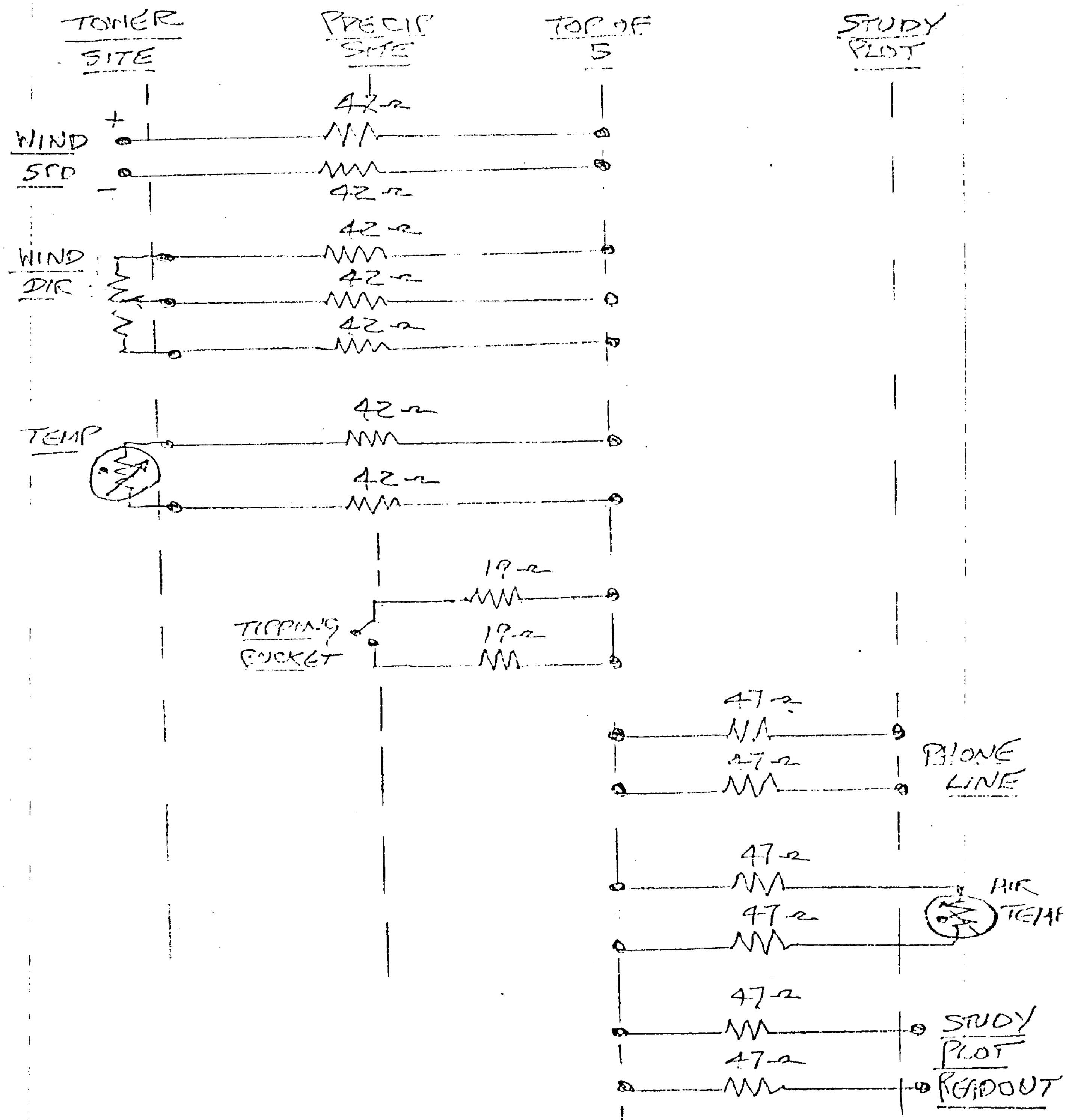
(SEE ALSO ATTACHED TOPO MAP)



NOTES

- AC POWER FROM TOP OF 1 TO PRECIP & TOWER SITES (SEE ATTACHED)
- TELEMETRY UNIT LOCATED TOP OF 5, USES LOCAL 110VAC
- TOWER + PRECIP SIGNALS TO TOP OF 5
- AIR TEMP FROM STUDY PLOT TO TOP OF 5
- PHONE LINE FROM STUDY PLOT TO TOP OF 5
- LOCAL READOUT LINE FROM TOP OF 5 TO STUDY PLOT.

INST LINE RESISTANCES



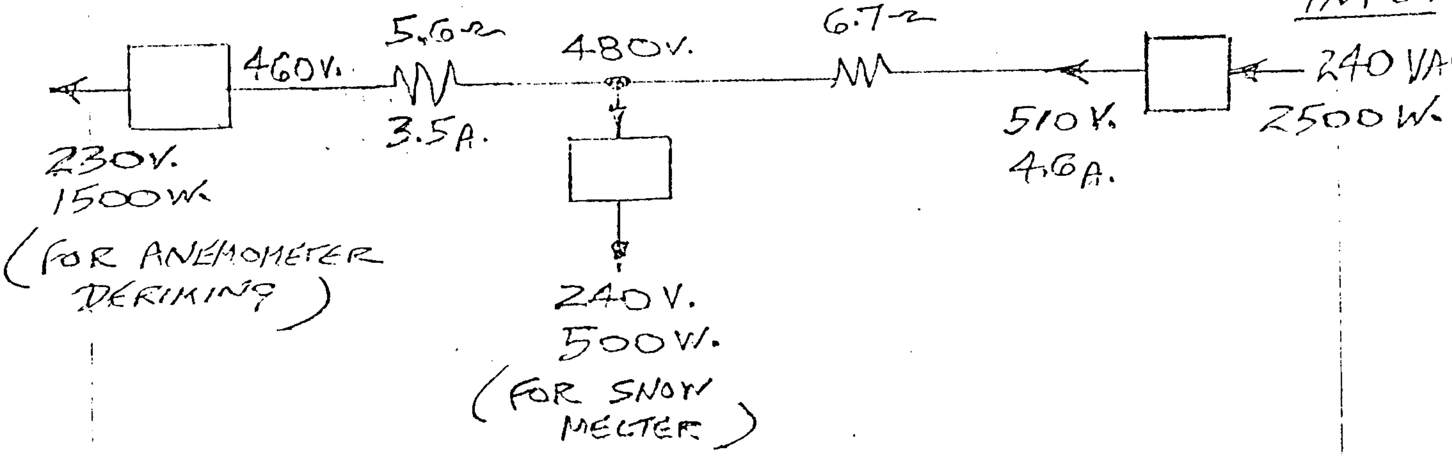
HL 'TOWER' CKT

TOP OF 1

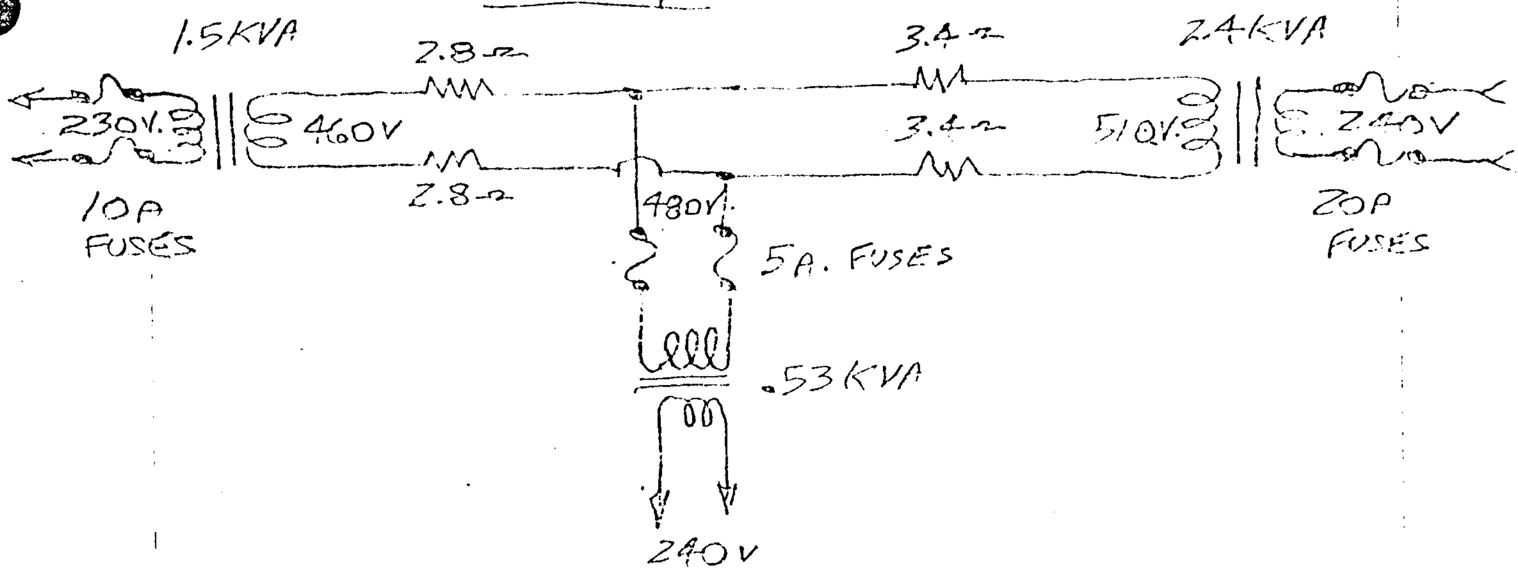
PRECIP SITE

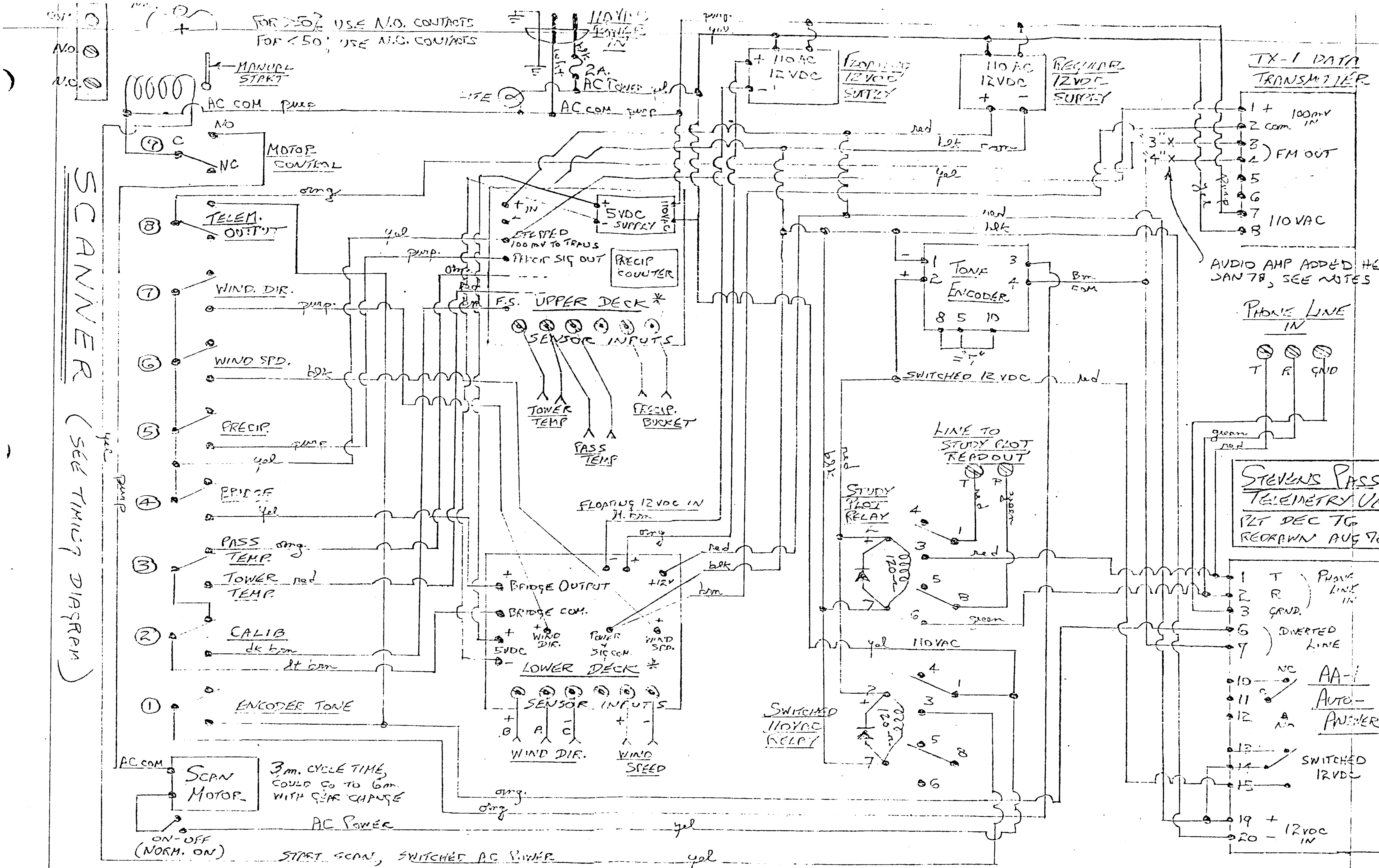
TOWER

SIMPLIFIED:

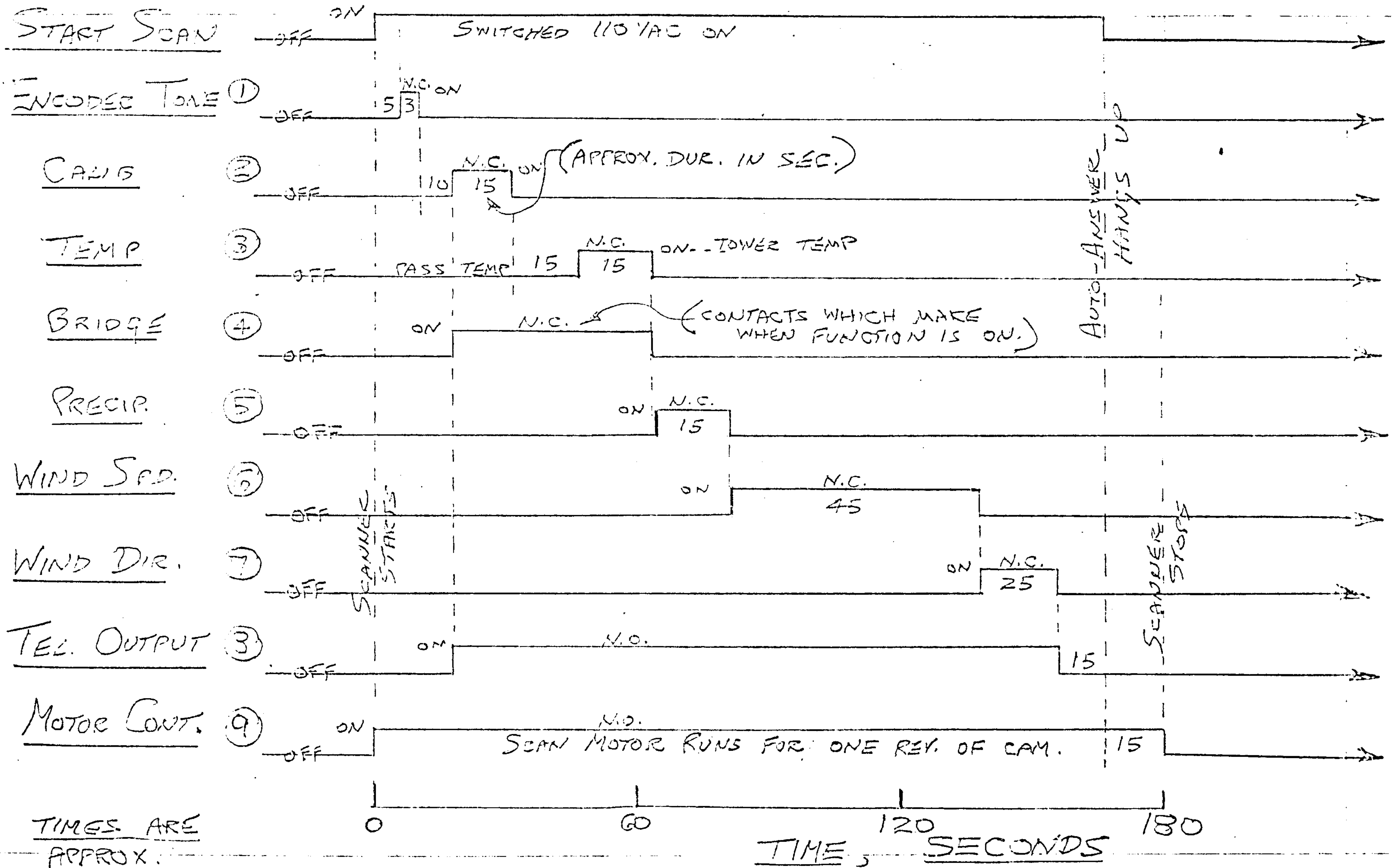


WIRING:





* SEE ATTACHED SHEETS FOR MORE DETAIL



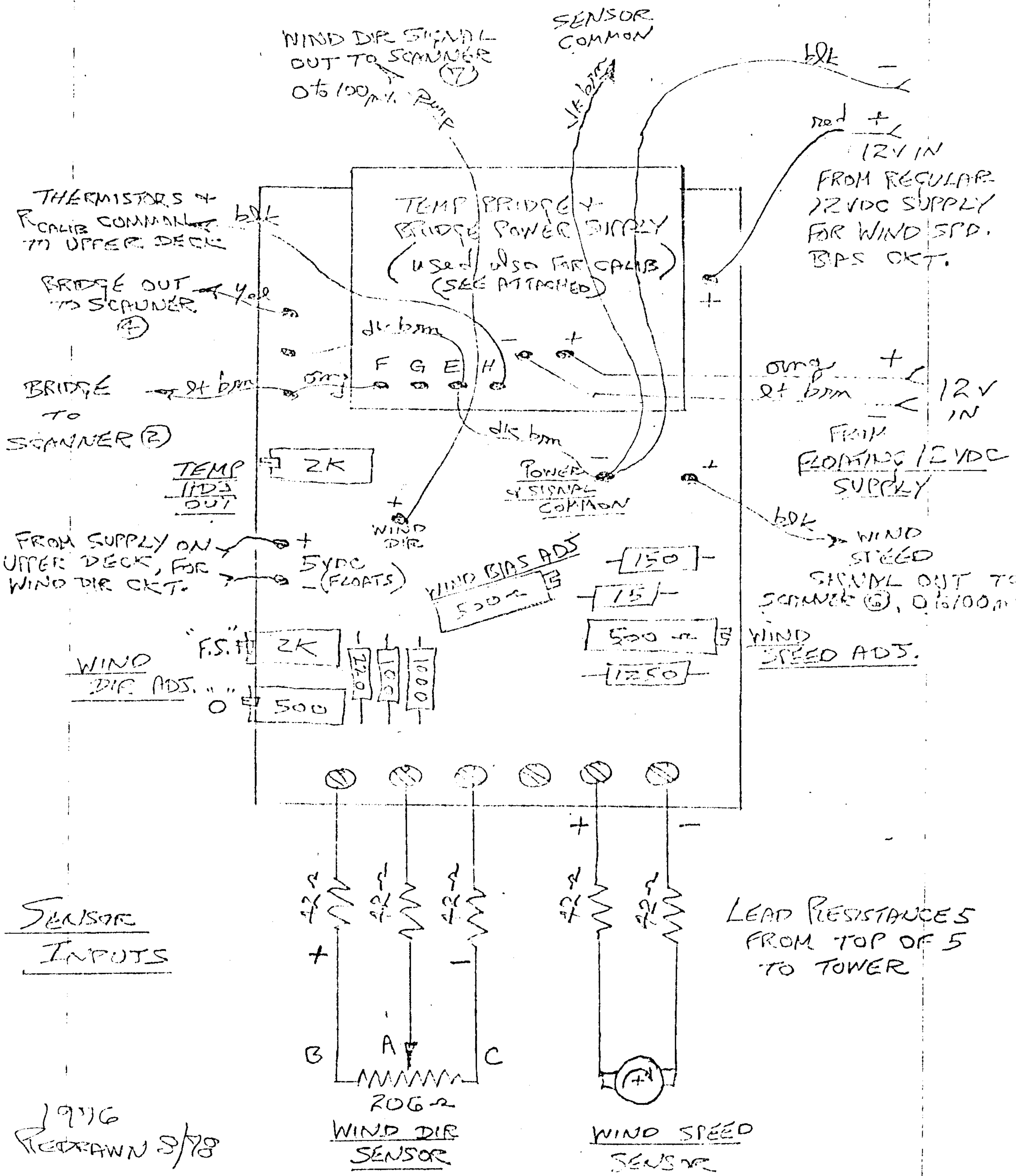
TIMING DIAG FOR STEVENS PASS TELEM. UNIT.

9

LOWER DECK

PARTS LAYOUT, ADJUSTMENTS, CONNECTIONS

(SEE ALSO SENSOR CKT. SCHEMATICS)

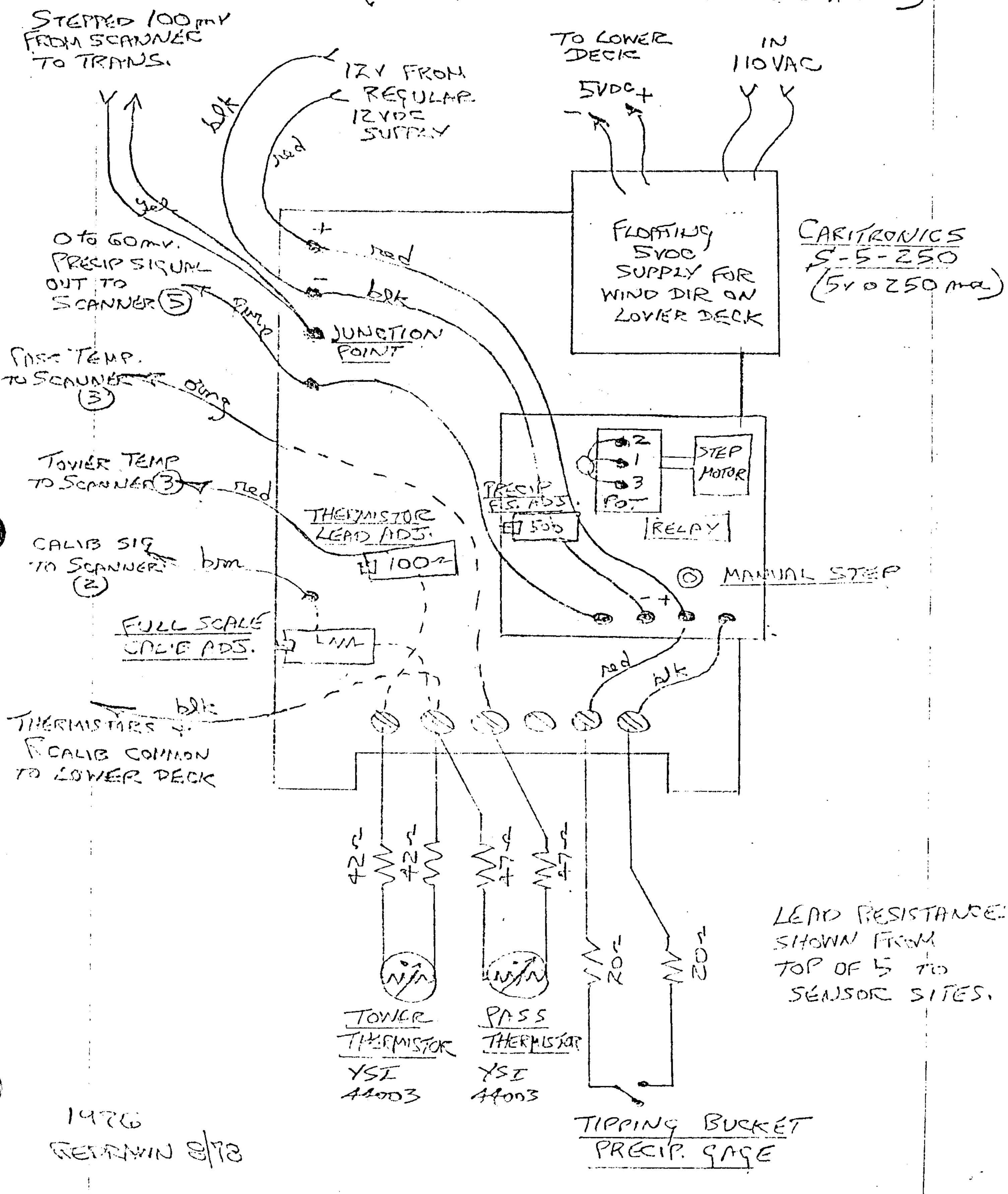


1976
REDRAWN 8/78

UPPER DECK

PARTS LAYOUT, ADJUSTMENTS, CONNECTIONS

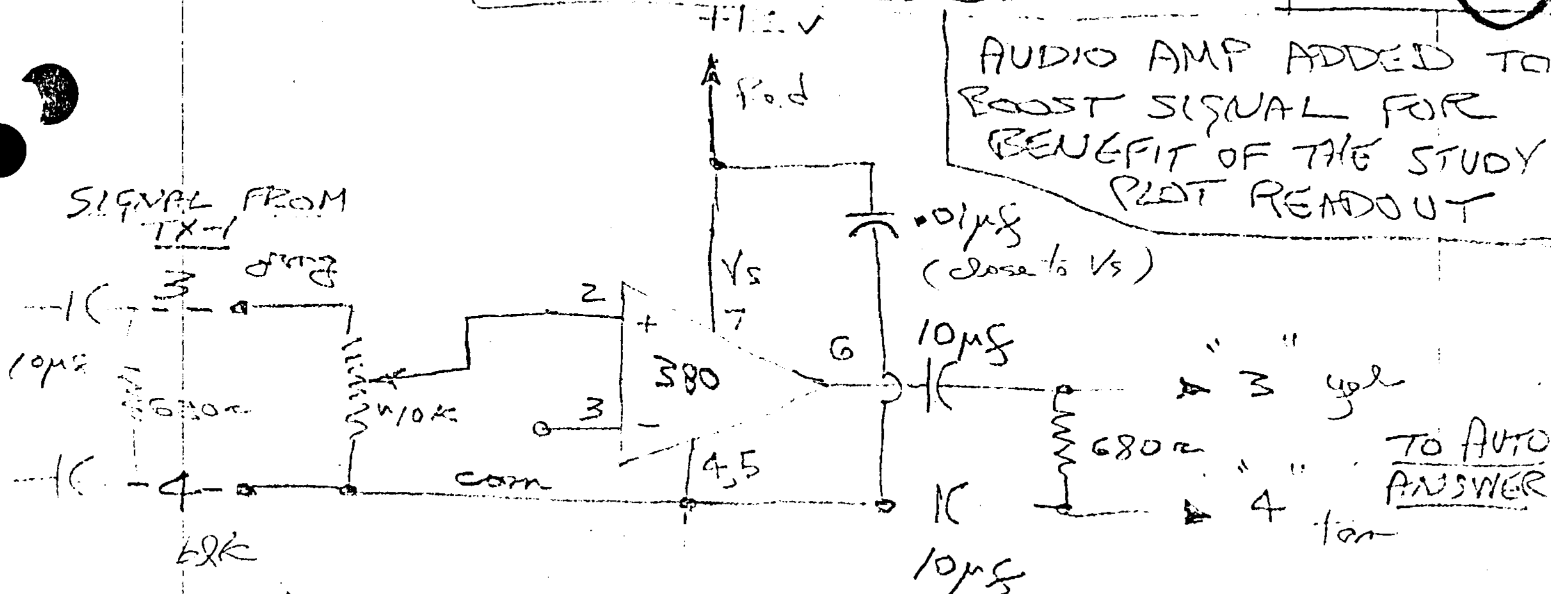
(SEE ALSO SENSOR CKT. SCHEMATICS)



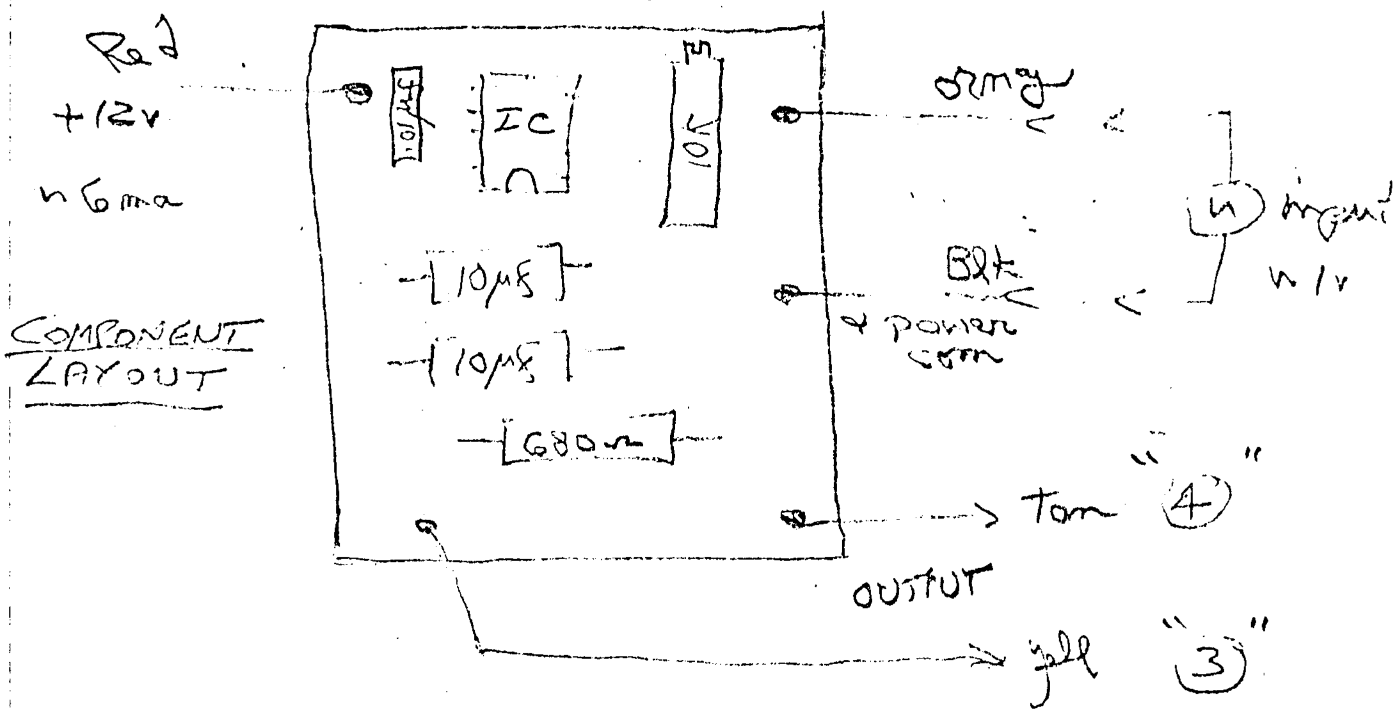
1976
REDRAWN 8/78

ADDED JAN 78

AUDIO AMP ADDED TO BOOST SIGNAL FOR BENEFIT OF THE STUDY PLOT READOUT

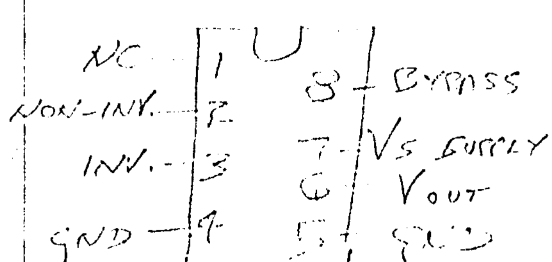


ADDED IN SERIES TO OUTPUT LEADS 3 & 4 FROM TX-1

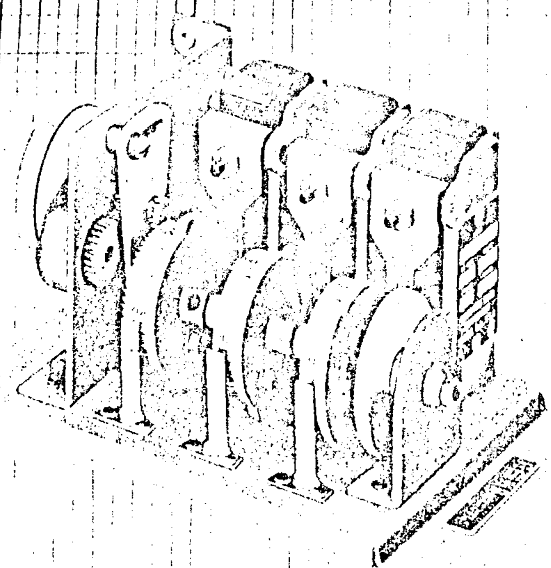


LM 380N-8
.6W max

~5V p-p



Youngs Corp 455-3460
(Yell, Fab75 book)



OPERATING INSTRUCTIONS

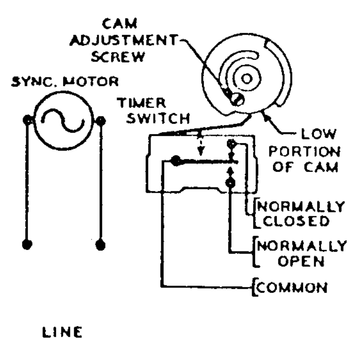
Series CM, MC, RA & RC

PROGRAMMING CAM TIMERS

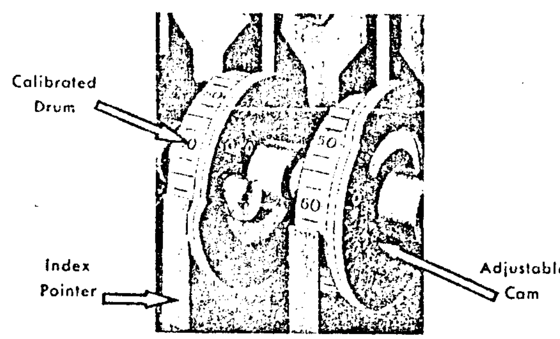
for

Catalog Bulletin #206

The switches used on the Cam Timer Series are Snap Action, Single Pole Double Throw totally enclosed micro switches, each switch is marked Normally Open (N.O.), Normally Closed (N.C.) and Common (C). These markings designate the condition of the switch in relation to the low or detent portion of the cam. A circuit is completed between the Common and the Normally Closed contact of the switch when actuator arm is in detent. Therefore, by setting the cam opening at 10%, the contacts will be closed for 10% and opened for 90% of the total time cycle. By wiring the switch to either N.O. or N.C. the load "on time" can be adjusted for a total of 2% to 98% of the total overall time cycle.



WIRING DIAGRAM ONE OR MORE CAMS



The cam opening may be adjusted by loosening the cam screw and turning the movable cam to the required degree of opening and then re-tightening the screw.

Refer to Catalog Bulletin #206 for gear rack chart and dimensions.

INDUSTRIAL TIMER
A UNIT OF ESTERLINE CORPORATION

TIMING SEQUENCE...MC & RC

(Multi-cam Types)

Each cam is individually mounted on the main shaft by means of a heavy duty friction which allows for easy finger adjustment of the timing sequence. The cams also incorporate a drum calibrated from 0% to 100%. Facing each calibrated drum is an index pointer for the cam sequencing.

1. Set first cam at zero on drum using index pointer as a guide.

2. Calculate the percentage of time difference when cam #2, 3, etc. should be operated. For example, if the overall time cycle is 60 seconds, the first cam is set at zero; if the next operation is to be started 15 seconds later, or 25% of the total overall time cycle, the second drum is set at 25%, against its index pointer. If the third operation is 15 seconds later, the third cam will be set at 50%, etc., additional cams are set in a like manner.

The knurled disc at the end of the camshaft should be held to prevent movement of the shaft while setting the sequence of individual cams. It may also be used to rotate the entire shaft for checking out program set-up, prior to timer operation.

CHANGING TIME CYCLE

1. Gear racks are interchanged by removing the gear rack screw. To prevent binding of gears when installing another gear rack, be certain there is a good amount of gear play. NOTE: the number and letter are stamped on the gear rack and should always face the cam shaft.

2. Additional gear rack assemblies for changing overall time cycles are listed in catalog gear rack chart.

ELECTRICAL CHARACTERISTICS

1. Cam Timers rated for 115 volt operation will operate within a range of 100 to 130 volts A.C.

2. 220 volt units will operate within a range of 205 to 240 volts A.C.

3. Switch rating 10 amps.

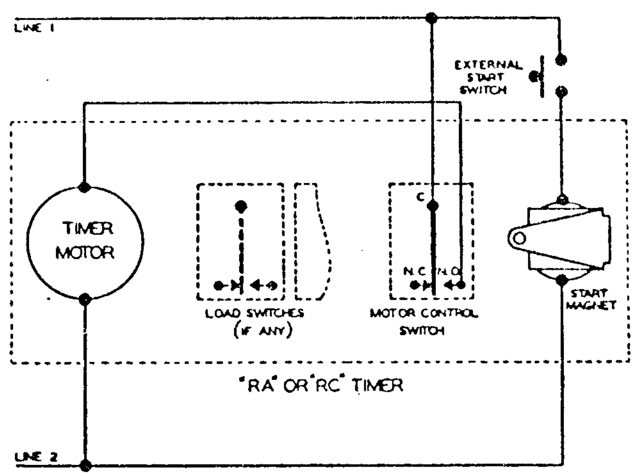
RA AND RC INSTRUCTIONS

For motor control switch and start magnet

Wire motor control switch as shown at right. Start timer by energizing the start magnet which, in turn, mechanically operates the switch.

For single cycle operation, energize the start magnet for a period which is less than the time required for the timer to complete a full cycle.

For continuous recycling the start magnet may be energized for any period of time. When released, the timer will run to the "O" position and stop.



Refer to Catalog Bulletin #206 for gear rack chart and dimensions.

programming cam timers concluded

gear rack chart

MODEL	RA 0	RA 1	RA 2	RA 3	RA 4	RA 5	RA 6	RA 7	RA 8	RA 9	RA 10	RA 11	RA 12
MODEL	CM 0	CM 1	CM 2	CM 3	CM 4	CM 5	CM 6	CM 7	CM 8	CM 9	CM 10	CM 11	CM 12
MODEL	MC 0	MC 1	MC 2	MC 3	MC 4	MC 5	MC 6	MC 7	MC 8	MC 9	MC 10	MC 11	MC 12
MODEL	RC 0	RC 1	RC 2	RC 3	RC 4	RC 5	RC 6	RC 7	RC 8	RC 9	RC 10	RC 11	RC 12
GEAR RACKS	SEE NOTE 2*												
E-12	40c	4 sec	10 sec	20s	40s	2m	3m20s	10m	20m	40m	2h	3h20m	8h
E-14	46.7c	4.67s	11.67s	23.33s	46.67s	2m20s	3m53s	11m40s	23m20s	46m40s	2h20s	3h53m	9h20m
D-12	48c	4.8s	12s	24s	48s	2m24s	4m	12m	24m	48m	2h24m	4h	9h36m
E-15	50c	5 sec	12.5s	25s	50s	2m30s	4m10s	12m30s	25m	50m	2h30m	4h10m	10h
E-16	53.3c	5.33s	13.33s	26.67s	53.3s	2m40s	4m27s	13m20s	26m40s	53m20s	2h40m	4h27m	10h40m
D-14	56c	5.6s	14s	28s	56s	2m48s	4m40s	14m	28m	56m	2h48m	4h40m	11h12m
C-12	1 sec	6 sec	15s	30s	60s	3m	5m	15m	30m	60m	3h	5h	12h
D-16	64c	6.4s	16s	32s	64s	3m12s	5m20s	16m	32m	64m	3h12m	5h20m	12h48m
E-20	66.7c	6.67s	16.67s	33.33s	66.67s	3m20s	5m33s	16m40s	33m20s	66m40s	3h20m	5h33m	13h20m
C-14	70c	7s	17.5s	35s	70s	3m30s	5m50s	17m30s	35m	70m	3h30m	5h50m	14h
D-18	72c	7.2s	18s	36s	72s	3m36s	6m	18m	36m	72m	3h36m	6h	14h24m
E-22	73.3c	7.33s	18.33s	36.67s	73.33s	3m40s	6m7s	18m20s	36m40s	73m20s	3h40m	6h7m	14h40m
C-15	75c	7.5s	18.75s	37.5s	75s	3m45s	6m15s	18m45s	37m30s	75m	3h45m	6h15m	15h
B-12	80c	8 sec	20s	[illegible]	80s	4m	6m40s	20m	40m	80m	4h	6h40m	16h
E-26	86.7c	8.67s	21.67s	43.33s	86.67s	4m20s	7m13s	21m40s	43m20s	86m40s	4h20m	7h13m	17h20m
D-22	88c	8.8s	22s	44s	88s	4m24s	7m20s	22m	44m	88m	4h24m	7h20m	17h36m
C-18	90c	9 sec	22.5s	45s	90s	4m30s	7m30s	22m30s	45m	90m	4h30m	7h30m	18h
B-14	93.3c	9.33s	23.33s	46.67s	93.33s	4m40s	7m47s	23m20s	46m40s	93m20s	4h40m	7h47m	18h40m
D-24	96c	9.6s	24s	48s	96s	4m48s	8m	24m	48m	96m	4h48m	8h	19h12m
B-15	100c	10 sec	25s	50s	100s	5m	8m20s	25m	50m	100m	5h	8h20m	20h
D-26	104c	10.4s	26s	52s	104s	5m12s	8m40s	26m	52m	104m	5h12m	8h40m	20h48m
B-16	106.7c	10.67s	26.67s	53.33s	106.7s	5m20s	8m54s	26m40s	53m20s	106m40s	5h20m	8h54m	21h20m
C-22	110c	11 sec	27.5s	55s	100s	5m30s	9m10s	27m30s	55m	110m	5h30m	9h10m	22h
D-28	112c	11.2s	28s	56s	112s	5m36s	9m20s	28m	56m	112m	5h36m	9h20m	22h24m
E-34	113.3c	11.33s	28.33s	56.67s	113.3s	5m40s	9m27s	28m20s	56m40s	113m20s	5h40m	9h27m	22h40m
A-12	2 sec	12 sec	30s	60s	2m	6m	10m	30m	60m	2h	6h	10h	24h
D-32	2s8c	12.78s	32s	64s	128s	6m24s	10m40s	32m	64m	2h8m	6h24m	10h40m	25h36m
C-26	2s10c	13 sec	32.5s	65s	130s	6m30s	10m50s	32m30s	65m	2h10m	6h30m	10h50m	26h
B-20	2s12c	13.2s	33.33s	66.67s	133.3s	6m40s	11m7s	33m20s	66m40s	2h13m	6h40m	11h7m	26h40m
D-34	2s16c	13.56s	34s	68s	136s	6m48s	11m20s	34m	68m	2h16m	6h48m	11h20m	27h12m
A-14	2s20c	14 sec	35s	70s	140s	7m	11m40s	35m	70m	2h20m	7h	11h40m	28h
D-36	2s24c	14.4s	36s	72s	144s	7m12s	12m	36m	72m	2h24m	7h12m	12h	28h48m
B-22	2s27c	14.7s	36.67s	73.33s	146.7s	7m20s	12m13s	36m40s	73m20s	2h27m	7h20m	12h13m	29h20m
A-15	2s30c	15 sec	37.5s	75s	150s	7m30s	12m30s	37m30s	75m	2h30m	7h30m	12h30m	30h
A-16	2s40c	16 sec	40s	80s	160s	8m	13m20s	40m	80m	2h40m	8h	13h20m	32h
C-34	2s50c	17 sec	42.5s	85s	170s	8m30s	14m10s	42m30s	85m	2h50m	8h30m	14h10m	34h
B-26	2s52c	17.2s	43.33s	86.67s	173.3s	8m40s	14m27s	43m20s	86m40s	2h53m	8h40m	14h27m	34h40m
A-18	3 sec	18 sec	45s	90s	3m	9m	15m	45m	90m	3h	9h	15h	36h
B-28	3s7c	18.7s	46.67s	93.33s	186.7s	9m20s	15m33s	46m40s	93m20s	3h7m	9h20m	15h33m	37h20m
A-20	3s20c	20 sec	50s	100s	200s	10m	16m40s	50m	100m	3h20m	10h	16h40m	40h
B-32	3s33c	21.3s	53.33s	106.7s	213.4s	10m40s	17m47s	53m20s	106m40s	3h33m	10h40m	17h47m	42h40m
A-22	3s40c	22 sec	55s	110s	220s	11m	18m20s	55m	110m	3h40m	11h	18h20m	44h
B-34	3s47c	22.7s	56.67s	113.3s	226.7s	11m20s	18m53s	56m40s	113m20s	3h47m	11h20m	18h54m	45h20m
A-24	4 sec	24 sec	60s	2m	4m	12m	20m	60m	2h	4h	12h	20h	48h
A-26	4s20c	26 sec	65s	130s	260s	13m	21m40s	65m	2h10m	4h20m	13h	21h40m	52h
A-28	4s40c	28 sec	70s	140s	280s	14m	23m20s	70m	2h20m	4h40m	14h	23h20m	56h
A-30	5 sec	30 sec	75s	150s	5m	15m	25m	75m	2h30m	5h	15h	25h	60h
A-32	5s20c	32 sec	80s	160s	320s	16m	26m40s	80m	2h40m	5h20m	16h	26h40m	64h
A-34	5s40c	34 sec	85s	170s	340s	17m	28m20s	85m	2h50m	5h40m	17h	28h20m	68h
A-36	6 sec	36 sec	90s	3m	6m	18m	30m	90m	3h	6h	18h	30h	72h

c-cycles s-seconds m-minutes h-hours

1. ORDERING INFORMATION—Model number selected from top of gear rack chart, gear rack, number of load switches, voltage and frequency.

   ALTERNATE ORDERING INFORMATION—Required time cycle (one complete rotation of cam shaft), number of load switches, ltage and frequency. Since some time cycles are available in 3 del numbers, the use of the ALTERNATIVE ordering informa- n may expedite delivery by allowing us to ship model in stock ith required time cycle.

2. Multi-switch cam timers requiring time cycles in shaded area may require high torque timing motor. This is due to increased torque encountered in rapid time cycles. To determine need of larger motor; multiply required time cycle in seconds by 2/3, the answer will be the maximum number of switches that can be operated with a standard timing motor. EXAMPLE: Time cycle 15 seconds. 2/3 x 15s=10. 10 switches can be operated at 15 seconds with a standard timing motor, more than 10 load switches requires the use of a high torque timing motor.

Price added for Hi-Torque motors:

Series	Motor Speed	120/60 Hz
MC-0 RC-0	1 RPS	$45.00
MC-1 RC 1	1/6 RPS	45.00

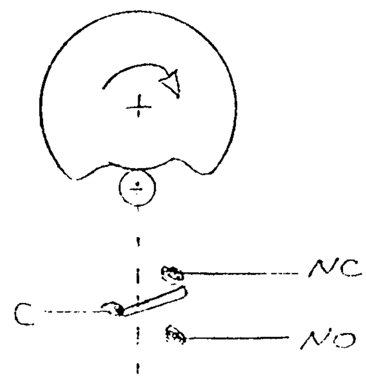
NOTES ON SCANNER CAMS

(REFER TO INDUSTRIAL TIMER OPERATING INSTRUCTIONS FOR PROGRAMMING TYPE PC CAM TIMERS)

- CYCLE TIME DEPENDS ON GEAR RACK

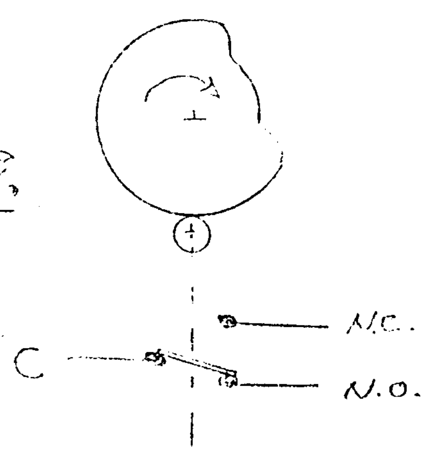
- IF AN ON TIME OF LESS THAN 50% OF THE CYCLE TIME IS DESIRED, USE THE N.C. CONTACT:

ON < 50%



- IF AN ON TIME OF MORE THAN 50% IS DESIRED, USE THE N.O. CONTACT:

ON > 50%



SEE INSTRUCTION SHEET FOR SETTING AND INDEXING CAMS

STANDARD POWER SUPPLIES

(99)

INSTRUCTION SHEET
SPS/CPS SERIES

FEATURES

- Voltage adjustment potentiometer
- Foldback current limiting
- 115/230 Vac, 47-440 Hz input
- 0.1% line/load regulation
- Temperature compensated circuitry
- 0.1% ripple
- Optional overvoltage protection
- Optional square current limiting
- Optional logic inhibit

DESCRIPTION

The SPS and CPS Series are series regulated, solid state power supplies designed to provide closely regulated DC voltages in all popular voltage and current levels. The output is floating, hence any voltage may be plus or minus or referenced to another voltage.

OPERATING PROCEDURE

For 115 Vac, 47-440Hz connect input leads to terminals 1 and 4 of transformer or input terminal block, terminals 1 & 3 and 2 & 4 will be jumpered. (Factory connection)

For 230 Vac input, remove jumpers between 1 & 3 and 2 & 4. Then jumper terminals 2 and 3 together and connect 230 Vac to terminals 1 and 4. Suggest twisted AC input wires if electrical noise reduction is prime concern.

Output terminals identified in figures on back of this sheet are marked + and -. Load should be connected to these terminals with due care to proper wire size and solid electrical connection for best results. Output voltages may be adjusted with the potentiometers identified in the figures located on the back of this sheet

SUGGESTED TEST PROCEDURE

Connect AC input power as outlined in operating procedure. Place a variac between Vac source and input to transformer. Place an AC voltmeter across transformer input terminals 1 and 4. Set input voltage for nominal 115 Vac with variac.

Place resistive load across output, check Vdc output specifications. DC voltmeter should be connected directly across output terminals. Greatest test errors are made at this point.

LINE REGULATION

With output adjusted to rated voltage, reduce input Vac to 104 volts and record or note output voltage. Then increase input Vac. to 126 Vac and note output voltage. Total output voltage change should not exceed .2% or ± .1%.

LOAD REGULATION

Set AC input voltage to 115 Vac. Place DC voltmeter across output terminals and record or note output voltage. A load resistor, equal to the rated load of the supply at selected DC voltage setting, is then applied to output terminals. The voltage change should be noted. This differential change should not exceed .2% or ± .1% of DC output voltage.

Output current adjust is accomplished by placing a load resistor of the desired value across output terminal; adjust current limit potentiometer identified in figures on back of this sheet until voltage starts to drop. This is the fold back point of current limiting, this control is factory set to 120% of rated output and sealed.

RIPPLE

With voltage set at 115 volts and full load across DC output terminals, the measurable AC voltage on output should not exceed 0.1% RMS.

OVERVOLTAGE PROTECTION

Optional overvoltage protection is available on most models. Consult the catalog selection guide or the listing on the next page for appropriate models or contact the factory for application note.

Loads generating high back EMF voltages should be checked with parallel diode, zener, or series diode to reduce detrimental effects on pass elements. It is recommended that the AC input circuit be fused. A suggested fuse rating is listed on the reverse side of this sheet.

SUGGESTED PRACTICES

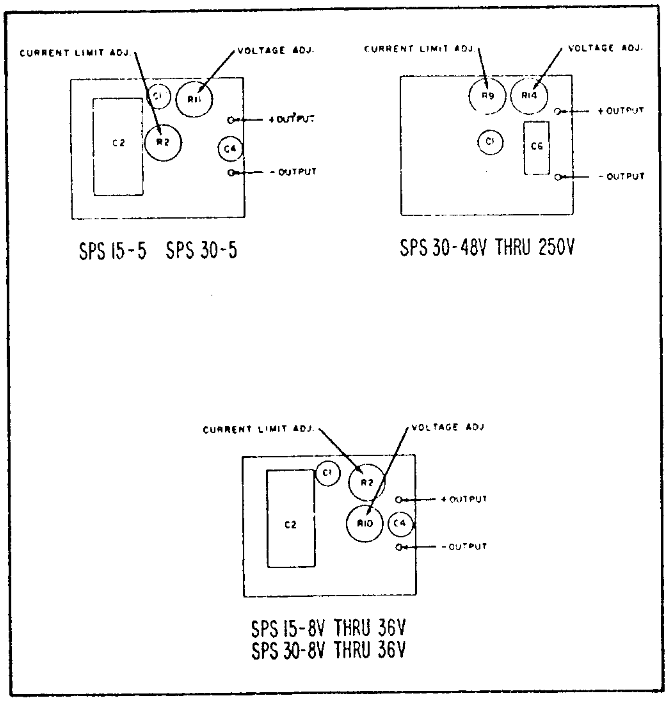
Moving air is desireable when mounting in a confined area. Chassis. may be attached to other heat dissipating surfaces to improve cooling characteristic at maximum ratings.

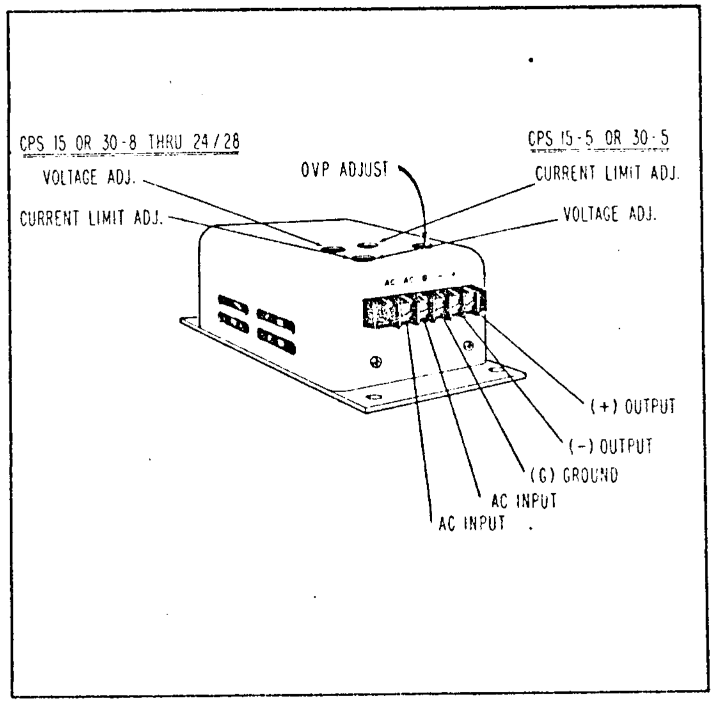
STANDARD POWER, INCORPORATED ■ 1400 South Village Way ■ Santa Ana, Calif. 92705 ■ phone (714) 558-8512

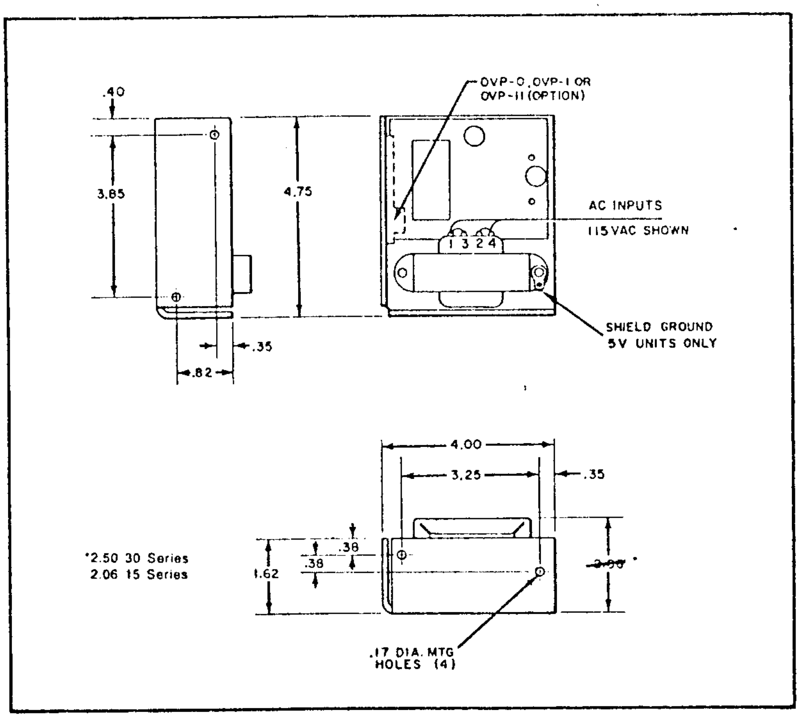
SPS / CPS 15 SERIES
SPS / CPS 30 SERIES

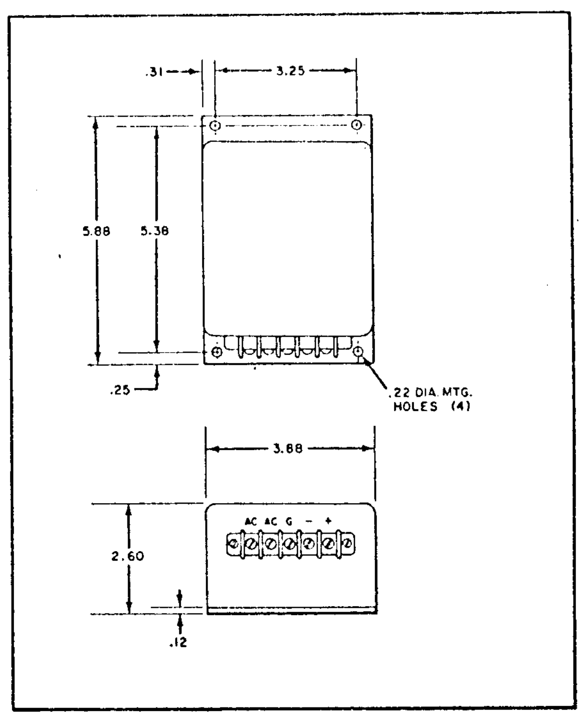
NOTES:

1. Recommended input fuse 1A, Type 3 AG.
2. OVP-1 is compatible with 5V through 28V models.
3. OVP-0 or OVP-11 may be used on 5V models.
4. If problems are encountered in series operation of two power supplies due to a common load connected across the two supplies, contact the factory for application note, AN 101.







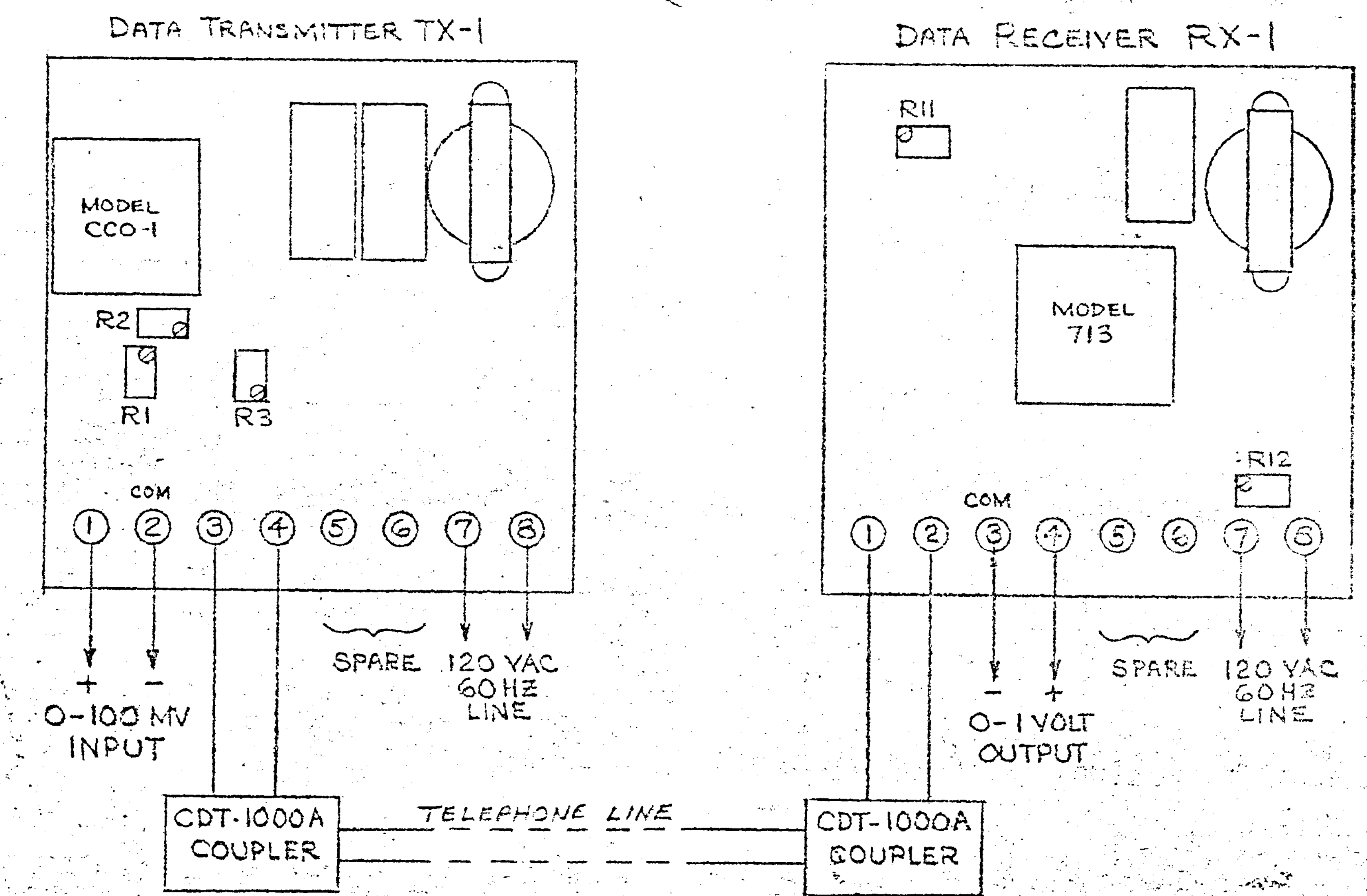


DATA TRANSMITTER MODEL TX-1
and
DATA RECEIVER MODEL RX-1

TECHNICAL DATA

An FSK system, compatable with the Bell Telephone DDD network and Data Access Arrangement using CDT couplers.

RICHARD-LEE COMPANY
New Providence, N.J.



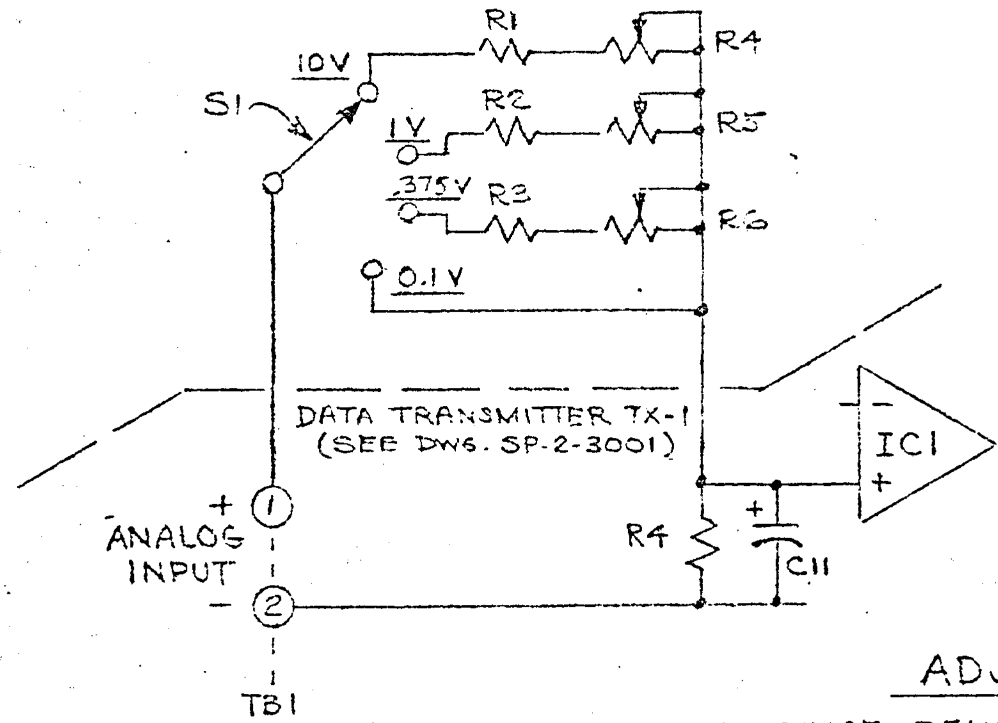
NOTE: FOR ADJUSTMENT PROCEEDURE SEE DWS: SP-2-3001 & SP-2-3002

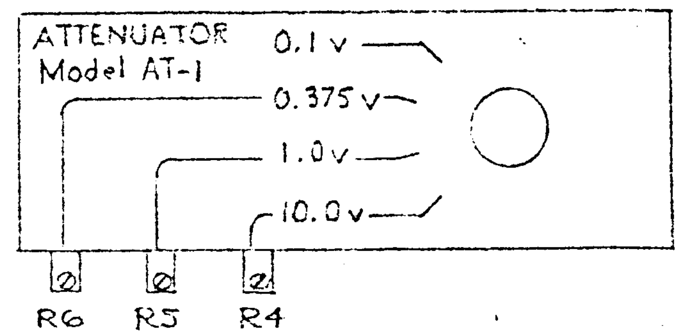
SIGNAL LEVEL: WITH DIRECT CONNECTION TX-1 TO RX-1 (NO TELE. LINE) APPROX. -4 DBM. WITH TELE. LINE APPROX -12 DBM. SIG MEASURED AT RX-1 TERMS. 1 & 2.

REVISIONS	RICHARD LEE CO. NEW PROVIDENCE, N. J. 07974	
	TITLE DATA TRANSMITTER/RECEIVER WIRING DIAGRAM	
	SCALE —	DR. BY H
	DATE 3/2/75	CK'D BY
	DRAWING NO. SP-2-4001	

102

FOR USE WITH DATA TRANSMITTER TX-1





PARTS LIST

S1 = CRL 2001
R1 = 453K, 1% RN55C
R2 = 20 K " "
R3 = 10 K " "
R4 = 100K, BOURNS 3006
R5 = 50K " "
R6 = 10K " "

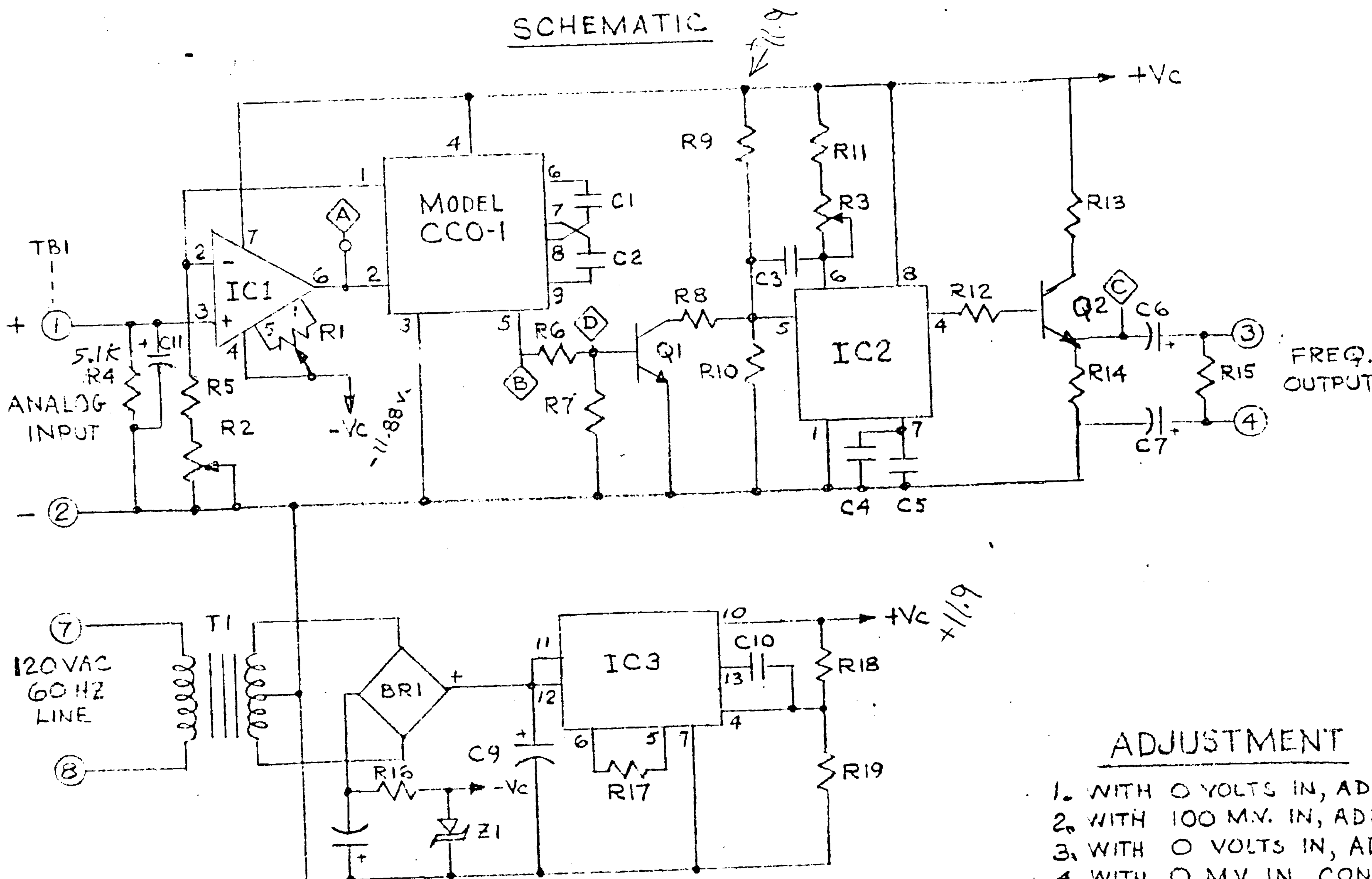
ADJUSTMENTS

1. SINCE SENSITIVITY OF MODEL TX-1 IS 100MV FOLLOW ADJ'MT PROCEEDURE FOR TX-1 & RX-1
2. WITH S1 SET TO .375V POSITION, APPLY 375 M.V. TO ANALOG INPUT TERMS 1 & 2 AND ADJUST R6 FOR FULL SCALE OUTPUT (1.0V) ON RECEIVER RX-1.
3. SET S1 TO 1.0V, APPLY 1.0V TO INPUT, & ADJ. R5 FOR F.S. (1.0V) ON RX-1
4. SET S1 TO 10.0V, APPLY 10V TO INPUT & ADJ. R4 FOR F.S. (1.0V) ON RX-1

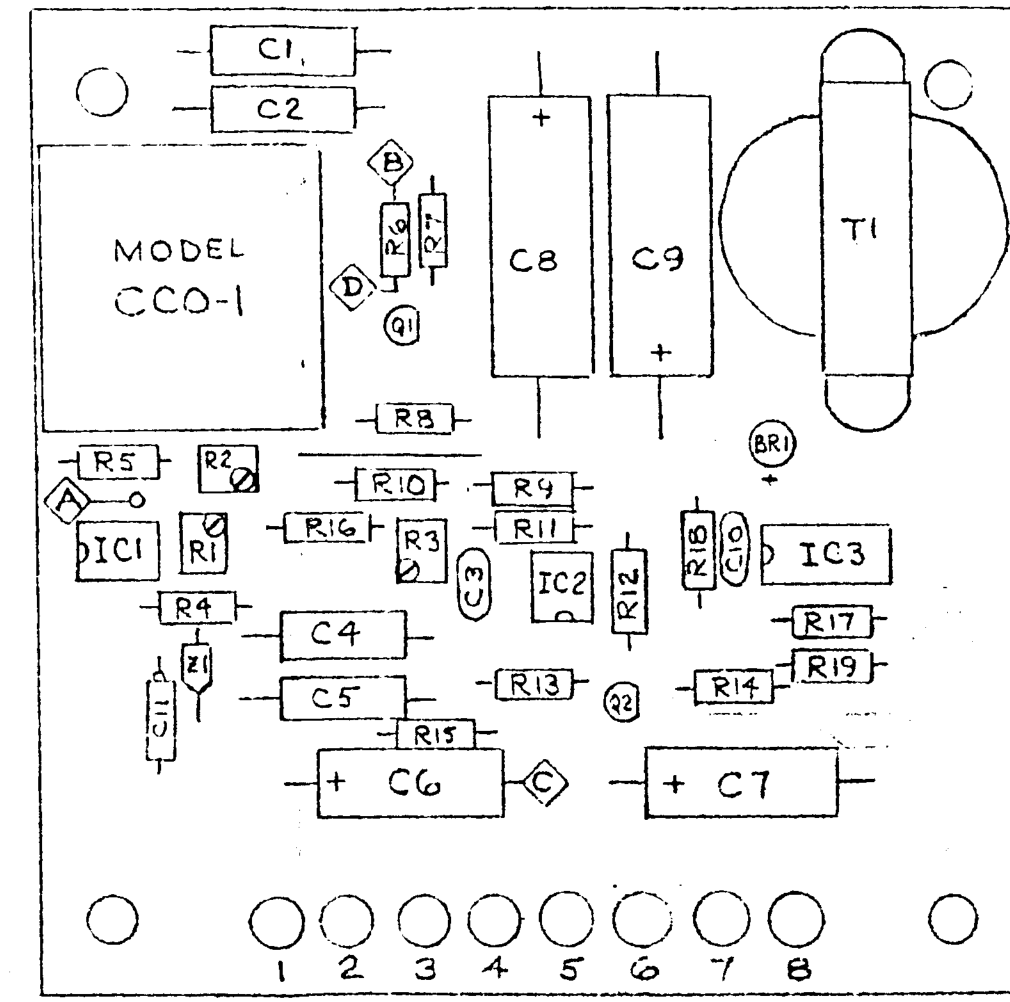
REVISIONS	RICHARD LEE CO. NEW PROVIDENCE, N. J. 07974		
	TITLE SIGNAL ATTENUATOR MODEL AT-1 SCHEMATIC, PARTS LIST & ADJ'MTS.		
	SCALE	DR. BY H	DRAWING NO. SP-3003
	DATE 8/18/75	CK'D. BY	

(107)

SCHEMATIC



COMPONENT LAYOUT



ADJUSTMENT

1. WITH 0 VOLTS IN, ADJ. R1 FOR SLIGHTLY NEG. VOLTS AT TEST POINT (A).
2. WITH 100 M.V. IN, ADJ. R2 FOR 300 HZ AT T.P. (B)
3. WITH 0 VOLTS IN, ADJ R3 FOR 2000 HZ AT T.P (C)
4. WITH 0 M.V. IN, CONNECT (D) TO TERM. 2 (COM) AND READ FREQ. AT T.P. (C) (SHOULD BE APPROX 1600 TO 1700 HZ)

PARTS LIST

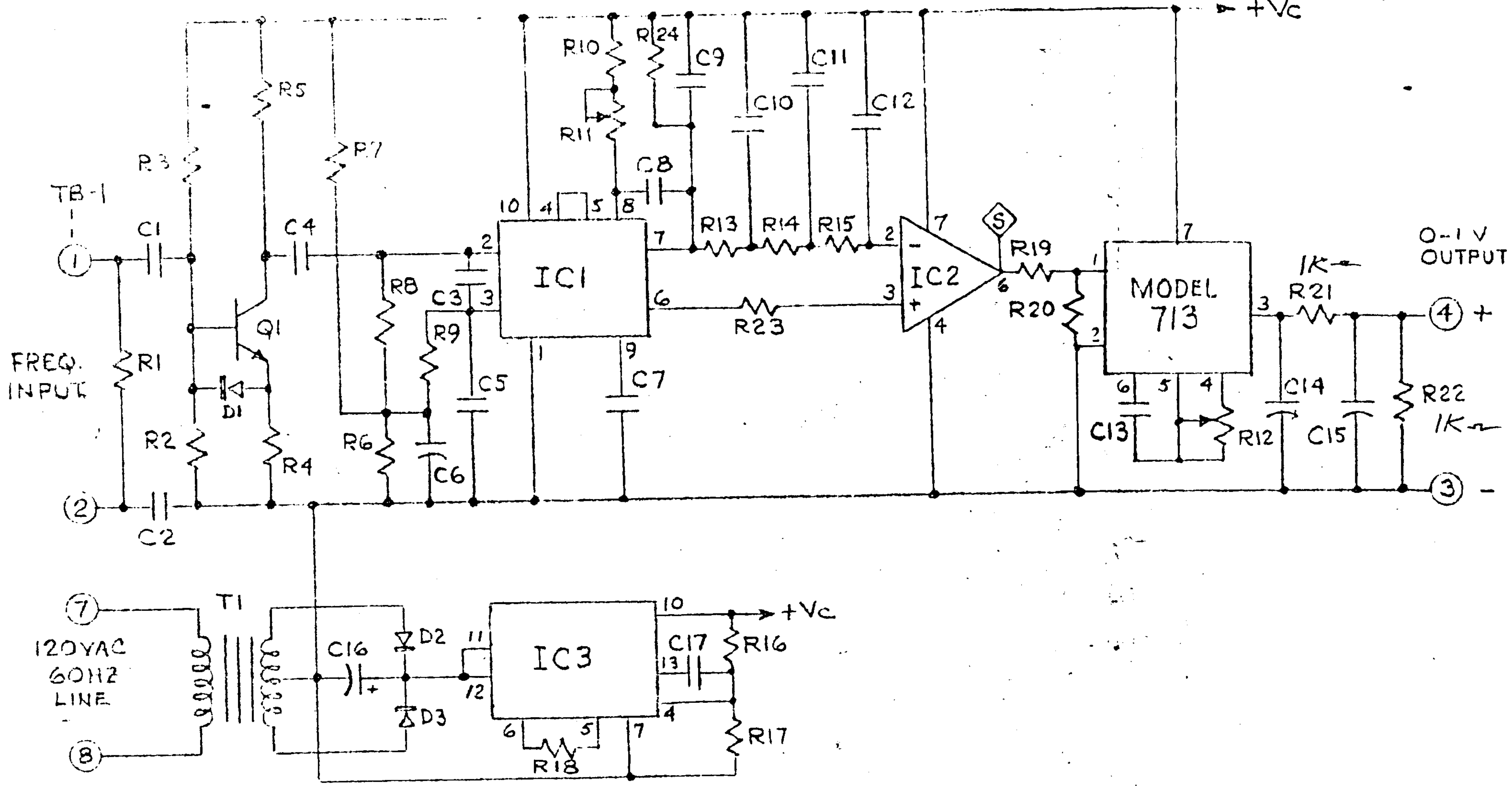
R1 - 10K POT, 3299W
R2 - 100Ω POT "
R3 - 10K POT "
R4 - 5.1 K, 1% RN55C
R5 - 75 Ω 1% RN55C
R6 - 22K
R7 - 22K
R8 - 82K
R9 - 2.2K
R10 - 18K
R11 - 10K, 1% RN55C
R12 - 3.9 K
R13 - 330Ω
R14 - 470Ω
R15 - 680Ω
R16 220Ω
R17 - 8.2K
R18 - 13.7K 1% RN55C
R19 - 20K 1% "

C1 - .047 (WMF)
C2 - .047 (WMF)
C3 - .001 DISC
C4 - .01 (WMF)
C5 - .005 (WMF)
C6 - 10 MF, 50V
C7 - 10 MF, 50V
C8 - 500MF, 50V
C9 - 500MF 50V
C10 - .005 DISC
C11 - 2.7MF 15V

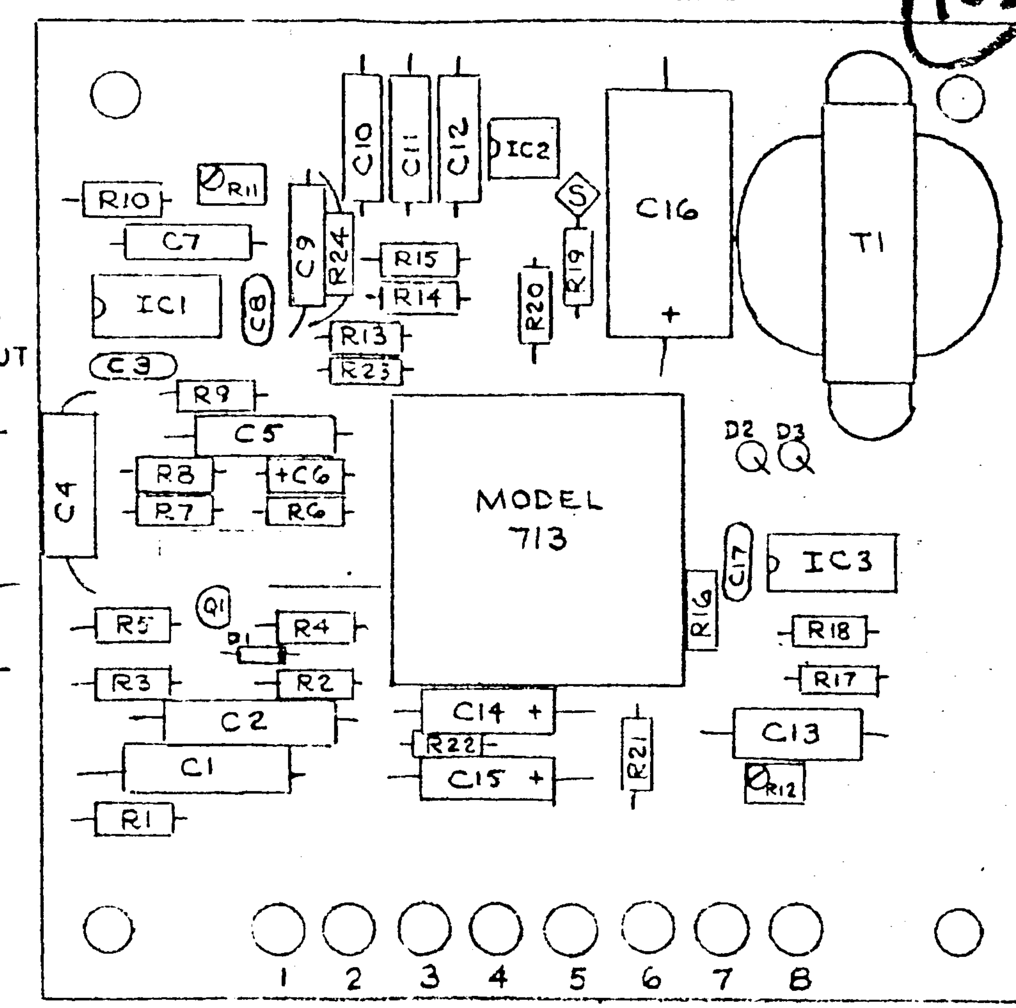
IC1	#46
IC2	#86
IC3	#42
MODEL	CCO-1
Z1	SZ 12.0A
BR1	VF-18
Q1	2N3704
Q2	2N3704
T1	P-8600
TB1	8-140Y
PC	TX-1
CASE	A-606CH

REVISIONS	RICHARD LEE CO. NEW PROVIDENCE, N. J. 07974		
CKT REVISED 3/4/75			
ADDED C11 6/10/75	TITLE DATA TRANSMITTER TX-1 SCHEMATIC, LAYOUT, PARTS LIST & ADJMTS.		
	SCALE —	DR BY H	DRAWING NO SP-2-3001
	DATE 2/24/75	CKD BY	

SCHEMATIC



COMPONENT LAYOUT



PARTS LIST

R1	680Ω	C1	.1 WMF	IC1	#85
R2	10K	C2	.1 WMF	IC2	#46
R3	47K	C3	.005 DISC	IC3	#42
R4	220Ω	C4	.047 WMF	MODEL	713
R5	1K	C5	.047 WMF	D1	1N914
R6	10K	C6	2.7MF, 15V	D2	1N4004
R7	15K	C7	.022 WMF	D3	1N4004
R8	2K	C8	.001 DISC	Q1	2N3711
R9	2K	C9	.022 WMF	T1	P-8600
R10	470Ω	C10	.022 WMF	TB1	8-140Y
R11	10K POT, 3299W	C11	.022 WMF	PC	RX-1
R12	50K POT, 3299W	C12	.022 WMF	CASE	A-606CH
R13	10K	C13	.33 WMF		
R14	10K	C14	100MF, 12V		
R15	10K	C15	100MF, 12V		
R16	13.7K 1% RN55C	C16	500MF, 25V		
R17	20K 1% RN55C	C17	.005 DISC		
R18	8.2K				
R19	47K				
R20	910Ω				
R21	1K				
R22	1K 1% RN55C				
R23	33K				
R24	FACTORY ADJ. (100K T/P)				

ADJUSTMENT

1. CONNECT DATA TRANSMITTER (TX-1) TO DATA RECEIVER (RX-1) PER DWG. SP-2-4001 ADJUST TRANSMITTER PER DWG. TX-1-3001 AND APPLY 100MV TO THE INPUT.
2. WITH A SCOPE CONNECTED TO Ⓢ ADJUST R11 FOR A SYMETRICAL SQUAREWAVE.
3. ADJUST R12 FOR +1.0 VOLTS OUTPUT (TERM'S 3 & 4)

REVISIONS
REVISION OF ALL CKTS 3/4/75
ADDED R24 8/10/75

RICHARD LEE CO.
NEW PROVIDENCE, N. J. 07974

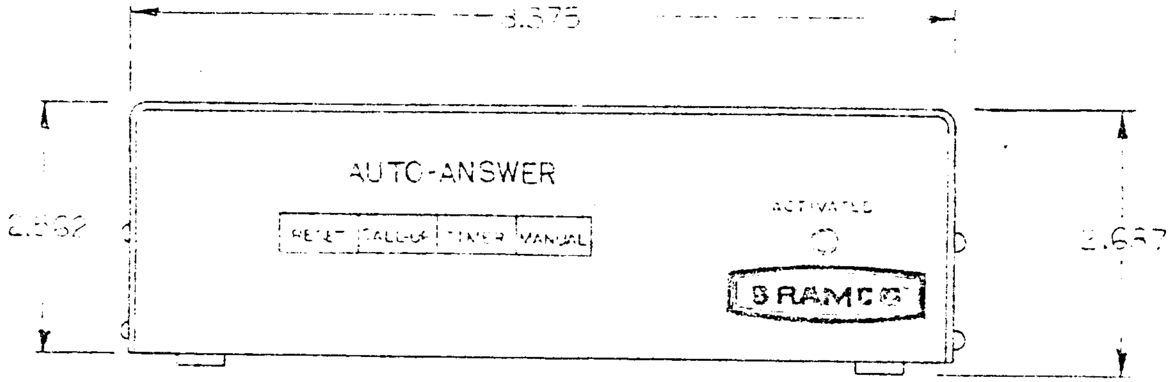
TITLE DATA RECEIVER RX-1
SCHEMATIC, LAYOUT, PARTS LIST & ADJUSTMENT

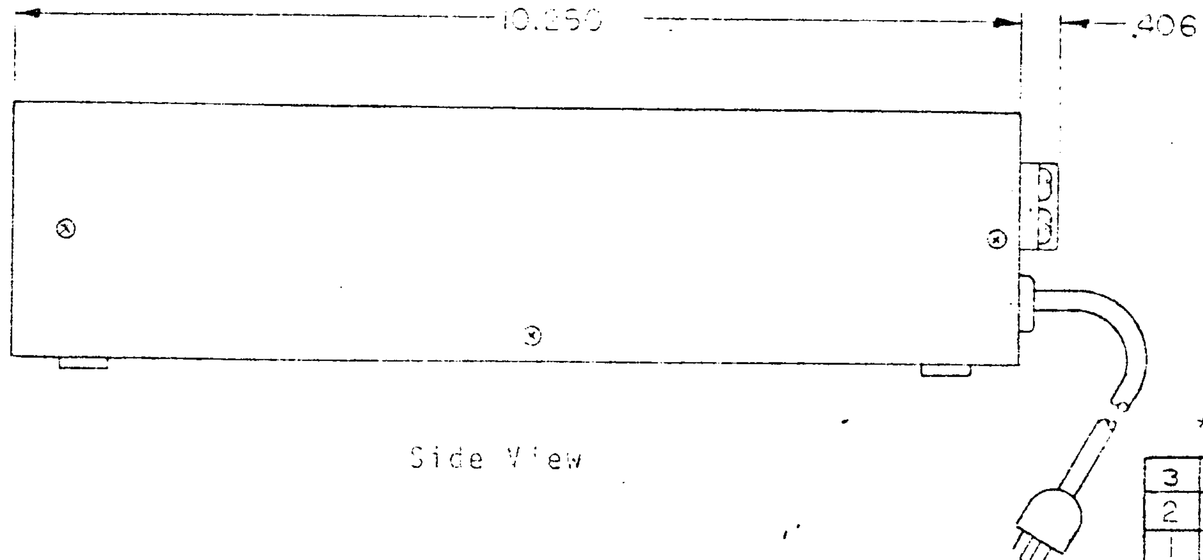
SCALE —	DR. BY H	DRAWING NO.
DATE 3/1/75	CK'D BY	SP-2-3002

105

A02443-X00XX

Front View





Side View

SUFFIX - X00XX

No. of Rings
-1 (1 only)(Std.
-3 (1,2, or 3)*

Diverted line terminals
-0 Transformer(st
-1 Hybrid

Power input
-1 12VDC
-2 24 VDC
-4 48 VDC
-5 117 VAC

*Factory set to 2 ring position

REV. NO.	E.R. NO.	REVISIONS	BY	
3	8913	GENERAL UPDATE	F.	
2	8615	ADD ...	KL	
1	8501	...	KLN	3

MATERIAL: Ckt. D14331-00001

FINISH

DFT. KLN

CKR.

ENGR.

FINAL ASSY

NEXT ASSY

SCALE

MODEL

SHEET 1 OF

BRAMCO CONTROLS DIV.
LEDEX INC.

DIMENSIONS ARE IN INCHES

TITLE:

A02443-X00A

SPECIFICATIONS:

1. a. Power Input: 12, 24, 48 VDC or 117 VAC.

   b. Temperature range: -30°C to +60°C

2. Typical line loss (input to diverted output)
   Transformer - 3.5 db
   Hybrid - 6.5 db (balanced)

3. Output control functions: 2 form C contacts sets (5 amp.).

4. Controls:

   a. Call-up - Momentarily depressing the "call-up" switch will cause the unit to activate in the same manner as if an incoming call was received. This will allow the operator to test the system operation, such as when a message recorder is being used.

   b. Timer - When the timer switch is in the "out" position, the unit will permanently latch when an incoming call is received or when the "call-up" switch is depressed. When the timer switch is moved to the "in" position, the unit will latch on for a predetermined time and then will automatically reset and await another call. The timing function is adjustable from 5 seconds to 7.5 minutes by varying the "time adj." pot. on the rear panel. If longer timing is required, remove the cover from the unit and move the timing program lead** from the "Lo" position to the "Hi" position. This will allow timing adjustable from 7.5 minutes to 20 minutes. (Factory set at 1 min.)

   c. Manual - When the manual switch is in the "out" position, the unit will automatically answer the telephone. When the switch is moved to the "in" position, the unit will not respond and the telephone must then be answered manually.

   d. Reset - Momentarily depressing this switch will completely reset the unit. The unit will then await another incoming call.

**Dark Blue Wire

REV. NO.	E.R. NO.	REVISIONS
4	9189	CHANGE TO PROPER COUPLER

MATERIAL
FINISH
DFT. KLN
CKP.
ENGR.
FINAL ASS'Y
SUPERSEDES:
SCALE
MODEL:
NEXT ASS'Y
SHEET

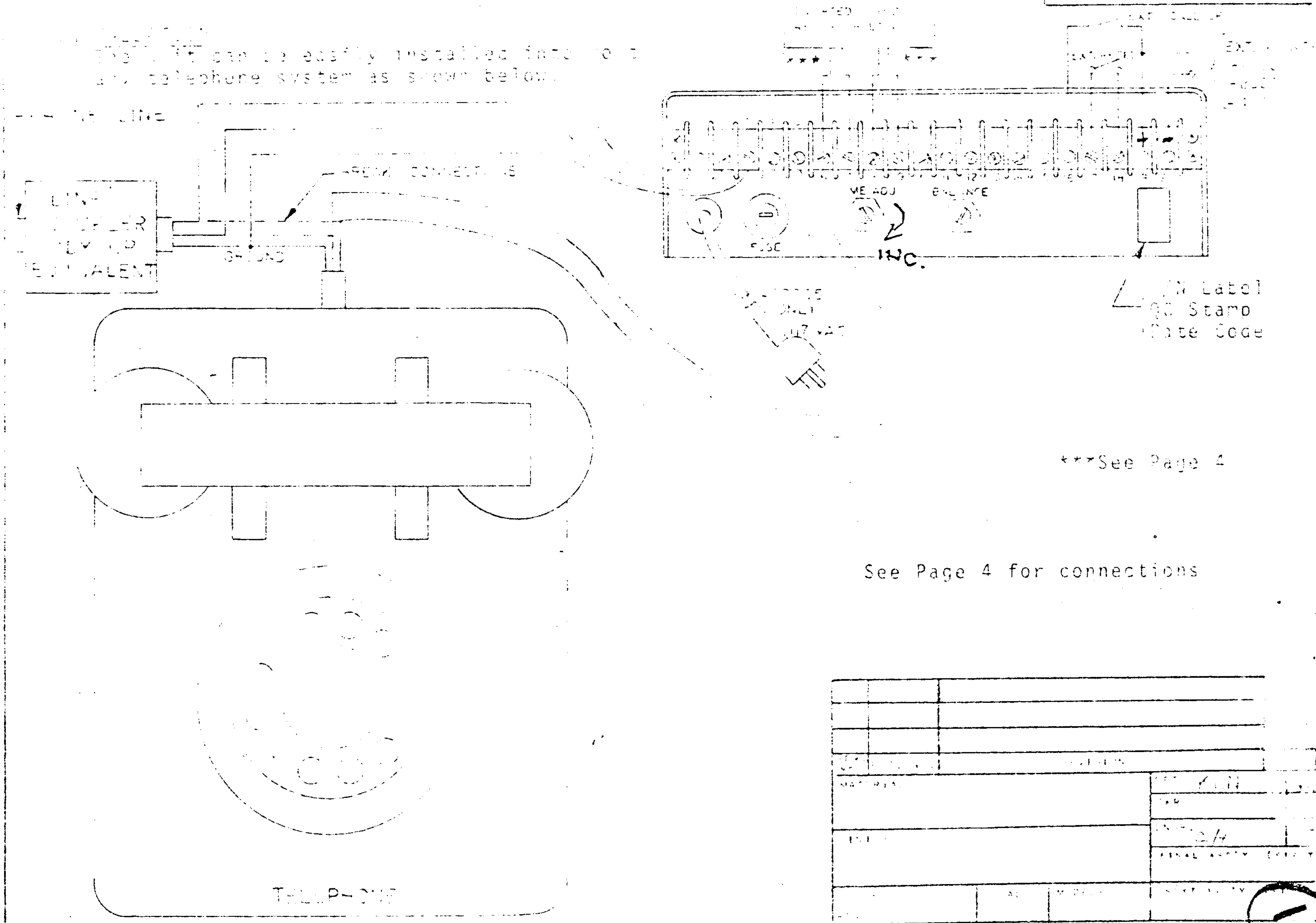
BRAMCO CONTROLS DIV.
LEDEX INC.

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

TITLE:

THE PROPERTY OF BRAMCO CONTROLS DIV. ... FURNISHED ... SOLELY FOR ENGINEERING INFORMATION. THE FURNISHING OF THIS DRAWING DOES NOT CONVEY ANY REPRODUCTION ... RIGHTS.

... can be easily installed into any telephone system as shown below.



***See Page 4

See Page 4 for connections

BRAMCO CONTROLS DIV.

TITLE:

Terminal No.	Connection	
1	Phone Line - Tip	Through Coupler
2	Phone Line - Ring	Through Coupler
3	Phone Line - Ground	Through Coupler
4	Telephone - Tip	
5	Telephone - Ring	
6	Diverted Line ***	
7	Diverted Line ***	
8	Diverted Line ***	
9	Diverted Line ***	
10	N.C. Contact	Form "C" output No. 1
11	C. Contact	Form "C" output No. 1
12	N.O. Contact	Form "C" output No. 1
13	N.C. Contact	Form "C" output No. 2
14	C. Contact	Form "C" output No. 2
15	N.O. Contact	Form "C" output No. 2
16	External "Call-up"	
17	External "Reset"	
18	Regulated B-	
19	+ D.C. Power Input	
20	- D.C. Power Input	

***Standard Output
Terminals 6 and 7

Hybrid Output
Transmit terminals 6 and 7

Receive terminals 8 and 9

(See suffix chart)

Hybrid balance pot. should be set lowest level of cross talk between transmit and receive terminals. If a lower level is needed, the .27 uf capacitor (C11) in the hybrid circuit should be varied in value.

DR.	KLN
CKR	
ENGR.	
FINAL ASSY	
NEXT ASSY	
SHEET	4 of 4
NO.	A02443-X00XY

BRAMCO CONTROLS DIV.
LEDEX INC.
PIQUA, OHIO

TITLE: AUTO-ANSWER

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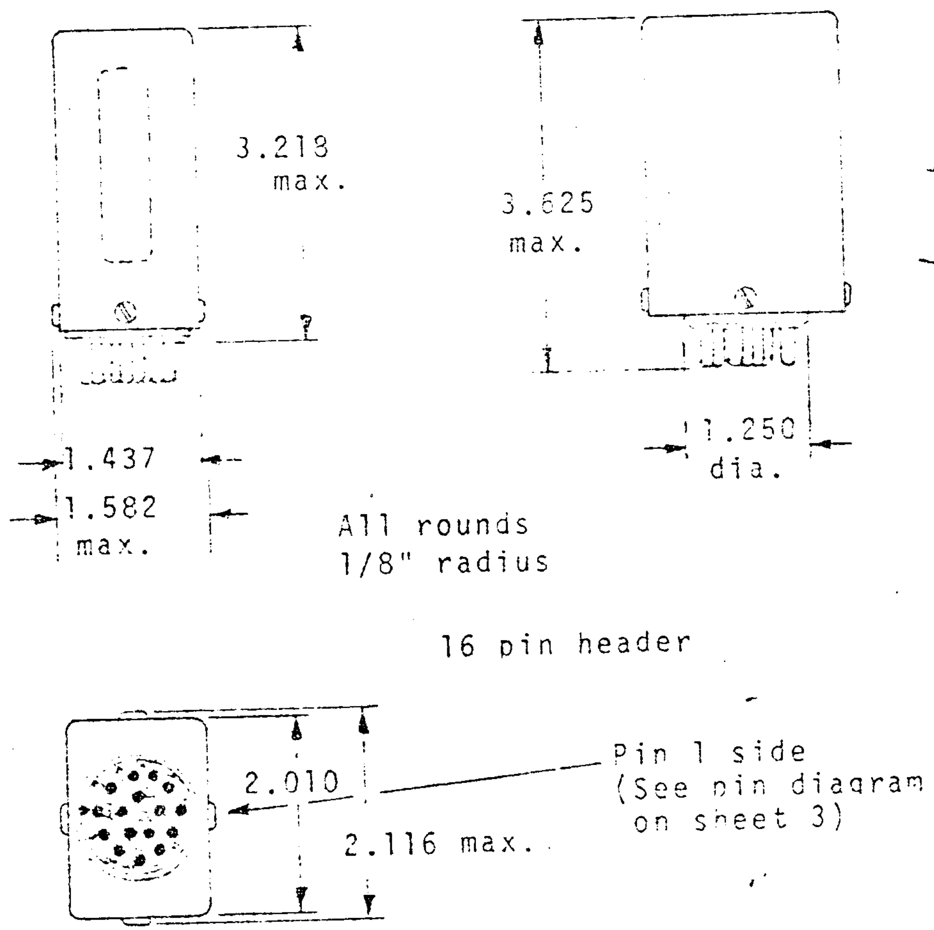
There is a very large (21 X 33") schematic of the auto-answer circuit (Ledex Inc.) which we had indented to put here. However, we have not been able to get it reproduced because of its large size. Phil Taylor has this schematic, if anyone is interested in seeing it. We are trying to obtain copies from Ledex in Ohio.

NO. A02331-0000X REV.

Name plate this side up
(on keyed side)



PLUG CONNECTIONS

1. (-) } Supply voltage
2. (+) }
3. } Tone output
4. }
5. Program Common

6. 697 Hz } Low freq
7. 770 Hz } tone
8. 852 Hz } program
9. 941 Hz }

10. 1209 Hz } High freq
11. 1336 Hz } tone
12. 1477 Hz } program
13. 1633 Hz }

A02331-0000X

Power supply
1 = 12 VDC
2 = 24 VDC
4 = 48 VDC

Note: *Touch-Tone is a registered service mark of AT&T Co.

REV. NO.	E.R. NO.	REVISIONS	BY
1			

MATERIAL: CKT. A13727-00001	DFT. KLN
	CKR.
FINISH: Blue Paint	ENGR.
SUPERSEDES: REV	SCALE 1:2
MODEL:	NEXT ASS'Y
SHEET 1 OF 3	NO. A02331-0000X

BRAMCO CONTROLS DIV. | DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED | TITLE: TOUCH-TONE* ENCODER MODULE

SPECIFICATIONS

1. Output: The encoder generates a two tone simultaneous code compatible with Touch-Tone* equipment.

   a. Frequencies:

Digit	Frequencies	
1	697 Hz	1209 Hz
2	697 Hz	1336 Hz
3	697 Hz	1477 Hz
4	770 Hz	1209 Hz
5	770 Hz	1336 Hz
6	770 Hz	1477 Hz
7	852 Hz	1209 Hz
8	852 Hz	1336 Hz
9	852 Hz	1477 Hz
*	941 Hz	1209 Hz
0	941 Hz	1336 Hz
#	941 Hz	1477 Hz
I (13)	697 Hz	1633 Hz
II (14)	770 Hz	1633 Hz
III (15)	852 Hz	1633 Hz
IV (16)	941 Hz	1633 Hz

   b. Frequency stability: ±0.5% at 25°C
      ±1.5% from -30 to +60°C

   c. Level: Adjustable to 0.5 VRMS composite into 600 ohms. The high frequency tone level is approximately equal to the low frequency tone level.

2. Input Power
   12 volt unit: 10.5 to 14 VDC
   24 volt unit: 21 to 28 VDC
   48 volt unit: 42 to 56 VDC

3. Temperature Range: -30 to +60°C

REV. NO.	E.R. NO.	REVISIONS	BY	
MATERIAL		DFT. KLN	DATE	
		CKR.	DATE	
FINISH		ENGR. EJB	REL. DATE 3/27/72	
		FINAL ASS'Y (FIRST USED)		
SUPERSEDES: REV	SCALE	MODEL:	NEXT ASS'Y (FIRST USED)	

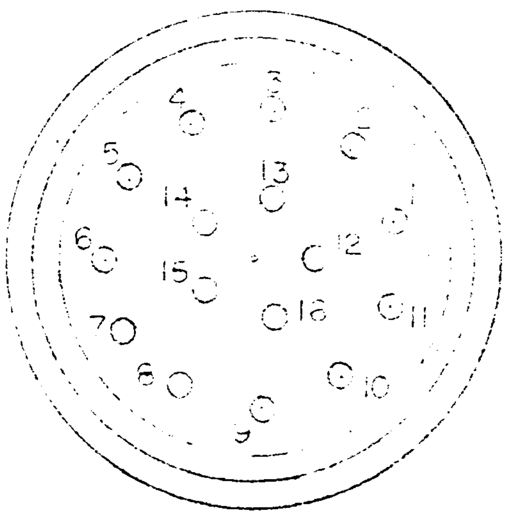
BRAMCO CONTROLS DIV. LEDEX INC. PIQUA, OHIO	DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED LIMITS: FRACTIONS ±1/64 DECIMALS ±	TITLE: TOUCH-TONE*ENCODER MODULE	SHEET 2 OF 3	NO. A02331-0000X

115

OPERATION

Connect one low frequency tone program terminal and one high frequency tone program terminal to the program common terminal to generate the desired code digit. (When no tone program terminals are connected, the supply voltage or the tone output should be disconnected to prevent hum or noise from being applied to the output load.)

PIN DIAGRAM
(Exploded View)

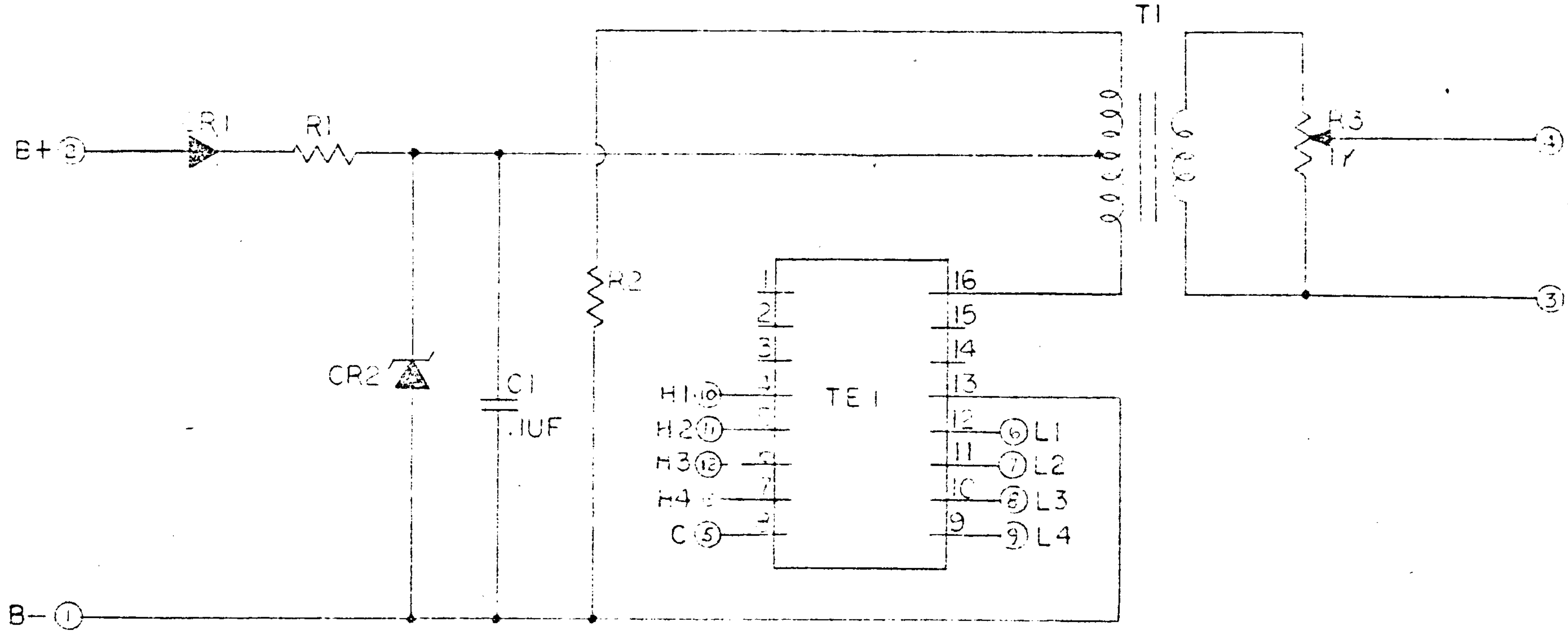


E.R. NO.	REVISIONS	BY

MATERIAL	DFT. KLN	DATE
	CKR.	DATE
FINISH	ENGR. EJQ	
	FINAL ASS'Y (FIRST USED)	
SUPERSEDES: REV	SCALE	MODEL:	NEXT ASS'Y

BRAMCO CONTROLS DIV. LEDEX INC.	DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED	TITLE: TOUCH-TONE* ENCODER MODULE	SHEET 3 OF 3	NO. A02331-0000X

No. A13727-000[illegible]X



Suffix	Voltage	R1	R2	CR2
-00001	10.5 to 14	Short	910	Omit
-00002	21 to 28	Short	1500	Omit
-00004	42 to 56	1000 ohm 2 W	910	1N4742A

CR1 1N4004
T1 A13216-00001
TE1 A13554-00001

REV. NO.	E.R. NO.	REVISIONS	BY
2	9584	correct suffix	R[illegible]
1	8099	[illegible]	P[illegible]

MATERIAL

FINISH

SUPERSEDES:

REV

DFT. KLN

CKR.

ENG. B. Schmid 11-[illegible]-7[illegible]

FINAL ASS'Y (FIRST USE) A02331-0000X

NEXT ASS'Y

SCALE

MODEL:

BRAMCO CONTROLS DIV.
LEDEX INC.
PIQUA, OHIO

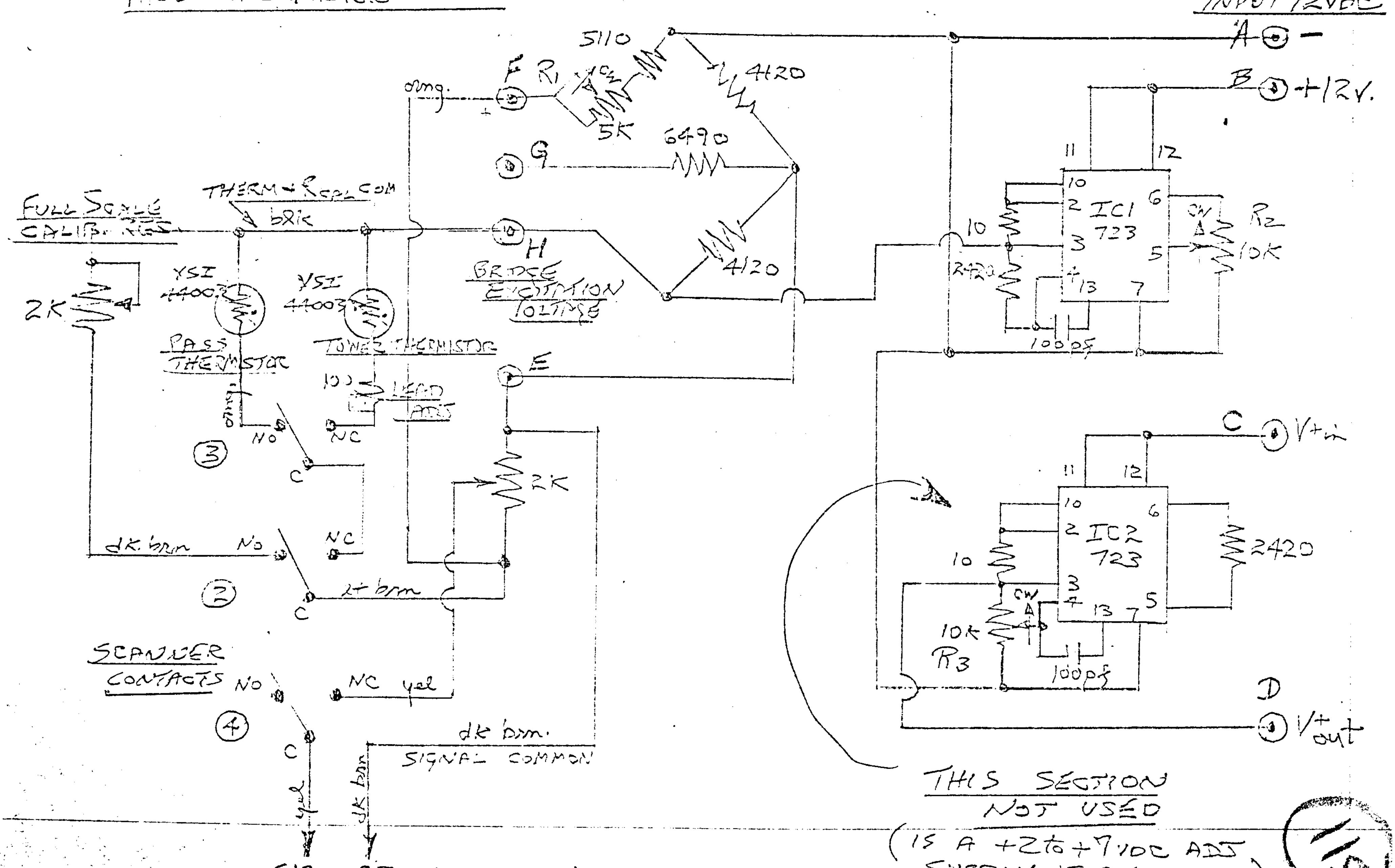
DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

TITLE: TOUCH-TONE* ENCODER MODULE CIRCUIT

SHEET 1 OF 1

NO. A13727-0000X

Bridge Ckt. and Simplified Relationship to Scanner and Thermistor Inputs

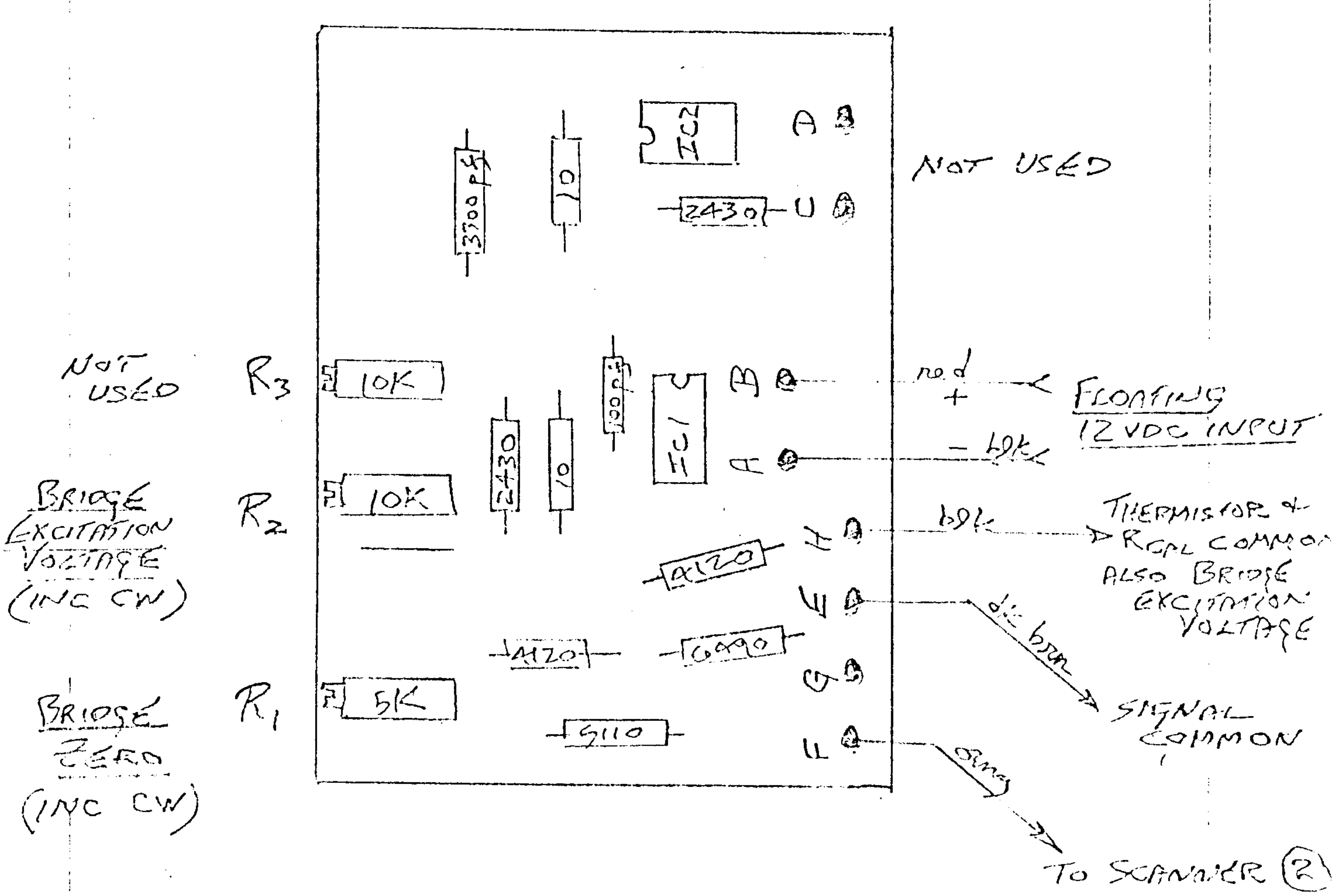


To Terminal Posts on Lower Deck

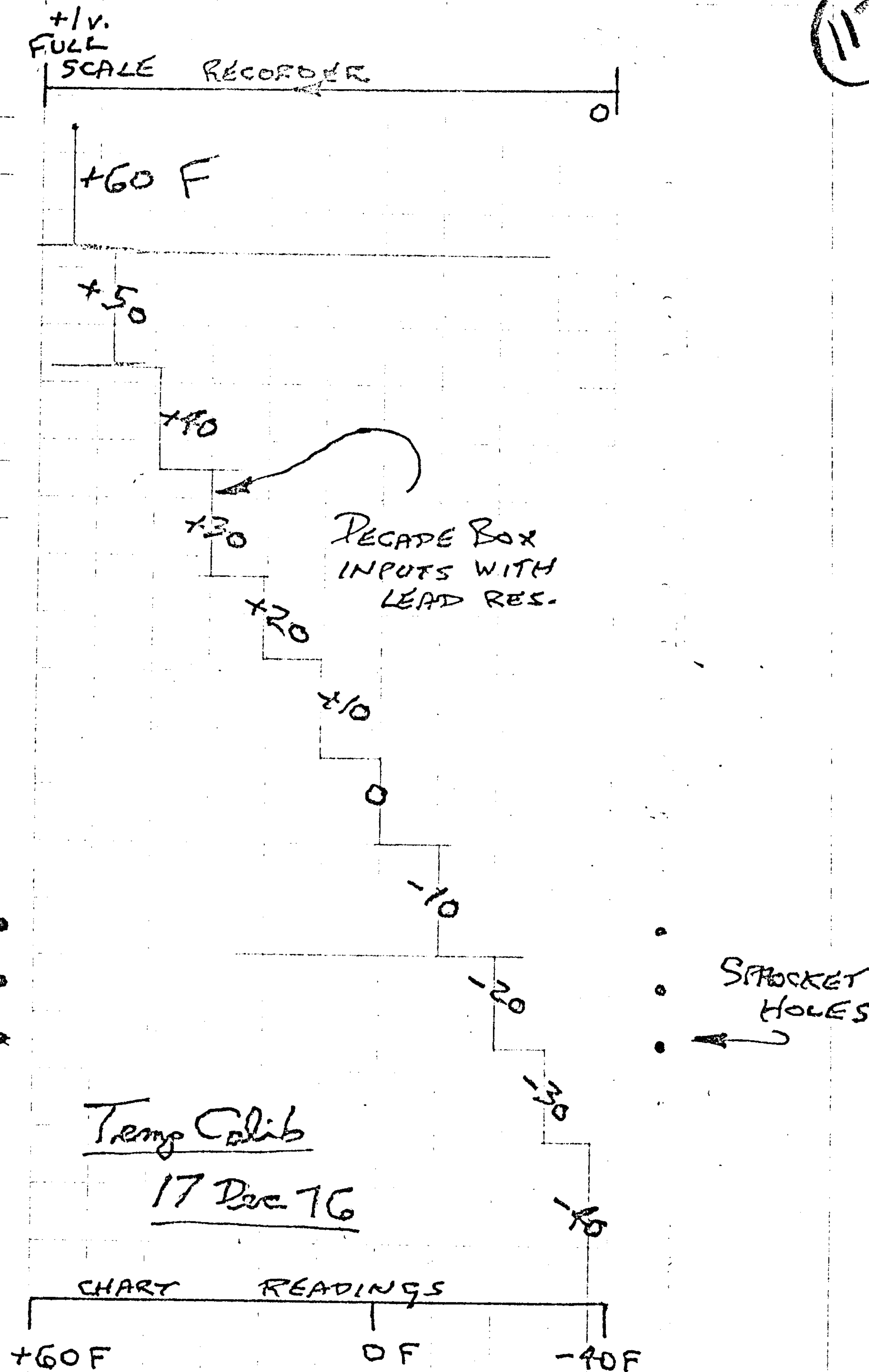
115

BRIDGE CKT LAYOUT AND ADJUSTMENTS

LOCATED ON LOWER DECK



IC1. IC2 μA723 VOLTAGE REGULATOR
(SEE ATTACHED FOR SPECS)


+1 v. FULL SCALE RECORDER
0
+60 F
+50
+40
+30
+20
+10
0
-10
-20
-30
-40
DECADE BOX INPUTS WITH LEAD RES.
SPROCKET HOLES
Temp Calib
17 Dec 76
CHART READINGS
+60F
0 F
-40F

YSI Thermistor Resistance Versus Temperature

PART NO.	44001	44002	44003	44004 44033	44005 44030	44007 44034	44006 44031	44008 44032	44011	44014	44015
Ω @ 25°C	100	300	1000	2252	3000	5000	10,000	30,000	100,000	300,000	1 MEG.
BODY	BLACK	BLACK	BLACK	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BROWN	BROWN	BROWN
END	BROWN	RED	ORANGE	YELLOW ORANGE	GREEN BLACK	VIOLET YELLOW	BLUE BROWN	GRAY RED	BROWN	YELLOW	GREEN
TEMP. °C	RESISTANCE Ω										
−80	11.73K	53.50K	229.0K	1660K	2211K	3685K	3558K				
79	10.97K	49.93K	213.1K	1518K	2022K	3371K	3296K				
78	10.30K	46.67K	198.5K	1390K	1851K	3086K	3055K				
77	9656	43.55K	184.9K	1273K	1696K	2827K	2833K				
76	9061	40.70K	172.4K	1167K	1555K	2592K	2629K				
75	8506	38.06K	160.8K	1071K	1426K	2378K	2440K				
74	7990	35.61K	150.0K	982.8K	1309K	2182K	2266K				
73	7509	33.33K	140.0K	902.7K	1202K	2005K	2106K				
72	7060	31.22K	130.8K	829.7K	1105K	1843K	1957K				
71	6642	29.25K	122.2K	763.1K	1016K	1695K	1821K				
−70	6251	27.42K	114.3K	702.3K	935.4K	1560K	1694K				
69	5886	25.71K	106.9K	646.7K	861.4K	1436K	1577K				
68	5545	24.12K	100.0K	595.9K	793.7K	1323K	1469K				
67	5227	22.65K	93.63K	549.4K	731.8K	1220K	1369K				
66	4929	21.27K	87.70K	506.9K	675.2K	1126K	1276K				
65	4650	19.98K	82.18K	467.9K	623.3K	1039K	1190K				
64	4389	18.78K	77.04K	432.2K	575.7K	959.9K	1111K				
63	4144	17.66K	72.25K	399.5K	532.1K	887.2K	1037K				
62	3915	16.62K	67.80K	369.4K	492.1K	820.5K	968.4K				
61	3700	15.64K	63.64K	341.8K	455.3K	759.2K	904.9K				
−60	3499	14.73K	59.77K	316.5K	421.5K	702.9K	845.9K				
59	3310	13.88K	56.15K	293.2K	330.5K	651.1K	791.1K				
58	3132	13.08K	52.78K	271.7K	361.9K	603.5K	740.2K				
57	2965	12.33K	49.63K	252.0K	335.7K	559.7K	692.8K				
56	2809	11.63K	46.69K	233.8K	311.5K	519.4K	648.8K				
55	2661	10.98K	43.94K	217.1K	289.2K	482.2K	607.8K				
54	2523	10.36K	41.37K	201.7K	268.6K	447.9K	569.6K				
53	2392	9785	38.97K	187.4K	249.7K	416.3K	534.1K				
52	2270	9245	36.72K	174.3K	232.2K	387.1K	501.0K				
51	2154	8738	34.62K	162.2K	216.0K	360.2K	470.1K				
−50	2045	8262	32.64K	151.0K	201.1K	335.3K	441.3K				
49	1942	7815	30.80K	140.6K	187.3K	312.3K	414.5K				
48	1846	7395	29.06K	131.0K	174.5K	291.0K	389.4K				
47	1754	7000	27.44K	122.1K	162.7K	271.3K	366.0K				
46	1668	6629	25.92K	113.9K	151.7K	253.0K	344.1K				
45	1587	6280	24.49K	106.3K	141.6K	236.2K	323.7K				
44	1510	5951	23.15K	99.26K	132.2K	220.5K	304.6K				
43	1438	5642	21.89K	92.72K	123.5K	205.9K	286.7K				
42	1369	5351	20.70K	86.65K	115.4K	192.5K	270.0K				
41	1304	5076	19.59K	81.02K	107.9K	180.0K	254.4K				
−40	1243	4818	18.55K	75.79K	101.0K	168.3K	239.8K	884.6K	3356K		
39	1185	4574	17.56K	70.93K	94.46K	157.5K	226.0K	830.9K	3147K		
38	1130	4344	16.64K	66.41K	88.46K	147.5K	213.2K	780.8K	2951K		
37	1078	4127	15.77K	62.21K	82.87K	138.2K	201.1K	733.9K	2769K		
36	1029	3922	14.94K	58.30K	77.66K	129.5K	189.8K	690.2K	2599K		
35	981.8	3729	14.17K	54.66K	72.81K	121.4K	179.2K	649.3K	2440K		
34	937.6	3546	13.44K	51.27K	68.30K	113.9K	169.3K	611.0K	2292K		
33	895.6	3374	12.76K	48.11K	64.09K	106.9K	160.0K	575.2K	2154K		
32	855.8	3211	12.11K	45.17K	60.17K	100.3K	151.2K	541.7K	2025K		
31	818.0	3057	11.50K	42.42K	56.51K	94.22K	143.0K	510.4K	1904K		
−30	782.1	2911	10.92K	39.86K	53.10K	88.53K	135.2K	481.0K	1791K		
29	748.1	2773	10.38K	37.47K	49.91K	83.72K	127.9K	453.5K	1685K		
28	715.7	2642	9866	35.24K	46.94K	78.26K	121.1K	427.7K	1586K		
27	685.0	2519	9381	33.15K	44.16K	73.62K	114.6K	403.5K	1494K		
26	655.7	2402	8922	31.20K	41.56K	69.23K	108.6K	380.9K	1407K		
25	627.9	2291	8489	29.38K	39.13K	65.24K	102.9K	359.6K	1326K		
24	601.5	2185	8079	27.67K	36.86K	61.45K	97.49K	339.6K	1250K		
23	576.4	2086	7692	26.07K	34.73K	57.90K	92.43K	320.9K	1178K		
22	552.4	1991	7325	24.58K	32.74K	54.58K	87.66K	303.3K	1111K		
21	529.6	1901	6978	23.18K	30.87K	51.47K	83.16K	286.7K	1049K		
−20	507.9	1816	6649	21.87K	29.13K	48.56K	78.91K	271.2K	989.8K		
19	487.3	1736	6338	20.64K	27.49K	45.83K	74.91K	256.5K	934.6K		
18	467.6	1659	6043	19.48K	25.95K	43.27K	71.13K	242.8K	882.7K		
17	448.8	1586	5764	18.40K	24.51K	40.86K	67.57K	229.8K	834.0K		
16	430.9	1517	5499	17.39K	23.16K	38.61K	64.20K	217.6K	788.2K		
15	413.8	1451	5248	16.43K	21.89K	36.49K	61.02K	206.2K	745.2K		
14	397.5	1388	5009	15.54K	20.70K	34.50K	58.01K	195.4K	704.7K		
13	382.0	1329	4783	14.70K	19.58K	32.63K	55.17K	185.2K	666.7K		
12	367.1	1272	4569	13.91K	18.52K	30.88K	52.48K	175.6K	630.9K		
11	352.9	1218	4365	13.16K	17.53K	29.23K	49.94K	166.6K	597.2K		
−10	339.4	1167	4172	12.46K	16.60K	27.67K	47.54K	158.0K	565.5K		
9	326.5	1118	3988	11.81K	15.72K	26.21K	45.27K	150.0K	535.6K		
8	314.1	1072	3813	11.19K	14.90K	24.83K	43.11K	142.4K	507.5K		
7	302.3	1028	3647	10.60K	14.12K	23.54K	41.07K	135.2K	481.0K		
6	291.0	985.5	3489	10.05K	13.39K	22.32K	39.14K	128.5K	456.0K		
5	280.2	945.3	3339	9534	12.70K	21.17K	37.31K	122.1K	432.4K		
4	269.8	907.0	3195	9046	12.05K	20.08K	35.57K	116.0K	410.2K		
3	259.9	870.4	3061	8586	11.44K	19.06K	33.93K	110.3K	389.2K		
2	250.5	835.5	2931	8151	10.86K	18.10K	32.37K	104.9K	369.4K		
− 1	241.4	802.3	2808	7741	10.31K	17.19K	30.89K	99.80K	350.7K		
0	232.7	770.5	2691	7355	9796	16.33K	29.49K	94.98K	333.1K	1038K	3956K
+ 1	224.4	739.9	2579	6989	9310	15.52K	28.15K	90.41K	316.4K	1030K	3740K
2	216.4	710.7	2472	6644	8851	14.75K	26.89K	86.09K	300.6K	975.3K	3529K
3	208.7	682.8	2370	6319	8417	14.03K	25.69K	81.99K	285.7K	973.8K	3330K
4	201.4	656.2	2273	6011	8006	13.34K	24.55K	78.11K	271.6K	875.2K	3144K
5	194.3	630.8	2181	5719	7618	12.70K	23.46K	74.44K	258.3K	829.5K	2969K
6	187.6	606.4	2093	5444	7252	12.09K	22.43K	70.96K	245.7K	786.3A	2804K
7	181.1	583.2	2009	5183	6905	11.51K	21.45K	67.66K	233.8K	745.6K	2649K
8	174.9	561.0	1928	4937	6576	10.96K	20.52K	64.53K	222.5K	707.2K	2504K
9	169.0	539.8	1852	4703	6265	10.44K	19.63K	61.56K	211.9K	671.0K	2367K
+10	163.3	519.4	1779	4482	5971	9951	18.79K	58.75K	201.7K	636.8K	2238K
11	157.8	500.0	1709	4273	5692	9496	17.98K	56.07K	192.2K	604.5K	2117K
12	152.5	481.4	1642	4074	5427	9046	17.22K	53.51K	183.1K	574.0K	2003K
13	147.4	463.6	1578	3886	5177	8628	16.49K	51.13K	174.5K	545.2K	1896K
14	142.6	446.6	1518	3708	4939	8232	15.79K	48.84K	166.3K	518.0K	1795K
15	137.9	430.2	1459	3539	4714	7857	15.13K	46.67K	158.6K	492.3K	1700K
16	133.4	414.6	1404	3378	4500	7500	14.50K	44.60K	151.3K	468.0K	1610K
17	129.1	399.6	1351	3226	4297	7162	13.90K	42.64K	144.3K	444.9K	1525K
18	125.0	385.3	1300	3081	4105	6841	13.33K	40.77K	137.7K	423.2K	1446K
19	121.0	371.5	1251	2944	3922	6536	12.79K	38.99K	131.4K	402.6K	1370K
+20	117.1	358.3	1204	2814	3748	6247	12.26K	37.30K	125.5K	383.1K	1299K
21	113.4	345.6	1160	2690	3583	5972	11.77K	35.70K	119.8K	364.6K	1232K
22	109.9	333.5	1117	2572	3426	5710	11.29K	34.17K	114.5K	347.1K	1169K
23	106.4	321.9	1076	2460	3277	5462	10.84K	32.71K	109.4K	330.6K	1110K
24	103.1	310.7	1037	2354	3135	5225	10.41K	31.32K	104.5K	314.9K	1053K
25	100.0	300.0	1000	2252	3000	5000	10.00K	30.00K	100.0K	300.0K	1000K
26	96.9	289.7	963.4	2156	2872	4787	9605	28.74K	95.51K	285.9K	949.7K
27	94.0	279.8	928.9	2064	2750	4583	9227	27.54K	91.34K	272.5K	902.2K
28	91.1	270.3	895.9	1977	2633	4389	8867	26.40K	87.38K	259.8K	857.2K
29	88.4	261.1	864.1	1894	2523	4204	8523	25.31K	83.60K	247.8K	814.7K
+30	85.7	252.4	833.7	1815	2417	4029	8194	24.27K	80.00K	236.4K	774.5K
31	83.2	244.0	804.5	1739	2317	3861	7880	23.28K	76.58K	225.6K	736.5K
32	80.7	235.9	776.5	1667	2221	3702	7579	22.33K	73.32K	215.3K	700.5K
33	78.4	228.1	749.6	1599	2130	3549	7291	21.43K	70.22K	205.5K	666.4K
34	76.1	220.6	723.8	1533	2042	3404	7016	20.57K	67.26K	196.7K	634.1K
35	73.9	213.4	699.0	1471	1959	3266	6752	19.74K	64.44K	187.4K	603.6K
36	71.7	206.5	675.2	1412	1880	3134	6500	18.96K	61.75K	179.0K	574.6K
37	69.7	199.8	652.4	1355	1805	3008	6258	18.21K	59.19K	171.0K	547.2K
38	67.7	193.4	630.4	1301	1733	2888	6026	17.49K	56.75K	163.5K	521.2K
+39	65.8	187.2	609.3	1249	1664	2773	5805	16.80K	54.42K	156.3K	496.6K

MINCO PRODUCTS, INC.

TEMPERATURE CONVERSION CHART

°F.	Reading in °F. or °C. to be converted	°C.
	-458	-272.22
	-456	-271.11
	-454	-270.00
	-452	-268.89
	-450	-267.78
	-448	-266.67
	-446	-265.56
	-444	-264.44
	-442	-263.33
	-440	-262.22
	-438	-261.11
	-436	-260.00
	-434	-258.89
	-432	-257.78
	-430	-256.67
	-428	-255.56
	-426	-254.44
	-424	-253.33
	-422	-252.22
	-420	-251.11
	-418	-250.00
	-416	-248.89
	-414	-247.78
	-412	-246.67
	-410	-245.56
	-408	-244.44
	-406	-243.33
	-404	-242.22
	-402	-241.11
	-400	-240.00
	-398	-238.89
	-396	-237.78
	-394	-236.67
	-392	-235.56
	-390	-234.44
	-388	-233.33
	-386	-232.22
	-384	-231.11
	-382	-230.00
	-380	-228.89
	-378	-227.78
	-376	-226.67
	-374	-225.56
	-372	-224.44
	-370	-223.33
	-368	-222.22
	-366	-221.11
	-364	-220.00
	-362	-218.89
	-360	-217.78

°F.	Reading in °F. or °C. to be converted	°C.
	-358	-216.67
	-356	-215.56
	-354	-214.44
	-352	-213.33
	-350	-212.22
	-348	-211.11
	-346	-210.00
	-344	-208.89
	-342	-207.78
	-340	-206.67
	-338	-205.56
	-336	-204.44
	-334	-203.33
	-332	-202.22
	-330	-201.11
	-328	-200.00
	-326	-198.89
	-324	-197.78
	-322	-196.67
	-320	-195.56
	-318	-194.44
	-316	-193.33
	-314	-192.22
	-312	-191.11
	-310	-190.00
	-308	-188.89
	-306	-187.78
	-304	-186.67
	-302	-185.56
	-300	-184.44
	-298	-183.33
	-296	-182.22
	-294	-181.11
	-292	-180.00
	-290	-178.89
	-288	-177.78
	-286	-176.67
	-284	-175.56
	-282	-174.44
	-280	-173.33
	-278	-172.22
	-276	-171.11
	-274	-170.00
-457.6	-272	-168.89
-454.0	-270	-167.78
-450.4	-268	-166.67
-446.8	-266	-165.56
-443.2	-264	-164.44
-439.6	-262	-163.33
-436.0	-260	-162.22

°F.	Reading in °F. or °C. to be converted	°C.
-432.4	-258	-161.11
-428.8	-256	-160.00
-425.2	-254	-158.89
-421.6	-252	-157.78
-418.0	-250	-156.67
-414.4	-248	-155.56
-410.8	-246	-154.44
-407.2	-244	-153.33
-403.6	-242	-152.22
-400.0	-240	-151.11
-396.4	-238	-150.00
-392.8	-236	-148.89
-389.2	-234	-147.78
-385.6	-232	-146.67
-382.0	-230	-145.56
-378.4	-228	-144.44
-374.8	-226	-143.33
-371.2	-224	-142.22
-367.6	-222	-141.11
-364.0	-220	-140.00
-360.4	-218	-138.89
-356.8	-216	-137.78
-353.2	-214	-136.67
-349.6	-212	-135.56
-346.0	-210	-134.44
-342.4	-208	-133.33
-338.8	-206	-132.22
-335.2	-204	-131.11
-331.6	-202	-130.00
-328.0	-200	-128.89
-324.4	-198	-127.78
-320.8	-196	-126.67
-317.2	-194	-125.56
-313.6	-192	-124.44
-310.0	-190	-123.33
-306.4	-188	-122.22
-302.8	-186	-121.11
-299.2	-184	-120.00
-295.6	-182	-118.89
-292.0	-180	-117.78
-288.4	-178	-116.67
-284.8	-176	-115.56
-281.2	-174	-114.44
-277.6	-172	-113.33
-274.0	-170	-112.22
-270.4	-168	-111.11
-266.8	-166	-110.00
-263.2	-164	-108.89
-259.6	-162	-107.78
-256.0	-160	-106.67
-252.4	-158	-105.56
-248.8	-156	-104.44
-245.2	-154	-103.33
-241.6	-152	-102.22
-238.0	-150	-101.11
-234.4	-148	-100.00
-230.8	-146	-98.89
-227.2	-144	-97.78
-223.6	-142	-96.67
-220.0	-140	-95.56

°F.	Reading in °F. or °C. to be converted	°C.
-216.4	-138	-94.44
-212.8	-136	-93.33
-209.2	-134	-92.22
-205.6	-132	-91.11
-202.0	-130	-90.00
-198.4	-128	-88.89
-194.8	-126	-87.78
-191.2	-124	-86.67
-187.6	-122	-85.56
-184.0	-120	-84.44
-180.4	-118	-83.33
-176.8	-116	-82.22
-173.2	-114	-81.11
-169.6	-112	-80.00
-166.0	-110	-78.89
-162.4	-108	-77.78
-158.8	-106	-76.67
-155.2	-104	-75.56
-151.6	-102	-74.44
-148.0	-100	-73.33
-144.4	-98	-72.22
-140.8	-96	-71.11
-137.2	-94	-70.00
-133.6	-92	-68.89
-130.0	-90	-67.78
-126.4	-88	-66.67
-122.8	-86	-65.56
-119.2	-84	-64.44
-115.6	-82	-63.33
-112.0	-80	-62.22
-108.4	-78	-61.11
-104.8	-76	-60.00
-101.2	-74	-58.89
-97.6	-72	-57.78
-94.0	-70	-56.67
-90.4	-68	-55.56
-86.8	-66	-54.44
-83.2	-64	-53.33
-79.6	-62	-52.22
-76.0	-60	-51.11
-72.4	-58	-50.00
-68.8	-56	-48.89
-65.2	-54	-47.78
-61.6	-52	-46.67
-58.0	-50	-45.56
-54.4	-48	-44.44
-50.8	-46	-43.33
-47.2	-44	-42.22
-43.6	-42	-41.11
-40.0	-40	-40.00
-36.4	-38	-38.89
-32.8	-36	-37.78
-29.2	-34	-36.67
-25.6	-32	-35.56
-22.0	-30	-34.44
-18.4	-28	-33.33
-14.8	-26	-32.22
-11.2	-24	-31.11
-7.6	-22	-30.00
-4.0	-20	-28.89

°F.	Reading in °F. or °C. to be converted	°C.
-0.4	-18	-27.78
+3.2	-16	-26.67
+6.8	-14	-25.56
+10.4	-12	-24.44
+14.0	-10	-23.33
+17.6	-8	-22.22
+19.4	-7	-21.67
+21.2	-6	-21.11
+23.0	-5	-20.56
+24.8	-4	-20.00
+26.6	-3	-19.44
+28.4	-2	-18.89
+30.2	-1	-18.33
+32.0	±0	-17.78
+33.8	+1	-17.22
+35.6	+2	-16.67
+37.4	+3	-16.11
+39.2	+4	-15.56
+41.0	+5	-15.00
+42.8	+6	-14.44
+44.6	+7	-13.89
+46.4	+8	-13.33
+48.2	+9	-12.78
+50.0	+10	-12.22
+51.8	+11	-11.67
+53.6	+12	-11.11
+55.4	+13	-10.56
+57.2	+14	-10.00
+59.0	+15	-9.44
+60.8	+16	-8.89
+62.6	+17	-8.33
+64.4	+18	-7.78
+66.2	+19	-7.22
+68.0	+20	-6.67
+69.8	+21	-6.11
+71.6	+22	-5.56
+73.4	+23	-5.00
+75.2	+24	-4.44
+77.0	+25	-3.89
+78.8	+26	-3.33
+80.6	+27	-2.78
+82.4	+28	-2.22
+84.2	+29	-1.67
+86.0	+30	-1.11
+87.8	+31	-0.56
+89.6	+32	±0.00
+91.4	+33	+0.56
+93.2	+34	+1.11
+95.0	+35	+1.67
+96.8	+36	+2.22
+98.6	+37	+2.78
+100.4	+38	+3.33
+102.2	+39	+3.89
+104.0	+40	+4.44
+105.8	+41	+5.00
+107.6	+42	+5.56
+109.4	+43	+6.11
+111.2	+44	+6.67
+113.0	+45	+7.22
+114.8	+46	+7.78

°F.	Reading in °F. or °C. to be converted	°C.
+116.6	+47	+8.33
+118.4	+48	+8.89
+120.2	+49	+9.44
+122.0	+50	+10.00
+123.8	+51	+10.56
+125.6	+52	+11.11
+127.4	+53	+11.67
+129.2	+54	+12.22
+131.0	+55	+12.78
+132.8	+56	+13.33
+134.6	+57	+13.89
+136.4	+58	+14.44
+138.2	+59	+15.00
+140.0	+60	+15.56
+141.8	+61	+16.11
+143.6	+62	+16.67
+145.4	+63	+17.22
+147.2	+64	+17.78
+149.0	+65	+18.33
+150.8	+66	+18.89
+152.6	+67	+19.44
+154.4	+68	+20.00
+156.2	+69	+20.56
+158.0	+70	+21.11
+159.8	+71	+21.67
+161.6	+72	+22.22
+163.4	+73	+22.78
+165.2	+74	+23.33
+167.0	+75	+23.89
+168.8	+76	+24.44
+170.6	+77	+25.00
+172.4	+78	+25.56
+174.2	+79	+26.11
+176.0	+80	+26.67
+177.8	+81	+27.22
+179.6	+82	+27.78
+181.4	+83	+28.33
+183.2	+84	+28.89
+185.0	+85	+29.44
+186.8	+86	+30.00
+188.6	+87	+30.56
+190.4	+88	+31.11
+192.2	+89	+31.67
+194.0	+90	+32.22
+195.8	+91	+32.78
+197.6	+92	+33.33
+199.4	+93	+33.89
+201.2	+94	+34.44
+203.0	+95	+35.00
+204.8	+96	+35.56
+206.6	+97	+36.11
+208.4	+98	+36.67
+210.2	+99	+37.22
+212.0	+100	+37.78
+213.8	+101	+38.33
+215.6	+102	+38.89
+217.4	+103	+39.44
+219.2	+104	+40.00
+221.0	+105	+40.56
+222.8	+106	+41.11

°F.	Reading in °F. or °C. to be converted	°C.
+224.6	+107	+41.67
+226.4	+108	+42.22
+228.2	+109	+42.78
+230.0	+110	+43.33
+231.8	+111	+43.89
+233.6	+112	+44.44
+235.4	+113	+45.00
+237.2	+114	+45.56
+239.0	+115	+46.11
+240.8	+116	+46.67
+242.6	+117	+47.22
+244.4	+118	+47.78
+246.2	+119	+48.33
+248.0	+120	+48.89
+249.8	+121	+49.44
+251.6	+122	+50.00
+253.4	+123	+50.56
+255.2	+124	+51.11
+257.0	+125	+51.67
+258.8	+126	+52.22
+260.6	+127	+52.78
+262.4	+128	+53.33
+264.2	+129	+53.89
+266.0	+130	+54.44
+267.8	+131	+55.00
+269.6	+132	+55.56
+271.4	+133	+56.11
+273.2	+134	+56.67
+275.0	+135	+57.22
+276.8	+136	+57.78
+278.6	+137	+58.33
+280.4	+138	+58.89
+282.2	+139	+59.44
+284.0	+140	+60.00
+285.8	+141	+60.56
+287.6	+142	+61.11
+289.4	+143	+61.67
+291.2	+144	+62.22
+293.0	+145	+62.78
+294.8	+146	+63.33
+296.6	+147	+63.89
+298.4	+148	+64.44
+300.2	+149	+65.00
+302.0	+150	+65.56
+303.8	+151	+66.11
+305.6	+152	+66.67
+307.4	+153	+67.22
+309.2	+154	+67.78
+311.0	+155	+68.33
+312.8	+156	+68.89
+314.6	+157	+69.44
+316.4	+158	+70.00
+318.2	+159	+70.56
+320.0	+160	+71.11
+321.8	+161	+71.67
+323.6	+162	+72.22
+325.4	+163	+72.78
+327.2	+164	+73.33
+329.0	+165	+73.89
+330.8	+166	+74.44

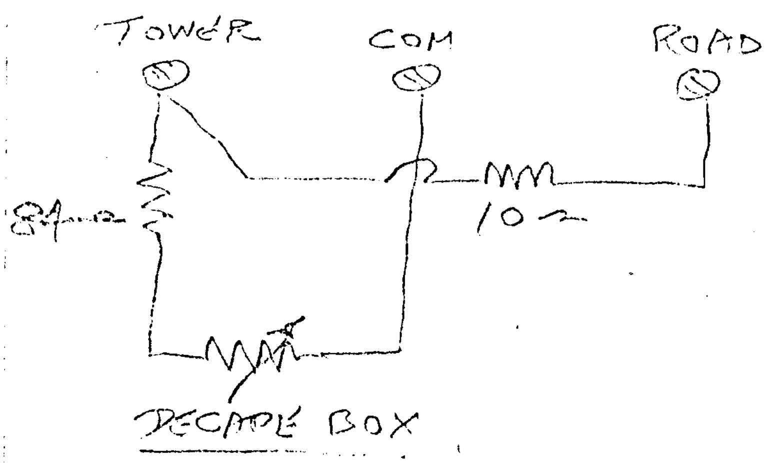
°F.	Reading in °F. or °C. to be converted	°C.
+332.6	+167	+75.00
+334.4	+168	+75.56
+336.2	+169	+76.11
+338.0	+170	+76.67
+339.8	+171	+77.22
+341.6	+172	+77.78
+343.4	+173	+78.33
+345.2	+174	+78.89
+347.0	+175	+79.44
+348.8	+176	+80.00
+350.6	+177	+80.56
+352.4	+178	+81.11
+354.2	+179	+81.67
+356.0	+180	+82.22
+357.8	+181	+82.78
+359.6	+182	+83.33
+361.4	+183	+83.89
+363.2	+184	+84.44
+365.0	+185	+85.00
+366.8	+186	+85.56
+368.6	+187	+86.11
+370.4	+188	+86.67
+372.2	+189	+87.22
+374.0	+190	+87.78
+375.8	+191	+88.33
+377.6	+192	+88.89
+379.4	+193	+89.44
+381.2	+194	+90.00
+383.0	+195	+90.56
+384.8	+196	+91.11
+386.6	+197	+91.67
+388.4	+198	+92.22
+390.2	+199	+92.78
+392.0	+200	+93.33
+393.8	+201	+93.89
+395.6	+202	+94.44
+397.4	+203	+95.00
+399.2	+204	+95.56
+401.0	+205	+96.11
+402.8	+206	+96.67
+404.6	+207	+97.22
+406.4	+208	+97.78
+408.2	+209	+98.33
+410.0	+210	+98.89
+411.8	+211	+99.44
+413.6	+212	+100.00
+415.4	+213	+100.56
+417.2	+214	+101.11
+419.0	+215	+101.67
+420.8	+216	+102.22
+422.6	+217	+102.78
+424.4	+218	+103.33
+426.2	+219	+103.89
+428.0	+220	+104.44
+431.6	+222	+105.56
+435.2	+224	+106.67
+438.8	+226	+107.78
+442.4	+228	+108.89
+446.0	+230	+110.00
+449.6	+232	+111.11

ROAD LEAD RES 94 Ω ± 5 Ω
TOWER " " 84 Ω ± 5 Ω

TEMP	RES	VCOM	CHART	CHART ERROR
−40 F	18.55 KΩ	+3.6 mV	−37 F	+3 F
−30 F	13.73 K	+11.6	−29 F	+1 F
−20 F	10.33 K	20.3	−20	0
−10 F	7808	30.0	−10.2	−.2
0	5987	40.1	0	0
+10 F	4612	50.5	+9.8	−.2
+20 F	3600	60.6	+19.7	−.3
+30 F	2820	70.3	+30	0
+32 F	2691	72.3		
+35 F	2504	75.1		
+40 F	2236	79.4	+39	−1
+50 F	1779	87.6	+47	−3
+60 F	1426	94.9	+55	−5

SEE ATTACHED CHART RECORD

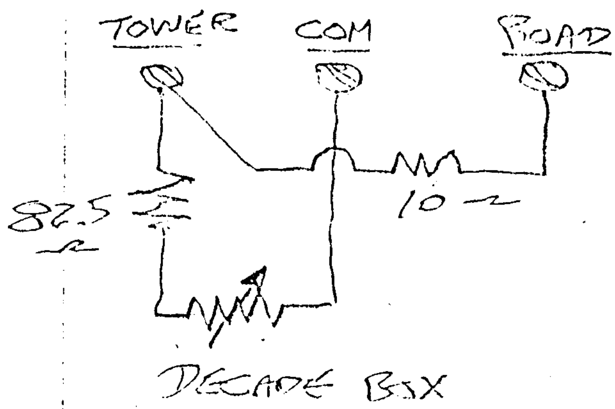
CALIB WIRING DIAG (UPPER BOARD INPUTS)



TEMP CALIB 2 NOV 77

ROAD LEAD RES 92.5 Ω
TOWER " " 82.5 Ω

TEMP	RES	VCO in
-40 F	18.55 KΩ	+4.4 mV
-30	13.73 K	11.7
-20	10.33 K	19.9
-10	7808	29.3
0	5787	39.2
+10	4612	49.6
20	3600	57.8
30	2820	70.0
32	2691	72.0
40	2236	77.4
50	1779	89.4
+60	1426	96.3
+35	2504	



	SCANNED	CALIB ADJ
CALIB	1ST	3rd
ROAD	2nd	1ST
TOWER	3rd	2nd

Voltage Regulators

LM723/LM723C voltage regulator

general description

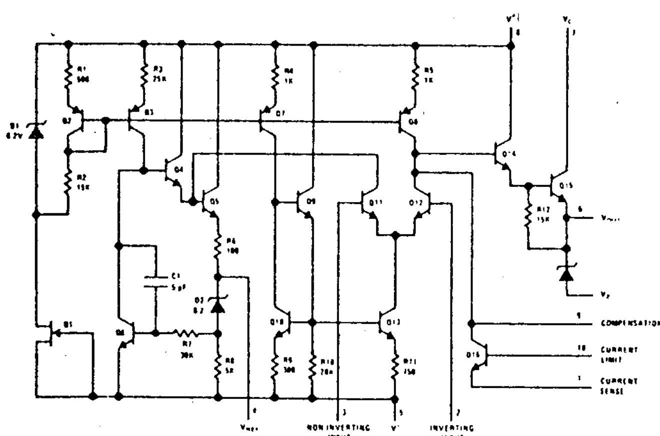
The LM723/LM723C is a voltage regulator designed primarily for series regulator applications. By itself, it will supply output currents up to 150 mA; but external transistors can be added to provide any desired load current. The circuit features extremely low standby current drain, and provision is made for either linear or foldback current limiting. Important characteristics are:

- 150 mA output current without external pass transistor
- Output currents in excess of 10A possible by adding external transistors
- Input voltage 40V max
- Output voltage adjustable from 2V to 37V
- Can be used as either a linear or a switching regulator.

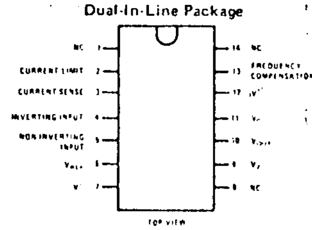
The LM723/LM723C is also useful in a wide range of other applications such as a shunt regulator, a current regulator or a temperature controller.

The LM723C is identical to the LM723 except that the LM723C has its performance guaranteed over a 0°C to 70°C temperature range, instead of −55°C to +125°C.

schematic and connection diagrams*



Dual-In-Line Package

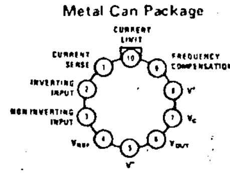


Order Number LM723D or LM723CD
See Package 28

Order Number LM723N or LM723CN
See Package 22

Order Number LM723J or LM723CJ
See Package 16

Metal Can Package

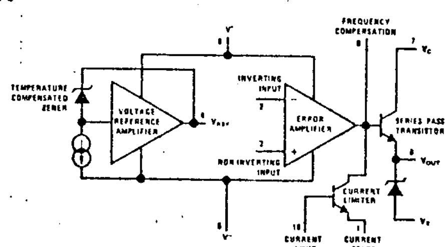


Note: Pin 5 connected to case.

TOP VIEW

Order Number LM723H or LM723CH
See Package 12

equivalent circuit*



*Pin numbers refer to metal can package.

absolute maximum ratings

Pulse Voltage from V^+ to V^- (50 ms)	50V
Continuous Voltage from V^+ to V^-	40V
Input-Output Voltage Differential	40V
Maximum Amplifier Input Voltage (Either Input)	7.5V
Maximum Amplifier Input Voltage (Differential)	5V
Current from V_Z	25 mA
Current from V_{REF}	15 mA
Internal Power Dissipation Metal Can (Note 1)	800 mW
Cavity DIP (Note 1)	900 mW
Molded DIP (Note 1)	660 mW
Operating Temperature Range LM723	−55°C to +125°C
LM723C	0°C to +70°C
Storage Temperature Range Metal Can	−65°C to +150°C
DIP	−55°C to +125°C
Lead Temperature (Soldering, 10 sec)	300°C

electrical characteristics (Note 2)

PARAMETER	CONDITIONS	LM723 MIN	LM723 TYP	LM723 MAX	LM723C MIN	LM723C TYP	LM723C MAX	UNITS
Line Regulation	V_{IN} = 12V to V_{IN} = 15V		.01	0.1		.01	0.1	% V_{OUT}
	$-55°C \leq T_A \leq +125°C$			0.3				% V_{OUT}
	$0°C \leq T_A \leq +70°C$						0.3	% V_{OUT}
	V_{IN} = 12V to V_{IN} = 40V		.02	0.2		0.1	0.5	% V_{OUT}
Load Regulation	I_L = 1 mA to I_L = 50 mA		.03	0.15		.03	0.2	% V_{OUT}
	$-55°C \leq T_A \leq +125°C$			0.6				% V_{OUT}
	$0°C \leq T_A \leq +70°C$						0.6	% V_{OUT}
Ripple Rejection	f = 50 Hz to 10 kHz, C_{REF} = 0		74			74		dB
	f = 50 Hz to 10 kHz, C_{REF} = 5 μF		86			86		dB
Average Temperature Coefficient of Output Voltage	$-55°C \leq T_A \leq +125°C$		.002	.015				%/°C
	$0°C \leq T_A \leq +70°C$					.003	.015	%/°C
Short Circuit Current Limit	R_{SC} = 10Ω, V_{OUT} = 0		65			65		mA
Reference Voltage		6.95	7.15	7.35	6.80	7.15	7.50	V
Output Noise Voltage	BW = 100 Hz to 10 kHz, C_{REF} = 0		20			20		μVrms
	BW = 100 Hz to 10 kHz, C_{REF} = 5 μF		2.5			2.5		μVrms
Long Term Stability			0.1			0.1		%/1000 hrs
Standby Current Drain	I_L = 0, V_{IN} = 30V		1.3	3.5		1.3	4.0	mA
Input Voltage Range		9.5		40	9.5		40	V
Output Voltage Range		2.0		37	2.0		37	V
Input-Output Voltage Differential		3.0		38	3.0		38	V

Note 1: See derating curves for maximum power rating above 25°C.

Note 2: Unless otherwise specified, T_A = 25°C, V_{IN} = V^+ = V_C = 12V, V^- = 0, V_{OUT} = 5V, I_L = 1 mA, R_{SC} = 0, C_1 = 100 pF, C_{REF} = 0 and divider impedance as seen by error amplifier $\leq$ 10 kΩ connected as shown in Figure 1. Line and load regulation specifications are given for the condition of constant chip temperature. Temperature drifts must be taken into account separately for high dissipation conditions.

Note 3: L_1 is 40 turns of No. 20 enameled copper wire wound on Ferroxcube P36/22-3B7 pot core or equivalent with 0.009 in. air gap.

Note 4: Figures in parentheses may be used if R1/R2 divider is placed on opposite input of error amp.

Note 5: Replace R1/R2 in figures with divider shown in Figure 13.

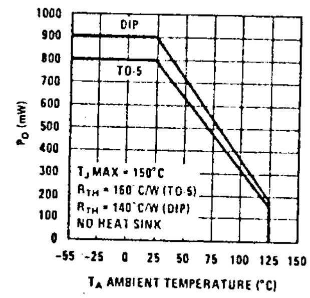
Note 6: V^+ must be connected to a +3V or greater supply.

Note 7: For metal can applications where V_Z is required, an external 6.2 volt zener diode should be connected in series with V_{OUT}.

maximum power ratings

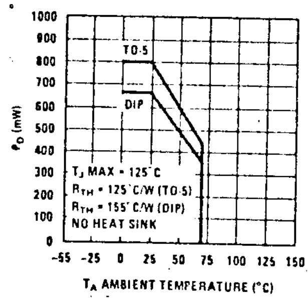
LM723

Power Dissipation vs Ambient Temperature



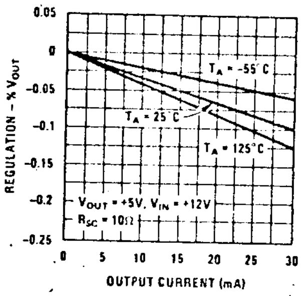
LM723C

Power Dissipation vs Ambient Temperature

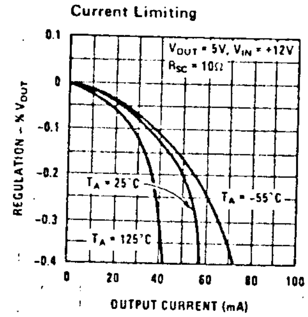


typical performance characteristics

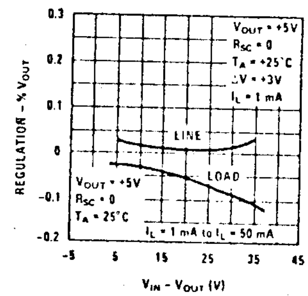
Load Regulation Characteristics with Current Limiting



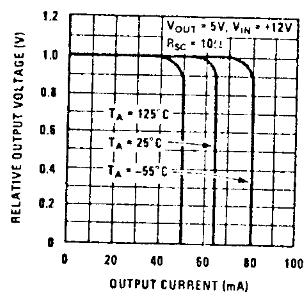
Load Regulation Characteristics with Current Limiting



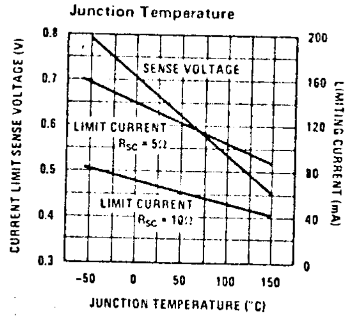
Load & Line Regulation vs Input-Output Voltage Differential



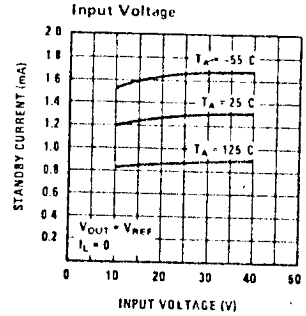
Current Limiting Characteristics



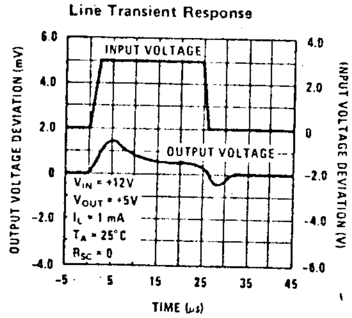
Current Limiting Characteristics vs Junction Temperature



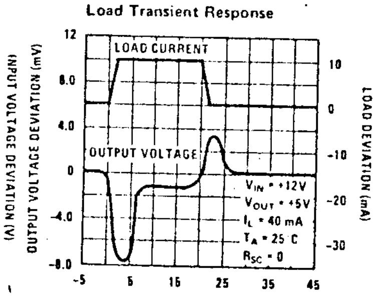
Standby Current Drain vs Input Voltage



Line Transient Response



Load Transient Response



Output Impedance vs Frequency

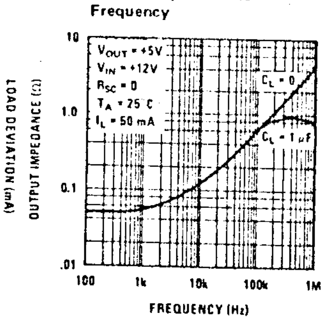


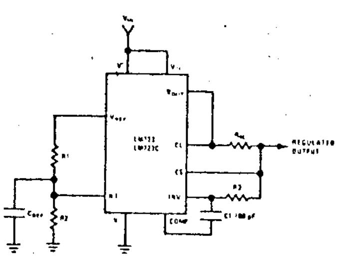
TABLE I RESISTOR VALUES (kΩ) FOR STANDARD OUTPUT VOLTAGE

POSITIVE OUTPUT VOLTAGE	APPLICABLE FIGURES	FIXED OUTPUT ±5%		OUTPUT ADJUSTABLE ±10% (Note 5)			NEGATIVE OUTPUT VOLTAGE	APPLICABLE FIGURES	FIXED OUTPUT ±5%		5% OUTPUT ADJUSTABLE ±10%		
	(Note 4)	R1	R2	R1	P1	R2			R1	R2	R1	P1	R2
+3.0	1, 5, 6, 9, 12 (4)	4.12	3.01	1.8	0.5	1.2	+100	7	3.57	102	2.2	10	91
+3.6	1, 5, 6, 9, 12 (4)	3.57	3.65	1.5	0.5	1.5	+250	7	3.57	255	2.2	10	240
+5.0	1, 5, 6, 9, 12 (4)	2.15	4.99	.75	0.5	2.2	−6 (Note 6)	3, (10)	3.57	2.43	1.2	0.5	.75
+6.0	1, 5, 6, 9, 12 (4)	1.15	6.04	0.5	0.5	2.7	−9	3, 10	3.48	5.36	1.2	0.5	2.0
+9.0	2, 4, (5, 6, 12, 9)	1.87	7.15	.75	1.0	2.7	−12	3, 10	3.57	8.45	1.2	0.5	3.3
+12	2, 4, (5, 6, 9, 12)	4.87	7.15	2.0	1.0	3.0	−15	3, 10	3.65	11.5	1.2	0.5	4.3
+15	2, 4, (5, 6, 9, 12)	7.87	7.15	3.3	1.0	3.0	−28	3, 10	3.57	24.3	1.2	0.5	10
+28	2, 4, (5, 6, 9, 12)	21.0	7.15	5.6	1.0	2.0	−45	8	3.57	41.2	2.2	10	33
+45	7	3.57	48.7	2.2	10	39	−100	8	3.57	97.6	2.2	10	91
+75	7	3.57	78.7	2.2	10	68	−250	8	3.57	249	2.2	10	240

TABLE II FORMULAE FOR INTERMEDIATE OUTPUT VOLTAGES

Outputs from +2 to +7 volts [Figures 1, 5, 6, 9, 12, (4)] $V_{OUT} = \left(V_{REF} \times \frac{R2}{R1 + R2}\right)$	Outputs from +4 to +250 volts [Figure 7] $V_{OUT} = \left(\frac{V_{REF}}{2} \times \frac{R2 - R1}{R1}\right)$; R3 = R4	Current Limiting $I_{LIMIT} = \frac{V_{SENSE}}{R_{SC}}$
Outputs from +7 to +37 volts [Figures 2, 4, (5, 6, 9, 12)] $V_{OUT} = \left(V_{REF} \times \frac{R1 + R2}{R2}\right)$	Outputs from −6 to −250 volts [Figures 3, 8, 10] $V_{OUT} = \left(\frac{V_{REF}}{2} \times \frac{R1 + R2}{R1}\right)$; R3 = R4	Foldback Current Limiting $I_{KNEE} = \left(\frac{V_{OUT}\, R3}{R_{SC}\, R4} + \frac{V_{SENSE}\,(R3 + R4)}{R_{SC}\, R4}\right)$ $I_{SHORT\,CKT} = \left(\frac{V_{SENSE}}{R_{SC}} \times \frac{R3 + R4}{R4}\right)$

typical applications

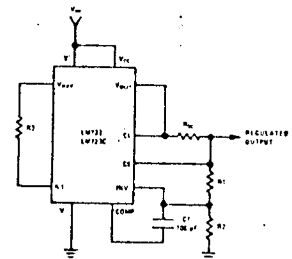


Note: $R3 = \frac{R1\, R2}{R1 + R2}$ for minimum temperature drift.

TYPICAL PERFORMANCE

Regulated Output Voltage	5V
Line Regulation (ΔV_{IN} = 3V)	0.5 mV
Load Regulation (ΔI_L = 50 mA)	1.5 mV

FIGURE 1. Basic Low Voltage Regulator (V_{OUT} = 2 to 7 Volts)

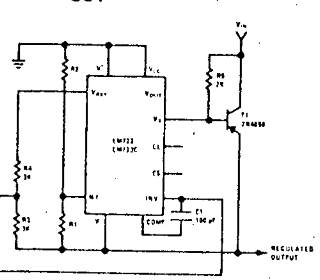


Note: $R3 = \frac{R1\, R2}{R1 + R2}$ for minimum temperature drift.
R3 may be eliminated for minimum component count.

TYPICAL PERFORMANCE

Regulated Output Voltage	15V
Line Regulation (ΔV_{IN} = 3V)	1.5 mV
Load Regulation (ΔI_L = 50 mA)	4.5 mV

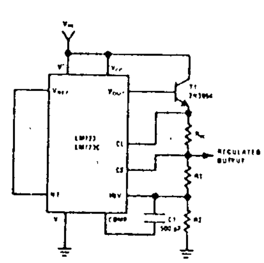
FIGURE 2. Basic High Voltage Regulator (V_{OUT} = 7 to 37 Volts)



TYPICAL PERFORMANCE

Regulated Output Voltage	−15V
Line Regulation (ΔV_{IN} = 3V)	1 mV
Load Regulation (ΔI_L = 100 mA)	2 mV

FIGURE 3. Negative Voltage Regulator

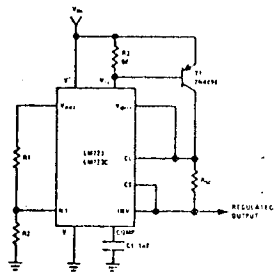


TYPICAL PERFORMANCE

Regulated Output Voltage	+15V
Line Regulation (ΔV_{IN} = 3V)	1.5 mV
Load Regulation (ΔI_L = 1A)	15 mV

FIGURE 4. Positive Voltage Regulator (External NPN Pass Transistor)

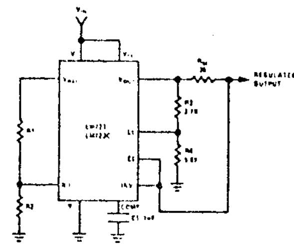
typical applications (con't.)



TYPICAL PERFORMANCE

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 3V)	0.5 mV
Load Regulation (ΔI_L = 1A)	5 mV

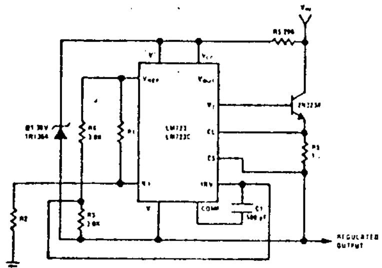
FIGURE 5. Positive Voltage Regulator (External PNP Pass Transistor)



TYPICAL PERFORMANCE

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 3V)	0.5 mV
Load Regulation (ΔI_L = 10 mA)	1 mV
Short Circuit Current	20 mA

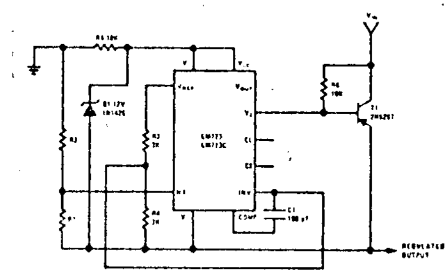
FIGURE 6. Foldback Current Limiting



TYPICAL PERFORMANCE

Regulated Output Voltage	+50V
Line Regulation (ΔV_{IN} = 20V)	15 mV
Load Regulation (ΔI_L = 50 mA)	20 mV

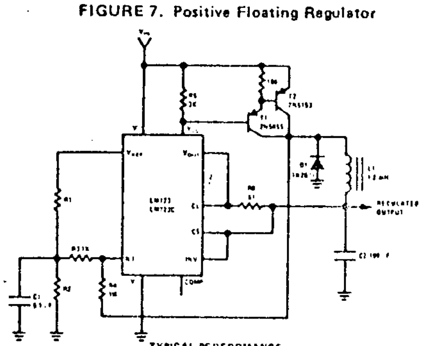
FIGURE 7. Positive Floating Regulator



TYPICAL PERFORMANCE

Regulated Output Voltage	−100V
Line Regulation (ΔV_{IN} = 20V)	30 mV
Load Regulation (ΔI_L = 100 mA)	20 mV

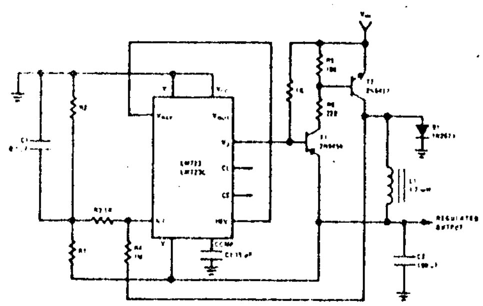
FIGURE 8. Negative Floating Regulator



TYPICAL PERFORMANCE

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 30V)	10 mV
Load Regulation (ΔI_L = 2A)	80 mV

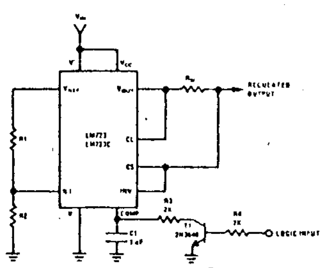
FIGURE 9. Positive Switching Regulator



TYPICAL PERFORMANCE

Regulated Output Voltage	−15V
Line Regulation (ΔV_{IN} = 20V)	8 mV
Load Regulation (ΔI_L = 2A)	6 mV

FIGURE 10. Negative Switching Regulator

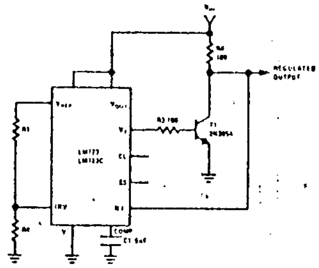


TYPICAL PERFORMANCE

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 3V)	0.5 mV
Load Regulation (ΔI_L = 50 mA)	1.5 mV

Note: Current limit transistor may be used for shutdown if current limiting is not required.

FIGURE 11. Remote Shutdown Regulator with Current Limiting



TYPICAL PERFORMANCE

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 10V)	0.5 mV
Load Regulation (ΔI_L = 100 mA)	1.5 mV

FIGURE 12. Shunt Regulator

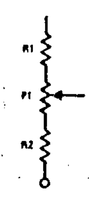
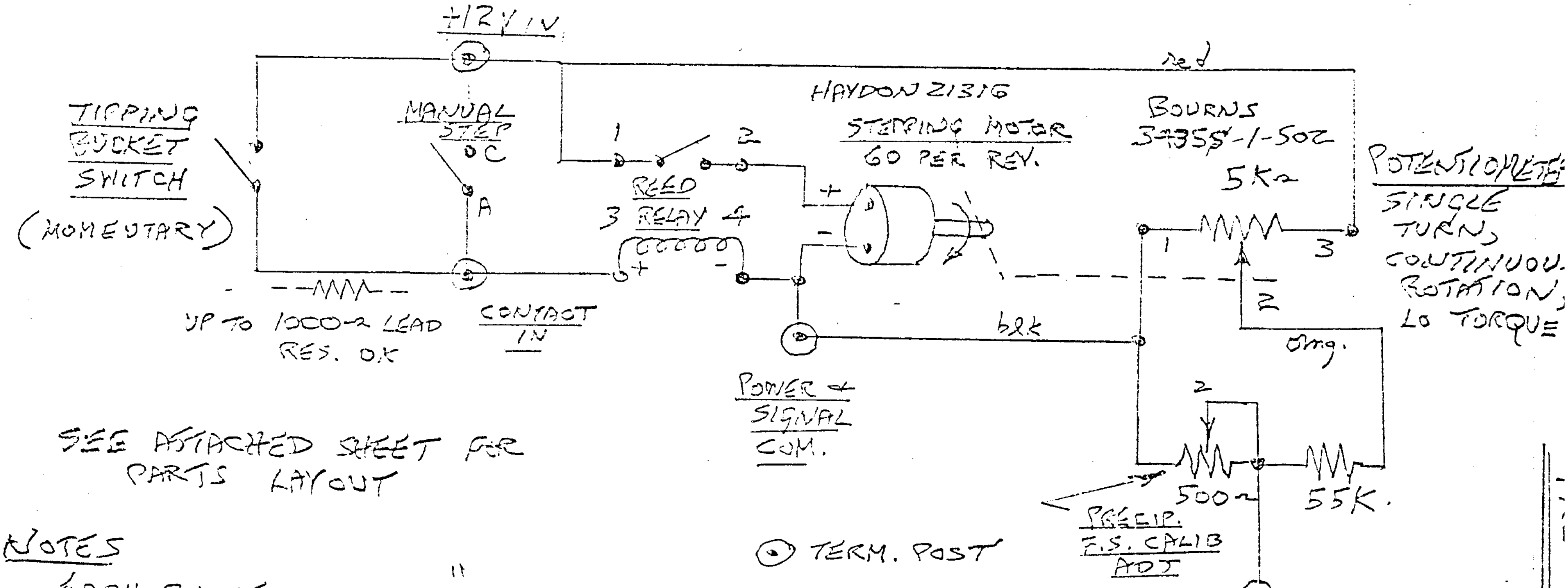


FIGURE 13. Output Voltage Adjust (See Note 5)



SEE ATTACHED SHEET FOR PARTS LAYOUT

NOTES

- EACH PULSE = .005" WATER.
- 60 PULSES TURNS POT ONE REVOLUTION, WHICH PRODUCES 0 TO +60 mv OUTPUT IN 1 mv STEPS TO THE SCANNER.
- THEREFORE, .3" WATER IS COUNTED, THEN COUNTER STARTS OVER; SCANNER SAMPLES THE INSTANTANEOUS VALUE OF ACCUMULATED COUNTS.

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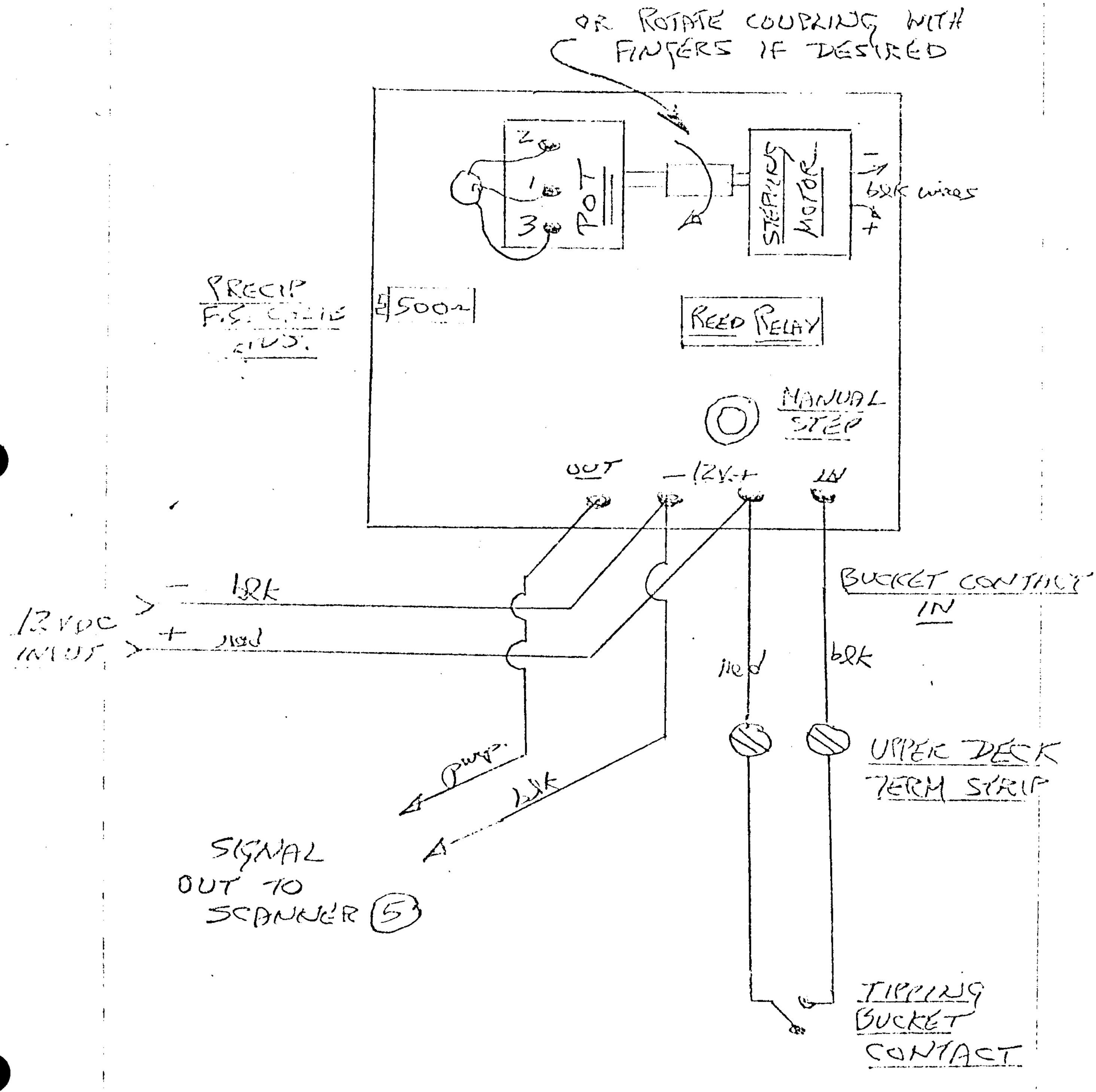
PRECIP COUNTER PARTS LAYOUT

LOCATED ON UPPER DECK
SEE ALSO UPPER DECK LAYOUT DIAG.

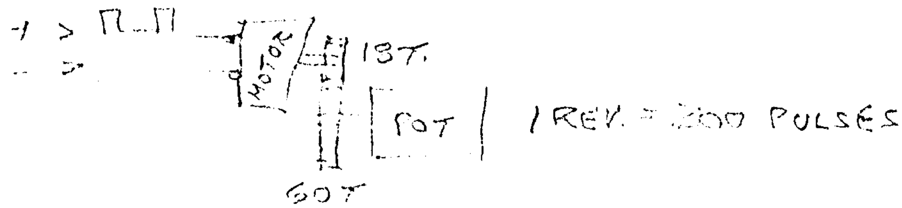


PRECIP COUNTER NOTES — AUG 28

THE EXISTING SET-UP IS SUCH THAT THE COUNTER ACCUMULATES 60 PULSES (TIPS) AND THEN STARTS OVER. THIS REPRESENTS .3 IN. OF WATER. ONLY 60 COUNTS CAN BE MADE BECAUSE THE STEPPING MOTOR MOVES AT 6° PER STEP. TO ELIMINATE CONFUSION, AND MAKE CHART EASIER TO READ, ONLY 60 MV FULL SCALE IS SET BY THE PRECIP. CALIB ADJ. (SEE PRECIP. COUNTER CKT), INSTEAD OF 100 MV F.S. AS IS DONE ON ALL THE OTHER SENSOR INPUTS TO THE SCANNER.

A DESIRABLE SITUATION IS TO HAVE 200 TIPS REPRESENT 1" OF WATER, WHICH WOULD BE ONE REVOLUTION OF THE POT WITH 100 MV F.S. OUTPUT, REPRESENTING THE FULL CHART WIDTH ON THE READOUT. THIS CAN BE ACCOMPLISHED NOW IF DESIRED AS FOLLOWS, EITHER BY SCHEME a) OR b)

a) USING THE EXISTING STEPPING MOTOR WITH A 18T - 64 D.P. 20° P.A. GEAR DRIVING A 60T - 64 D.P. 20° P.A GEAR ON THE POT. 200 PULSES NOW TURN THE POT AROUND ONCE. RECALIBRATE TO 100 MV F.S. WITH THE PRECIP. CALIB ADJ.



OR

b) USE A .36° PER STEP MOTOR (#3131B) WITH THE 10T - 64 D.P. 20° PA GEAR THAT COMES WITH IT, THEN PUT A 20T - 64 D.P. 20° P.A. GEAR ON THE POT. THIS ALSO GIVES 200 PULSES PER REVOLUTION.

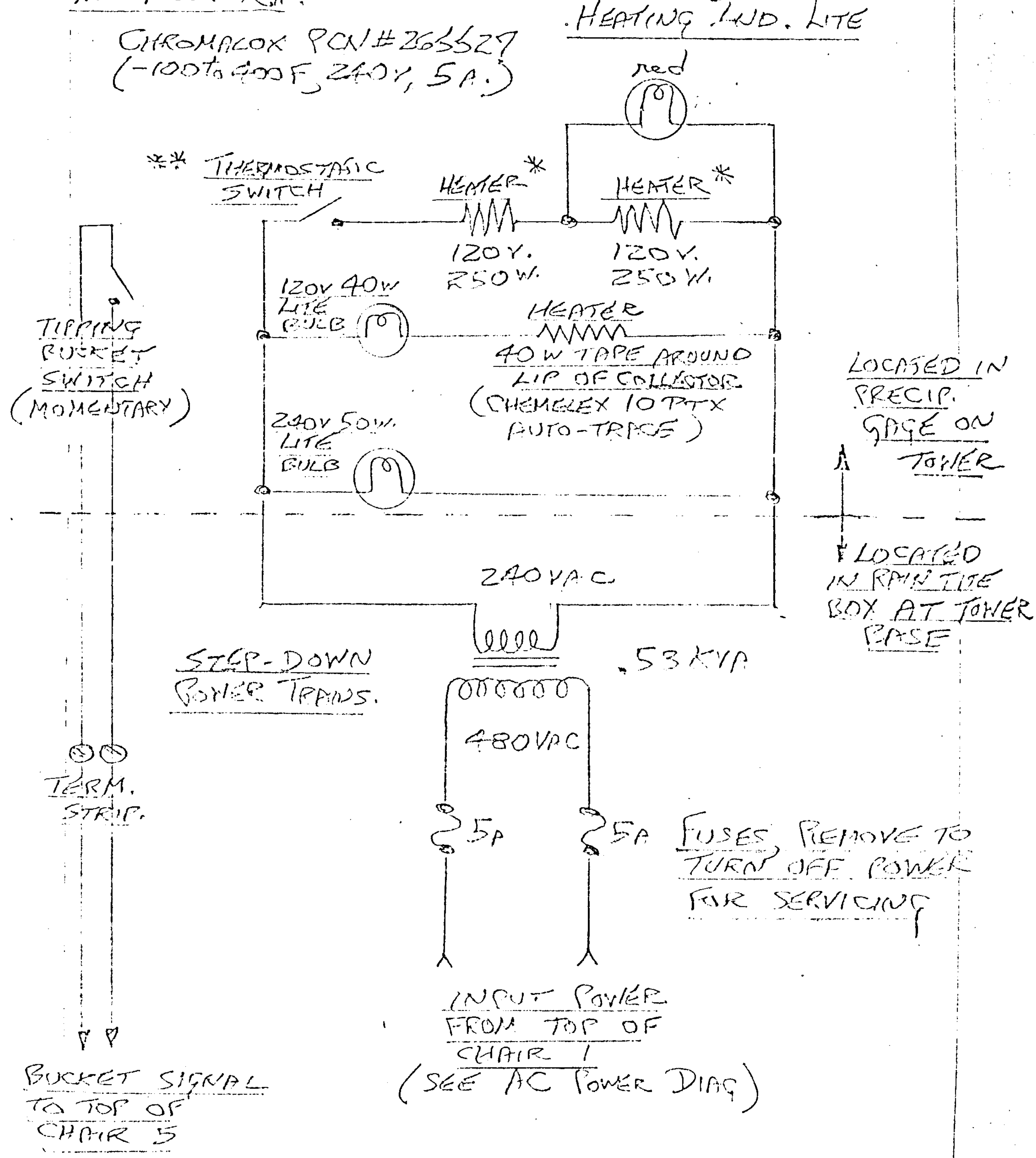
USE THE SAME POT IN EITHER CASE, ITS RESOLUTION IS ADEQUATE.

Paul Taylor

PRECIP. GAGE WIRING

* HEATER: CHROMALOX RIN-25 PCN#253331, 2 REQD
120 V, 250 W., IMMERSION TYPE

** THERMOSWITCH:
CHROMALOX PCN#265527
(-100 to 400 F, 240 V, 5 A.)



CATALOG NO. 102A

(131)

BIG INCH®
MINIATURE
PRECISION
MOTORS

Oct 76

H·S·I®
HAYDON SWITCH & INSTRUMENT, INC.
1500 MERIDEN ROAD, WATERBURY, CONN 06705 AREA CODE (203) 756-7441

Thank you for your interest in our products.

The attached literature will give you the information you requested. Should you have further questions about your specific requirements, they can be answered by our representative in your area:

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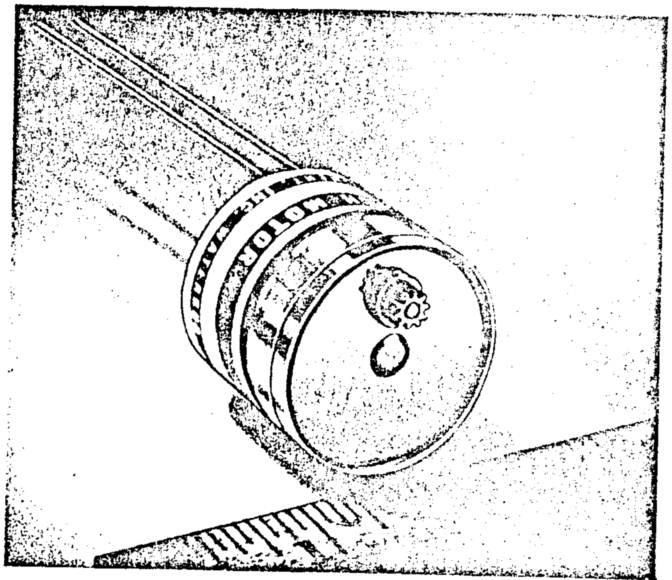
Bldg. - Two - Suite 200
300 - 120th. Ave., N.E.
Bellevue, WA 98005
Tel: 206-454-7922

H·S·I®
HAYDON SWITCH & INSTRUMENT, INC.
1500 Meriden Road, Waterbury, Conn. 06705 (203) 756-7441



BIG INCH®

TWO-WIRE STEPPER MOTORS

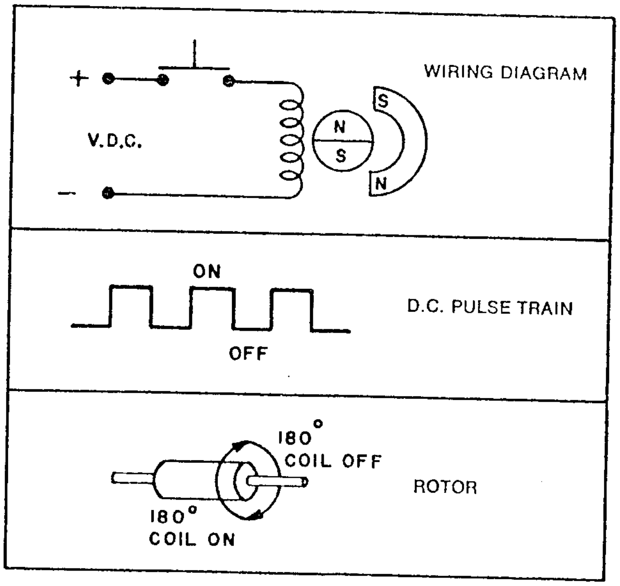
SERIES 31300

TWO-WIRE STEPPER MOTOR

The Series 31300 2-wire Stepper Motor*directly converts electrical impulses into discrete angular steps of the output shaft without need for control logic. For each impulse the rotor turns 360°, 180° when power is applied and 180° more when power is removed. No power is consumed between pulses.

Here's how it works. The rotor is a cylindrical permanent magnet polarized N-S across a diameter. The stator is basically two-pole with shading to provide unidirectional rotation. Another permanent magnet biases the stator poles so that with no power applied to the coil one pole is N and the other is S. The rotor therefore detents firmly with its poles adjacent to stator poles of opposite polarity.

*Patent Pending



When voltage of proper polarity is applied to the coil, the induced field overrides the permanent magnet bias field reversing polarity of the stator poles and the rotor turns 180°, aligning its poles with stator poles of opposite polarity. As long as power continues to be applied to the coil, the rotor will remain in this position. However, when power is removed from the coil, the bias field takes over, reversing polarity of the stator poles and causing the rotor to turn another 180°, where the rotor poles again align themselves with stator poles of opposite polarity.

A single positive-going pulse, therefore, results in 360° rotation of the rotor. The simplicity of control circuitry is evident since a form A contact (single pole single throw) or simple transistor switch is all that is required for driving this stepper motor.

Note that only a two-wire circuit is required, in contrast to three wires needed tor a three-wire stepper.

The Series 31300 stepper motor develops 5 inch-grams torque with 6° step angle at pulse rates up to 15 per second. Power input 2 watt. Positively unidirectional.

Catalog Part Numbers

VOLTS	STEP ANGLE				ROTATION
	36°	30°	6°	.36°	
24	31301	31303	31305	31307	LEFT
24	31302	31304	31306	31308	RIGHT
12	31311	31313	31315	31317	LEFT
12	31312	31314	31316	31318	RIGHT

H·S·I® BIG INCH®

TWO-WIRE STEPPER MOTORS

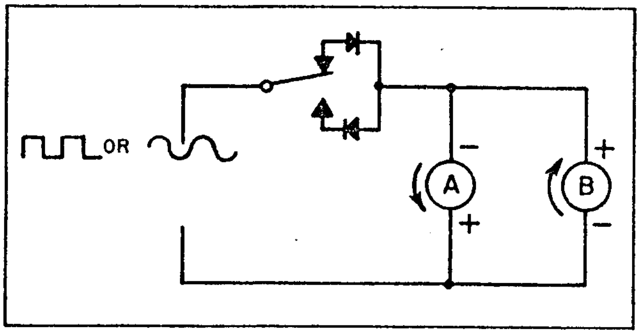
The unique characteristics of this stepper motor make possible interesting and unusual control possibilities. For instance, sine wave or square wave power applied to the motor (within its operating range) will cause it to step on the positive half cycles and ignore the negative half cycles. If a second motor is added with its leads reversed, it will operate from the negative half cycles of the input frequency and ignore the postive half cycles. Or one motor can be operated with positive pulses and the other with negative pulses, performing two independenf functions selectively on a two-wire circuit.

Now, by adding an SPDT switch and two diodes, either or both motors can be operated at the will of the operator and only two wires are required for control. The two motors might also be mechanically coupled through a differential to drive a potentiometer or an add-subtract counter.

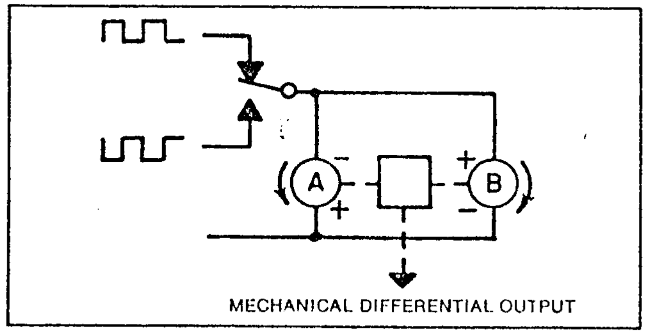
There is an almost unlimited variety of control functions that can be provided with these new two-wire stepper motors.

The fact that no power is consumed between pulses makes this unit ideal for battery operated systems where power is limited.

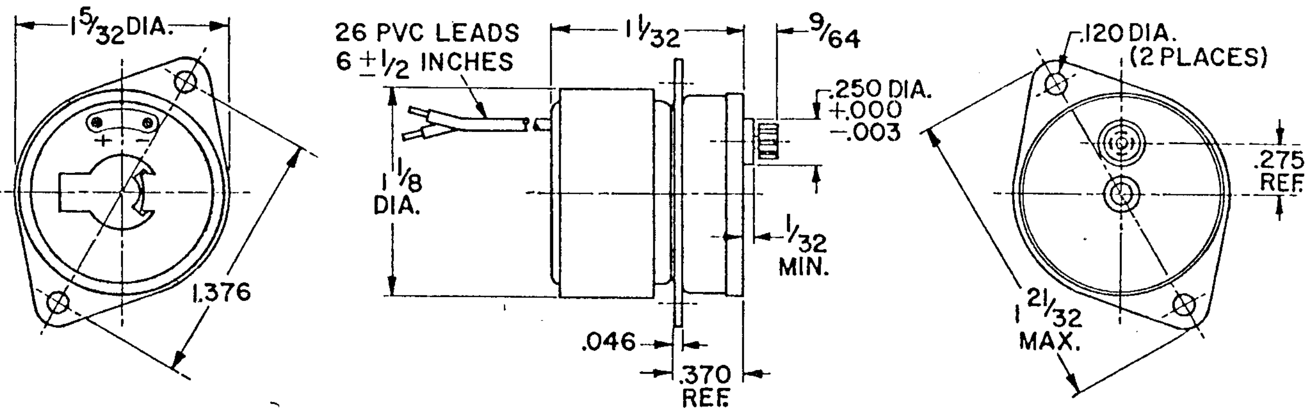
2-WIRE CONTROL OF 2 MOTORS



2-WIRE REVERSIBLE CONTROL



DIMENSION DATA



MOUNTING FLANGE (P/N 09–071) MAY BE ROTATED TO ANY POSITION REQUIRED. PINION 10T–64 D.P. 20° P.A. OPTIONAL SHAFT 1/8 DIA. x 9/32 LONG AVAILABLE.

BOURNS INC

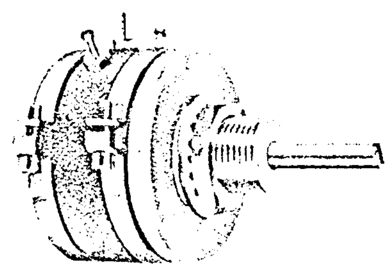
Model 3435
1¹⁄₁₆" Diameter Single-Turn, Bushing Mount Wirewound Element

134

FEATURES

- Extended temperature range: −65° to +125°C
- Outstanding resistance to humidity. Exceeds humidity cycling requirements of MIL-R-12934
- Dual collector pick-off assures outstanding vibration and shock performance
- Shaft supported front and rear by precision sleeve bearings
- Housing: high temperature, moisture resistant, thermosetting plastic
- Custom design capability is available to satisfy your most demanding and difficult special requirements.
- Performance of the Model 3435 is guaranteed by the Bourns Reliability Program, which includes individual inspection to published electrical and physical characteristics.

Actual Size



STANDARD RESISTANCES

Resistance (Ohms)	Part Number*	Resolution (Percent)
50	3435S-1-500	0.323
100	3435S-1-101	0.246
200	3435S-1-201	0.200
500	3435S-1-501	0.154
1,000	3435S-1-102	0.120

Resistance (Ohms)	Part Number*	Resolution (Percent)
2,000	3435S-1-202	0.106
5,000	3435S-1-502	0.115
10,000	3435S-1-103	0.085
20,000	3435S-1-203	0.072
50,000	3435S-1-503	0.058

* The last three digits of the part number represent the resistance in standard code.

STANDARD SPECIFICATIONS

THE SPECIFICATIONS LISTED BELOW ARE FOR THE STANDARD MODEL. MODIFICATIONS OF ALL TYPES (MECHANICAL, ELECTRICAL AND ENVIRONMENTAL) CAN BE CUSTOM ENGINEERED TO YOUR SPECIFIC REQUIREMENTS.

ELECTRICAL CHARACTERISTICS

Resistance Range .... 50 ohms to 50K ohms
Resistance Tolerance* .... ±3%
Linearity (Independent)* .... ±0.5%
Resolution .... See Standard Resistance Table
Effective Electrical Angle* .... 350° ±2°
Absolute Minimum Resistance* .... 1 ohm or 0.1%, whichever is greater
Noise* .... 100 ohms maximum
Power Rating
  70°C .... 1.5 watts
  125°C .... 0 watt
Dielectric Strength MIL-R-12934
  Sea Level .... 1000 volts AC minimum
  70,000 feet .... 300 volts AC minimum
Insulation Resistance, 500 volts DC* .... 1000 megohms minimum

ENVIRONMENTAL CHARACTERISTICS

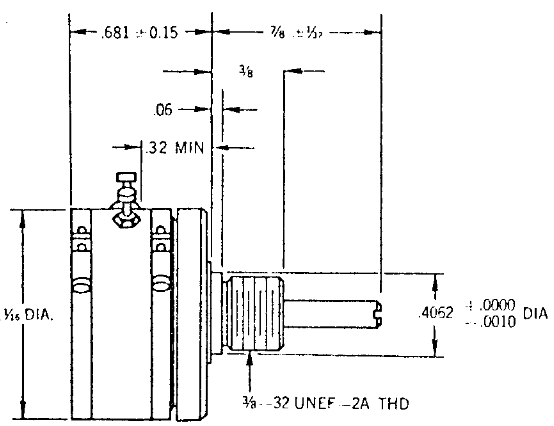
Operating Temperature Range .... —65 to +125°C
Temperature Coefficient of Wire .... 20 ppm/°C maximum
Humidity .... MIL-R-12934, Humidity cycling
Vibration MIL-R-12934, 15G
  Wiper Bounce .... 0.1 millisecond maximum
  Wiper Shift .... 1.0% maximum
Shock MIL-R-12934, 50G
  Wiper Bounce and Wiper Shift .... Same as Vibration
Load Life .... MIL-R-12934, 1000 hours
  Resistance Shift .... 2.0% maximum
Sand and Dust MIL-E-5272
Fungus MIL-E-5272
Salt Spray MIL-R-12934

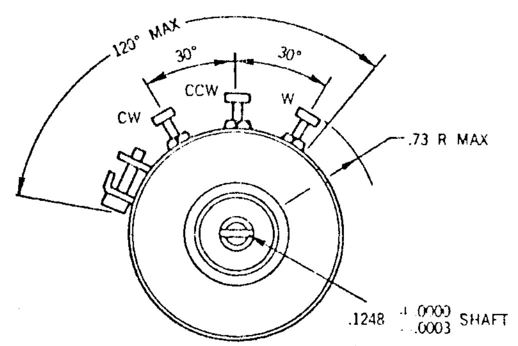
MECHANICAL AND PHYSICAL CHARACTERISTICS

Mechanical Angle .... Continuous
Shaft Runout* .... .001 in. T.I.R.
Shaft End Play* .... .003 in. T.I.R.
Shaft Radial Play* .... .003 in. T.I.R.
Rotational Life .... 2,000,000 shaft revolutions
Torque*
  Starting .... .2 oz.-in. maximum
  Running .... .2 oz.-in. maximum
  (Add 75% for each additional cup)
Ganging .... 8 cups maximum
Weight .... Approximately 0.8 oz.
Terminals .... Gold-plated turrets
Markings* .... Manufacturer's name and part number, resistance value and tolerance, linearity tolerance, wiring diagram and date code.

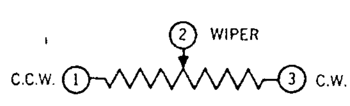
NOTES
* 100% or statistical sampling inspection performed to insure highest quality.
Specifications are subject to change without notice.

3435





NOTES:
1. ADD .405 TO .681 DIM FOR EACH ADDITIONAL CUP.
2. LOCK WASHER AND HEX NUT TO BE SUPPLIED WITH EACH UNIT.

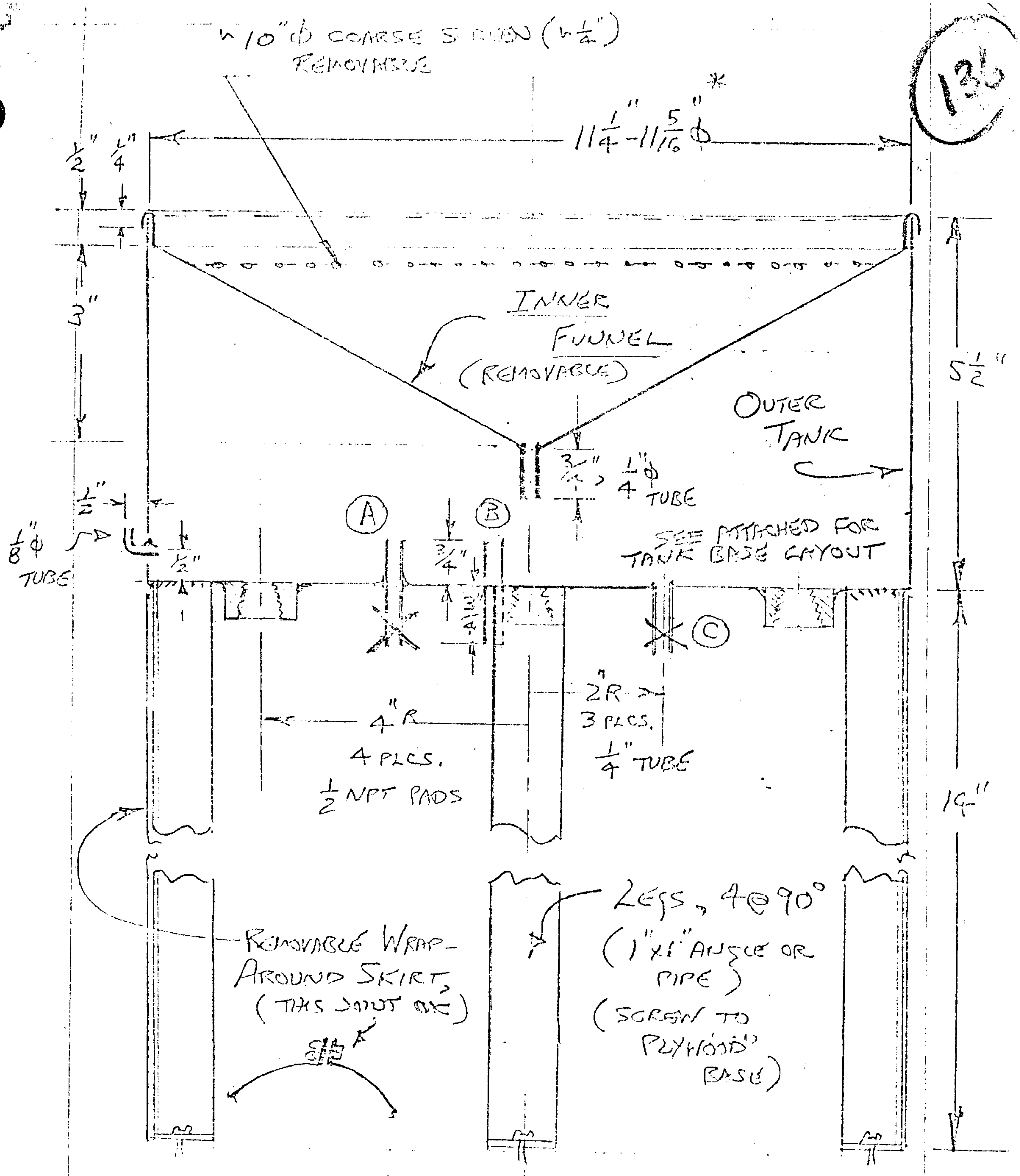


TOLERANCES: EXCEPT WHERE NOTED
DECIMALS: .XX ± .010, .XXX ± .005
FRACTIONS: ± 1/64

BOURNS

BOURNS, INC., PRECISION CONTROLS OPERATIONS, TRIMPOT PRODUCTS DIVISION
1200 COLUMBIA AVENUE, RIVERSIDE, CALIFORNIA 92507
SUBSIDIARY: BOURNS (CANADA) LTD., 36 CRANFIELD RD., EAST YORK, TORONTO, ONTARIO, CANADA

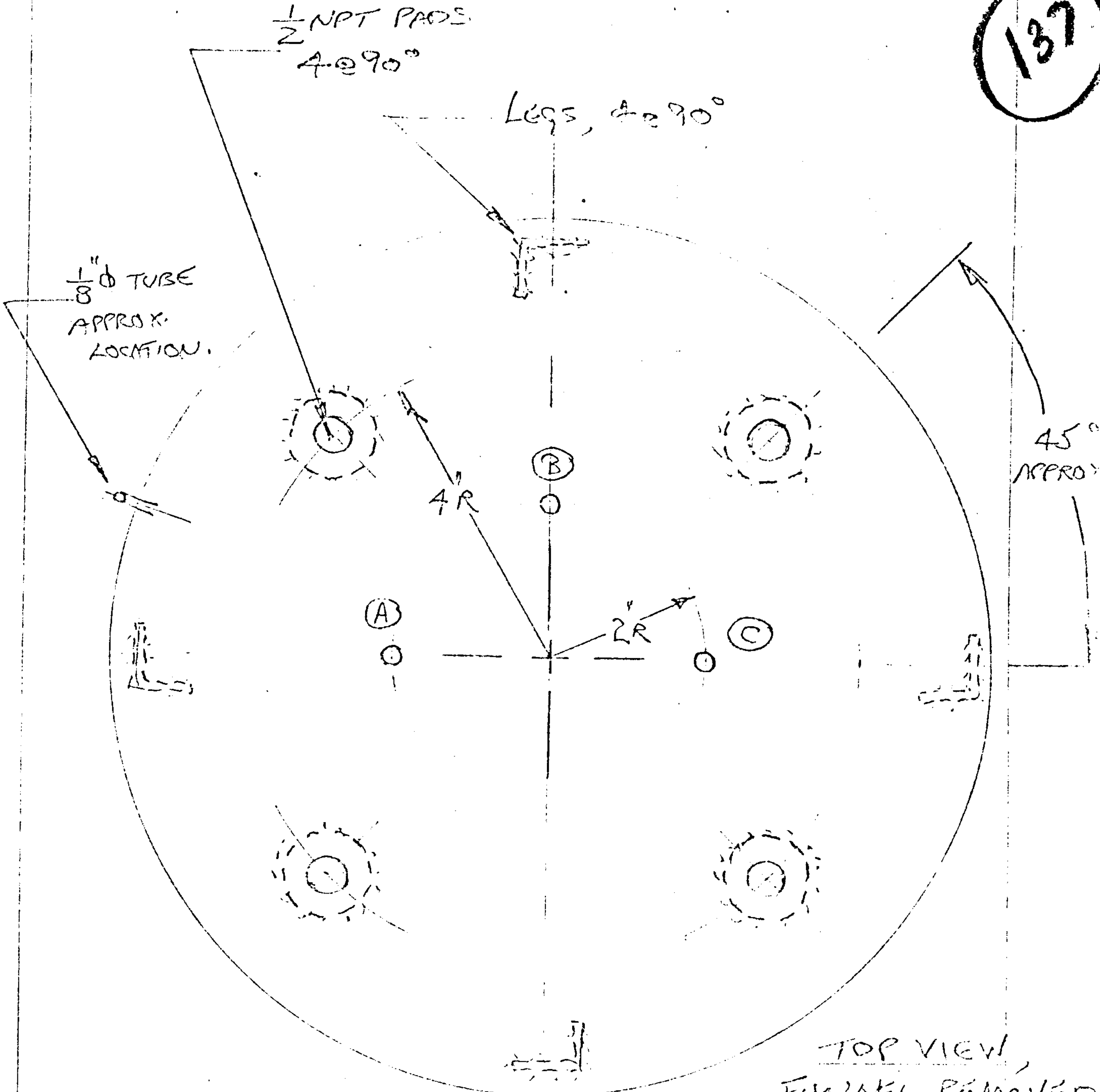
LITHO IN U.S.A.



*IF POSSIBLE, ONLY CRITICAL DIMENSION ON SKETCH.

FUNNEL & TANK TO BE WATERTITE.

PRECIP GAGE
SCALE 1" = 2"
MAT: GALV
NOV 76 - PLT



TOP VIEW,
FUNNEL REMOVED

(A) FEED-THRU WITH VALVE
(B) FEED-THRU ONLY
(C) TANK DRAIN WITH VALVE

BASE LAYOUT OF
OUTER TANK

SCALE 1" = 2"
MAT: GALV.
NOV 76 - PLT

(138)

meteorology research, inc. • 464 w. woodbury rd. • altadena, calif.

Mailing address:
Box 637, Altadena,
Calif. 91001
Phone 213 791-1901

TIPPING BUCKET
RAINGAGE
Models 302 & 303

IM-78B

INSTALLED IN U of W
HEATED OIL SNOW PRECIP
GAGE NOV 76

SEE ATTACHED NOTES +
SKETCHES

USE FOR REFERENCE TO
TIPPING BUCKET MECHANISM ONLY

Issue:
June 1976

A Subsidiary of Cohu, Inc.

WARRANTY

METEOROLOGY RESEARCH, INC., provides a continuing program of assistance, support, and consultation with all its customers. In practice, this service usually goes far beyond the ordinary limits of warranty. Therefore, the warranty that follows is intended to define the legal obligations.

MRI WARRANTS EACH ITEM of equipment that it manufactures to be free from defects of material and workmanship. Any part or parts will be repaired or replaced when proven by MRI examination to have been defective within one year (90 days for potentiometers, semi-conductor devices, batteries, fuses, lamps and tubes) from date of shipment to the original customer. Transportation charges for warranty repairs shall be paid by the customer. Transportation charges to the factory (MRI, 464 West Woodbury Road, Altadena, California 91001) shall be prepaid by the customer; transportation charges for the return of the repaired equipment shall be billed by MRI to the customer.

THIS WARRANTY DOES NOT EXTEND to MRI equipment subjected to misuse, accident, neglect, improper application, or any incidental or consequential damages caused by, or resulting from, a defect in material or workmanship or other equipment failure. It does not apply to MRI equipment repaired or altered by other than MRI personnel or other persons authorized by MRI in writing to perform repairs.

THIS WARRANTY IS IN LIEU OF all other warranties expressed or implied. MRI shall not be liable for collateral or consequential damages.

NOTE IF ANY UNUSUAL or special service problems arise, it is suggested that you contact MRI for advice or assistance. No equipment should be returned to the factory until return authorization is requested and received from MRI.

SHIPPING DOCUMENTS on equipment returned to MRI from outside the USA must state: "This instrumentation was manufactured in the United States of America."

PRESIDENT

Meteorology Research, Inc.
P. O. Box 637
464 West Woodbury Road
Altadena, California 91001, USA
Telephone: 213-791-1901

METEOROLOGY RESEARCH, INC. SEAL 1966 DELAWARE

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USE OF THIS MANUAL

This manual is designed to cover the complete installation, operation and maintenance instructions necessary for the Tipping Bucket Raingage.

CHANGE NOTICE

In a continuing effort to improve our products, we reserve the right to change the design or specifications for this equipment without notice.

PROPRIETARY NOTICE

TABLE OF CONTENTS

1 INTRODUCTION

The MRI-designed Rainfall Measuring System employs an exclusive low inertia Tipping Bucket to obtain outstandingly accurate results. U. S. Weather Bureau standards are bettered by a factor of 2.5 -- the MRI unit consistently measures with ±1% of total at a rate of three inches of rainfall an hour. There are no swinging wires connected to the bucket or open contact points that might fail or create drag on the buckets.

Built-in features of the MRI Raingage include: a collector tube whose funnel is eight inches below the upper rim for maximum collection efficiency even in strong turbulent winds with high rainfall rates; a molded epoxy bucket whose knife edges pivot in Delrin wedges; a water guide over the center line of the bucket to assure equal fill and eliminate splash loss, the magnet is molded in epoxy for maximum life and to reduce possible corrosion; plus the fact that the entire unit is housed in heavy gauge plated aluminum frame for rugged use in all environments.

In field operations, a raingage is only as accurate as its mounting is rigid and level. The MRI Raingage uses an exceptionally sturdy post mount bolted to the frame. A low level installation, concrete or large plywood base, will provide a stable non-moving platform. A carpenter's level on the splash shield will permit the field set-up crew to exactly duplicate the precise factory leveling for calibration and thus duplicate the system accuracy. Should it become necessary, the MRI Raingage design also permits a simple and accurate means of recalibration.

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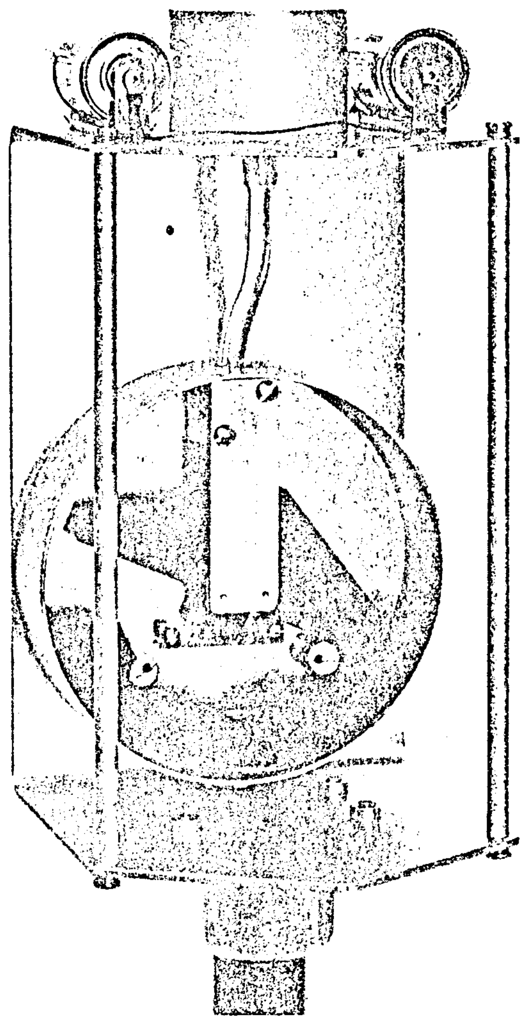


FIG. E
INTERIOR VIEW,
TIPPING-BUCKET
RAINGAGE

75-089

2 DESCRIPTION

2.1 Equipment List

1. Rainfall tipping bucket mechanism with magnetic switch.

2. Eight inch rain collector sleeve, screen, and funnel assembled.

3. Hardware and tools

   1 ea Mounting Pipe and 1 ea Pipe Flange
   1 ea Allen Wrench - 3/16" size

4. Instruction Manual

5. Custom fitted corrugated packing and box

2.2 Theory of Operation

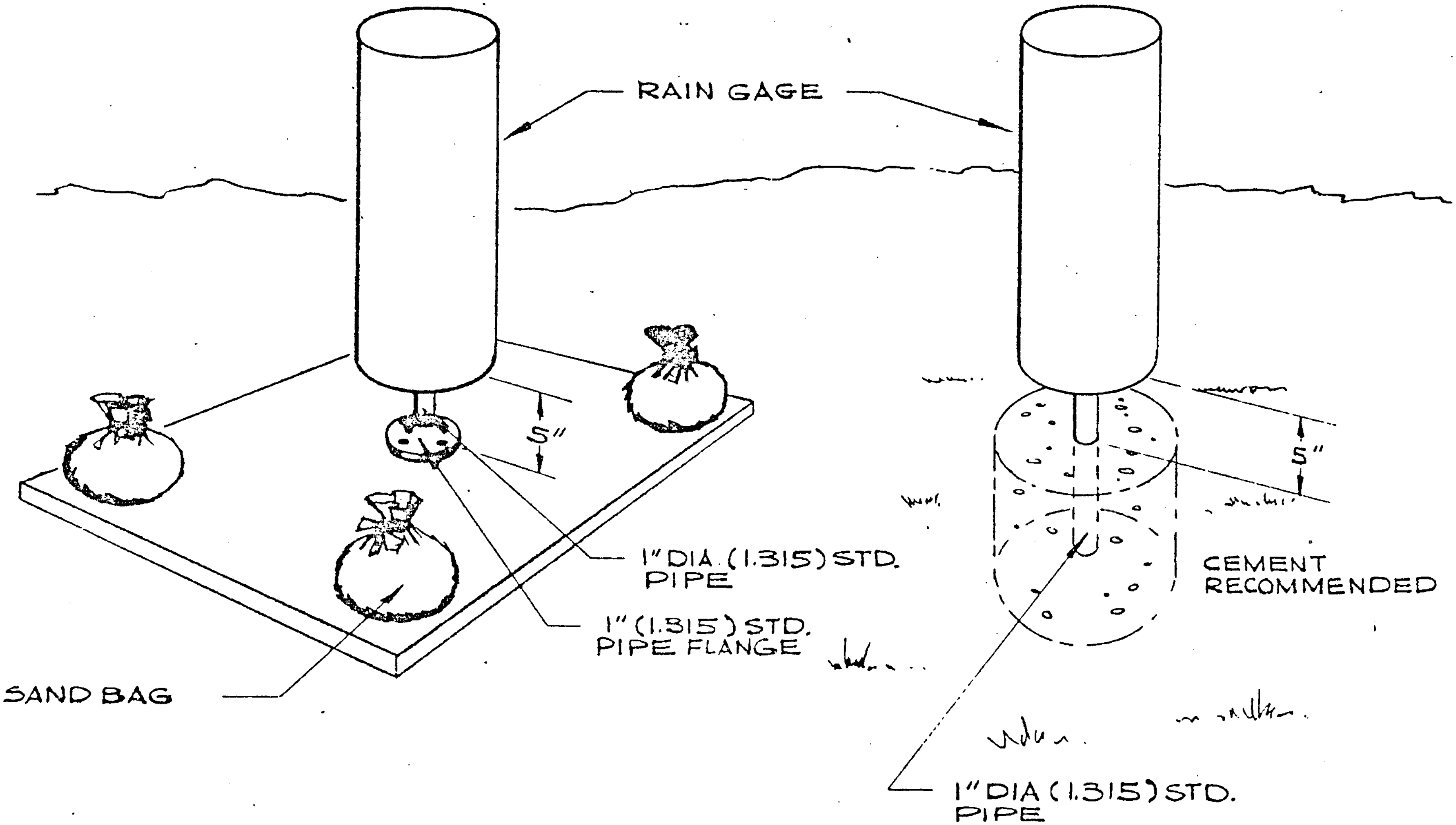
2.2.1 The MRI-designed tipping bucket raingage is designed to operate with a variety of recording systems. A measured 7.95 cc of water causes the bucket to over balance and swing to the opposite side. A magnet mounted under the bucket passes close to a magnetic switch during the tipping action causing a momentary closure of the switch. This pulse may be used to trigger a step marking stylus motor like the type used in the Mechanical Weather Station, or actuate a digital counter, or other similar devices.

2.2.2 Each bucket tip of 7.95 cc of water, funneled from the 7.86 inch diameter collector tube, is equal to 1/100 of an inch of rainfall.

2.3 Specifications

Low Inertia Tipping Bucket Raingage

7.86 inch I. D. Collector Tube
One tip = 7.95 cc of water
One tip = 1/100 of an inch of rain
Accuracy at 3" per hour rate is within ±1%
Accuracy at 10" per hour rate is within ±5%
Magnetic Switch rated 12 VA at 500 V. max. D.C. - resistive load
Collector Tube is 24" high and 8" in diameter
Shipping case is 11" x 12" x 27"
Packaged Weight is 18 pounds complete



Alternate Installations for the MRI Tipping Bucket Raingage

3 INSTALLATION AND OPERATION

3.1 Mounting

3.1.1 Prepare the recording station for operation in an area best suited for this system. The recorder and collector may be separated by up to several thousand feet and operate accurately.

3.1.2 Establish a location for the Raingage Collector at the desired spot to obtain required data. Prepare the area and mounting system which fits the local terrain as described below:

1. Post mount - A standard 1" pipe, 1.315" diameter, 24" long should be used for installations of a semi-permanent nature. It is recommended that this pipe be set in the ground with cement to assure rigidity and a vertical attitude under adverse conditions. The rainfall collector should clear the ground by approximately five inches in its assembled position as indicated in the installation sketch.

2. Plate mount - A short length of 1" pipe, approximately 8" long, fitted with a large flange and attached to a four-foot square of plywood will make a mount for hard surface ground or rooftop type of installations. The plywood base should be leveled using blocks or other handy material, then weighted at the corners to maintain proper position.

3.1.3 The rainfall collector system consists of two major assemblies: the 8" diameter aluminum sleeve 24" long with funnel and screen, and the tipping bucket assembly in a support bracket with pipe mounting receptacle. The two parts separate easily by sliding the aluminum sleeve up and off the support bracket; the sleeve funnel simply rests in the tipping bucket water entry plastic cone when assembled for operation. The units must be separated for installation and precise leveling.

3.1.4 To uncage tipping buckets, first remove the circular plastic shield, 304, which covers the face of the unit, then lift out the small piece of urethane foam which holds the buckets from moving. Check to see the buckets swing freely. Save this foam as it should be replaced when system is transported. Leave the shield off until bucket bracket is installed and leveled.

3.2 Testing and Operation

3.2.1 Place the tipping bucket bracket unit on the prepared mount. Rotate unit to get a preliminary check on vertical post attitude. General sightings should be used for post attitude and basic setup of bracket assembly; the carpenter's level for final adjustment. Tighten the two 3/16" Allen setscrews.

3.2.2 Leveling the rainfall system in line with the tipping bucket's swing action is extremely important and a precise carpenter's level is provided in the molded splash shield. Leveling opposite the bucket action is much less critical; two or three degree accuracy, as sighting by eye, is sufficient. Adjust this phase of leveling first. After the preliminary setup and securely tightening the rainfall bracket to the post, use the following procedure to obtain a precise level:

1. Loosen wing nut on back side of the bucket bracket.

2. The inner bucket assembly is pivoted so it may be swung back and forth until the carpenter's level bubble is exactly centered.

3. Tighten wing nut and recheck level for possible change when the nut was tightened.

3.2.3 Connect a dual conductor wire using lugs to the Jones terminal strip located on the rear of bucket bracket for Model 302. Follow the wire color coding on Models 303 and 304 to complete the magnetic switch circuits. Loop the wire around the post once or twice and, if the system is a ground installation, lay wire loosely between collector and recording station. Weighting the wire with small rocks or other handy items will prevent inadvertent snags by hunters, wild animals, etc.

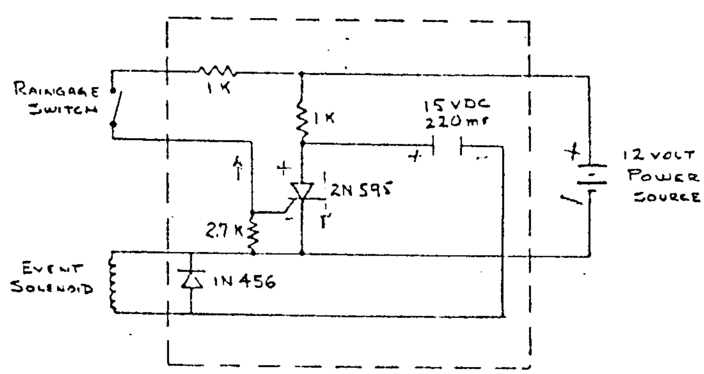
3.2.4 The magnetic switch was designed to operate at 12 VA at 500 volts maximum D.C. when used with a resistive load. Life expectancy at maximum is 20×10^6. Eveready Alkaline E-95 "D" flashlight batteries are recommended.

NOTE: For reactive load uses, a protective circuit is required. MRI Engineering will be happy to assist users in the design of a proper protective circuit for a specific application.

3.2.5 Test the system continuity and operation by gently tipping the bucket from one side to the other, checking the stylus or recorder for corresponding action.

3.2.6 It will be best to provide in advance for water actuation tests at the point of operation by supplying the field crew with one quart of water. After assembly is complete, pour water slowly into collector, listening for the individual tips and checking the chart record to verify the corresponding action and, if desired, measuring the drain accumulation. Replace the circular splash shield.

3.2.7 After the rainfall buckets have been installed and checked operationally, slide the 24" long cover tube and funnel down over the top of the bracket assembly to complete the installation. The funnel simply rests on the small collector and no locking screws are required.



4 FINE CALIBRATION

4.1 Basic Calibration

Each Rainfall Collector has been accurately calibrated and adjusted at time of manufacture. The continued accuracy during field operation will naturally depend on the system being level. To test basic tipping bucket accuracy, the following figures are given for the volume of water required to produce one or more tips of the bucket:

7.95 cc of water = 1 tip
95.40 cc of water = 12 tips

4.2 Recalibration

If it should become necessary to recalibrate for each tip of the bucket to regain system accuracy, these following steps will approximate original factory procedure:

1. Set up the tipping bucket bracket assembly in an exactly level attitude. Note the two eccentric limit travel studs with slotted ends for screwdriver adjustment. Locking screws for these studs are located on the rear of the bracket.

2. Slowly pour a measured 7.95 cc of water into the bucket through the normal collector and tube. The bucket should tip within a drop or two of all the water, or 7.95 cc. If it does not, the eccentric stud opposite the bucket being filled should be adjusted.

3. For all adjustments, set the locking slotted capscrews for a snug fit. If the bucket tilts too soon, indicating water quantity is low, turn opposite side eccentric stud outward or away from system center line. This will raise the bucket being filled.

   If the bucket requires more than 7.95 cc of water to tilt, indicating water quantity is high, turn the opposite side eccentric stud inward, or toward the system center line.

4. It is best to average 12 consecutive tips, six each way, for greater system accuracy.

5. Tighten the locking screws and recheck the action on both buckets to be certain settings did not change during tightenting.

5 MAINTENANCE

5.1 Preventive Maintenance

The uncomplicated electro-mechanical design of the entire rainfall system will require very little attention. Every six months the cover tube should be removed and the system given a thorough inspection. The bucket pivot points should be cleaned but never lubricated. The leaf screen should be cleaned at established service intervals, probably once a month.

5.2 Trouble Shooting

5.2.1 If trouble should occur, check the cable, connection, including the recorder connections. Color coded plugs or numbered terminals on the Jone's strip will indicate if the connections have been properly installed, especially where polarity is used in the system.

5.2.2 Next check power voltages and/or proper battery installation. In the Mechanical Weather Station for instance, if the tipping buckets are held in a horizontal position the magnetic switch will remain closed, causing the marking stylus motor to cycle until the switch is opened. A voltmeter may be used to test circuit continuity.

5.3 Transporting

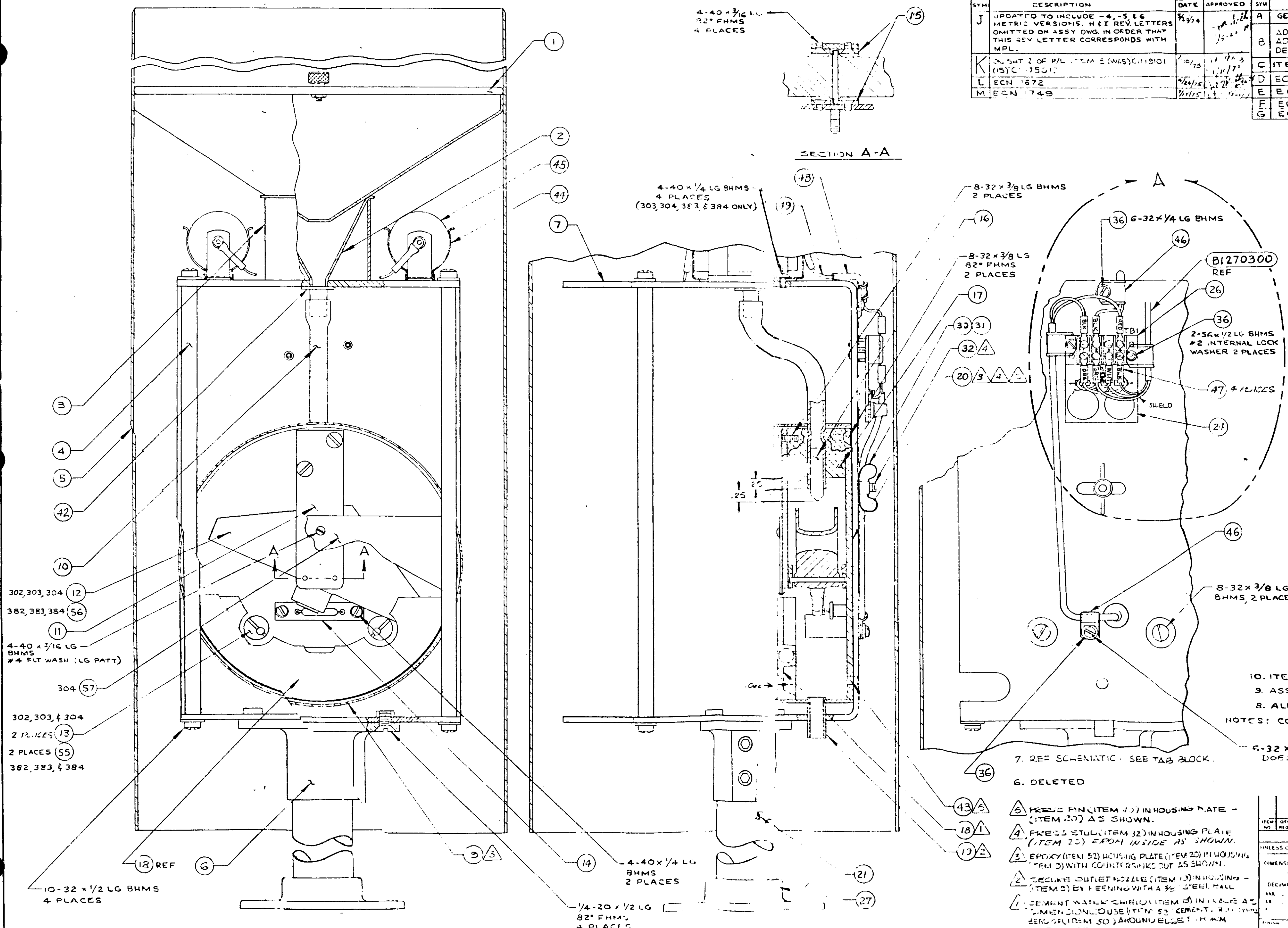
When transporting rainfall unit, it is important to cage the rainfall tipping bucket system. After disassembly, remove batteries and cage bucket system by replacing the foam insert inside the circular plastic water shield. These simple precautions will prevent damage to the system.

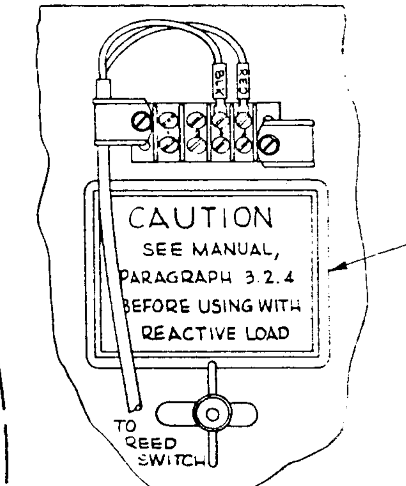
5.4 Service

If any unusual or special service problems arise, it is suggested that you contact MRI for advise and assistance. MRI maintains a stock of spare or replacement parts for this raingage system. Allow two weeks for normal delivery. No equipment should be returned to the factory until return authorization is requested and received.

SYM	DESCRIPTION	DATE	APPROVED
REVISIONS (CONTINUED)			
J	UPDATED TO INCLUDE -4, -5, & 6 METRIC VERSIONS. H & I REV. LETTERS OMITTED ON ASSY DWG. IN ORDER THAT THIS REV. LETTER CORRESPONDS WITH MPL.	5/24/74	[illegible]
K	ON SHT 2 OF P/L ITEM 5 (WAS) C119101 (IS) C 7531	7/10/75	[illegible]
L	ECN 1672	4/24/75	[illegible]
M	ECN 1749	11/11/75	[illegible]

SYM	DESCRIPTION	DATE	APPROVED
REVISIONS			
A	GENERAL CHANGES	4-19-68	CHS.
B	ADDED VIEW A - MODEL 302. ADDED NOTE 6, ADDED PART 51 DELETED "MODEL 303" FROM TITLE	7-1-68	CHS.
C	ITEM 38 WAS 4 PLACES, 37 WAS 2 PLACES	8-22-68	[illegible]
D	ECN 552	2/5/69	[illegible]
E	ECN 675	29 Nov 71 ELANG	[illegible]
F	ECN 846 GRN (WAS) BLK	10/11/72	[illegible]
G	ECN 840	11/3/72	[illegible]





VIEW A
MODEL 302 & 382
(FOR MODEL 302 & 382 DELETE ITEMS 24, 44, 45, 49, & 6-32 × 1/4 BHMS)

DASH No.	MODEL №	SCHEMATIC
-1	302	SEE VIEW A
-2	303 (USED WITH 1072 MWS)	B11694
-3	304	B13916
-4	382	SEE VIEW A
-5	383 (USED WITH 1072 MWS)	B11694
-6	384	B13916

D 1010930

10. ITEM 23, ALLEN WRENCH, NOT SHOWN.
9. ASSEMBLE PER M.R.I. SHOP STD., SECTION 12.
8. ALL HARDWARE SST.
NOTES: CONTINUED

6-32 × 1/4 LG BHMS (VERIFY THAT SCREW DOES NOT BOTTOM OUT AGAINST ITEM 20)

7. REF SCHEMATIC - SEE TAB BLOCK.

6. DELETED

5. PRESS PIN (ITEM 43) IN HOUSING PLATE - (ITEM 20) AS SHOWN.

4. PRESS STUD (ITEM 32) IN HOUSING PLATE (ITEM 20) FROM INSIDE AS SHOWN.

3. EPOXY (ITEM 52) HOUSING PLATE (ITEM 20) IN HOUSING (ITEM 9) WITH COUNTERSINKS OUT AS SHOWN.

2. SECURE OUTLET NOZZLE (ITEM 13) IN HOUSING - (ITEM 9) BY PEENING WITH A 3/8 STEEL BALL

1. CEMENT WATER SHIELD (ITEM 18) IN PLACE AS DIMENSIONED. USE (ITEM 52) CEMENT, [illegible] BEAD OF (ITEM 50) AROUND EDGE FOR WATER SEAL.

NOTE:

ITEM NO	QTY REQ'D	PART OR IDENT. NO	DESCRIPTION	NOTES

MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS: .XXX ± .010; .XX ± .03; .X ± .1
ANGLES: ± 0° 30'
FINISH
MATERIAL

meteorology research, inc.
altadena, calif.

DRAWN 7/12/66 D. CHIN
CHECK [illegible]

RAIN GAGE ASSEMBLY

ENGR
APPD
SIZE D 1010930 REV M
SCALE [illegible] SHEET 1

RAINGAGE - 1010930

Item No.	Part No. Assy. Level	Description
1	B1119700	Screen Assy.
2	5060950518	Funnel
4	A1117600	Spacer
5	C1117500	Rain Collector Housing Assy.
6	B1118300	Mounting Flange
10	A1119200	Inlet Tube
11	B1126700	Bearing Plate
12	B1126700	Tipping Bucket
13	A1114900	Stop Adjustment
14	B1440700	Switch Assy.
15	B1115600	Knife Edge Cradle
16	A1149600	Drop Maker
17	B1116600	Inlet Block
21	A1123400	Mounting Post
24	B1142800	Ckt. Bd. Assy, Motor Control
26	5200351176	Terminal
27	5060650512	Pipe Floor Flange
42	5115-43	Retaining Ring, Circular
44	5080651000	Battery Holder
45	5020150030	Battery, Alkaline

7 ACCESSORIES

7.1 Operating Instructions for the MRI Precipitation Gage Heater Model 370

1. This MRI Heater accessory fits all types of MRI raingages. It is a 105 watt AC powered unit that replaces the standard collector tube.

2. Thermostatically controlled and runaway safe, this heater provides funnel and critical area temperatures to be held near 53° F so that snow and freezing rain can be converted to a measurable liquid state.

3. Installation and operation are as simple as sliding the Collector/ Heater Tube over the mounted gage and plugging in the power cord. Provisions should be made to insulate or weather proof the power connection. Operationally the heater will turn on and off at 38° F and 60° F respectively.

4. On 220 VAC models, desired temperatures are thermostatically selectable between 0°F and 100°F. A control box is installed on the outside of the heater jacket tube. MRI recommends a 50°F setting for most climatic snow conditions.

INSTRUCTIONS

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P565 WINDSHIELD

November 1976

P/N 550202

WEATHER MEASURE CORPORATION
A Subsidiary of Systron-Donner Corp.
P.O. BOX 41257 SACRAMENTO, CALIFORNIA 95841 U.S.A.
TELEPHONE (916) 481-7565
TELEX NO. 377-310
CABLE ADDRESS: WEATHER SACRAMENTO

P565 WINDSHIELD

I. DESCRIPTION

The P565 Windshield is used to obtain improved accuracy of precipitation measurements. The Alter windshield has 32 free swinging tapered leaves, 3-1/2" x 16", spaced evenly around a metal ring 48 inches in diameter. Updrafts at the gage are minimized because of the deflection of the wind by the inward movement of the leaves. The top of the screen also generates a turbulent motion when the wind blows that interferes with the streamlined air movement over the gage orifice, permitting precipitation to settle into the gage that would otherwise be lost. Rigid posts are provided for mounting the shield with the top approximately one-half inch above the gage top.

II. WARRANTY

All instruments are tested prior to shipment and are warranted for one year against defects in material and workmanship. Should any instruments or parts prove to be defective, within the warranty period, upon written notice and return of the unit, WeatherMeasure Corporation will, at its option, repair or replace the defective unit and return it, transportation prepaid. Equipment repaired, abused, or improperly used or installed, and modification or alteration of instruments by other, may cancel warranty. Major parts or sub-assemblies supplied by others, which may be included as part of our instruments or systems generally carry the original manufacturers warranty and are therefore not covered by WeatherMeasure Corporation warranty.

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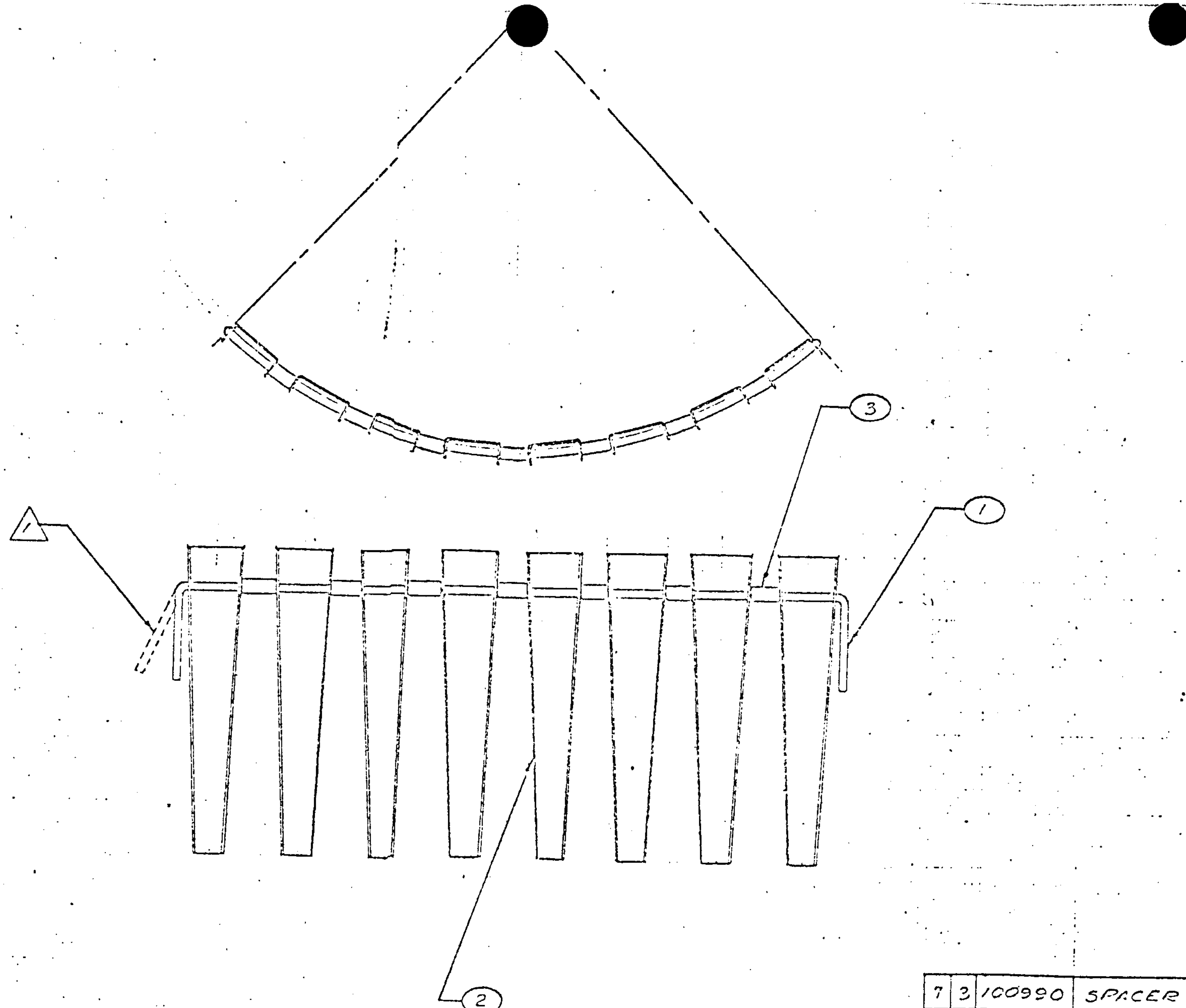
TABLE OF CONTENTS



NOTES:

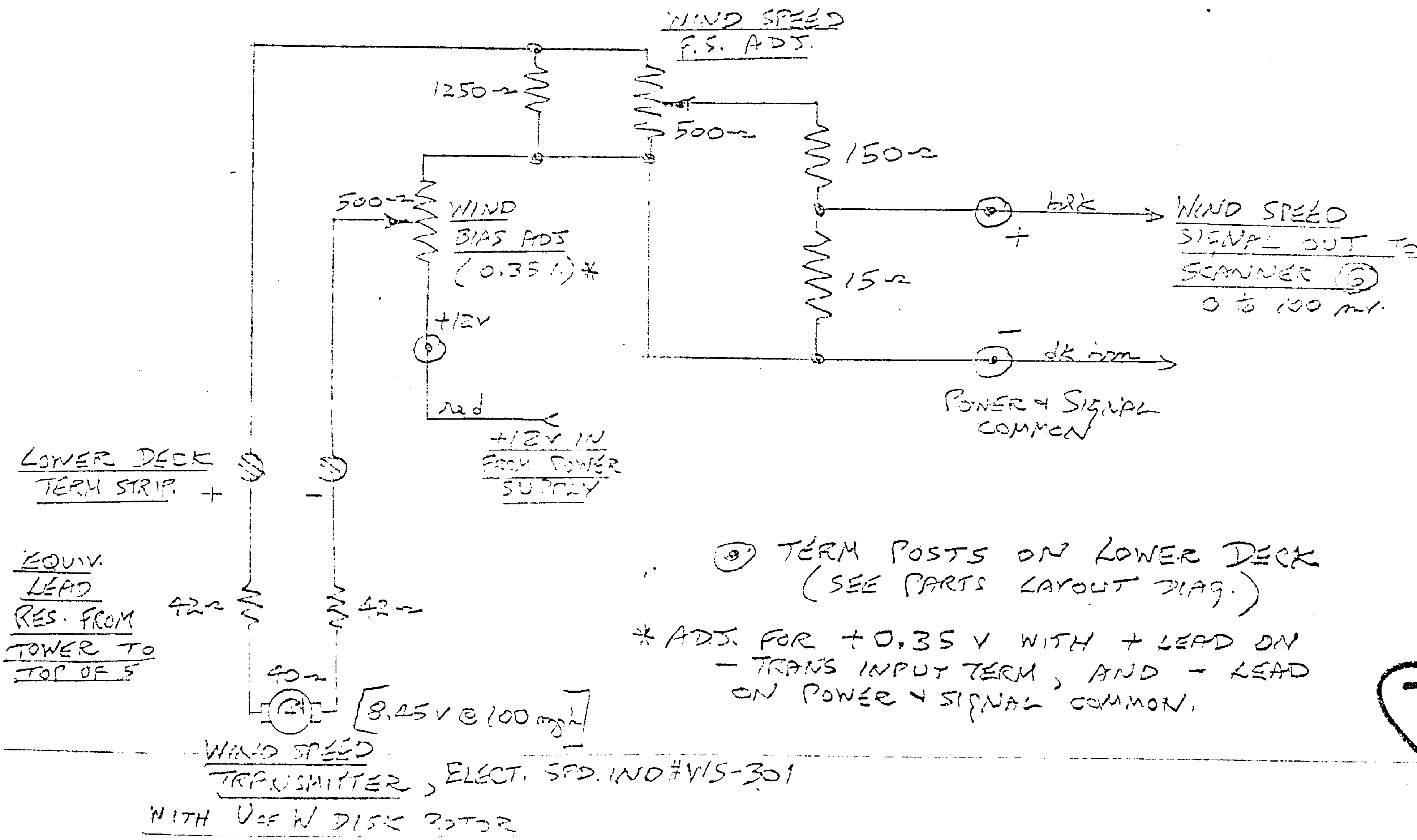
1. AFTER ASSY OF 100005 LEAF AND 100990 SPACER BEND TO 90°. ASSEMBLE AS SHOWN.
2. 3 REQD PER ASSY.

QTY	ITEM	PART NO	DESCRIPTION/MATERIAL
7	3	100990	SPACER
8	2	100005	LEAF
1	1	100998	RING, SEGMENT (STD)

SHIELD ASSY (STD)

100994

WIND SPEED SENSOR CKT.
USING U of W DISK ROTOR
1976 - REDRAWN 8/78



TERM POSTS ON LOWER DECK (SEE PARTS LAYOUT DIAG.)

* ADJ. FOR +0.35 V WITH + LEAD ON – TRANS INPUT TERM, AND – LEAD ON POWER + SIGNAL COMMON.

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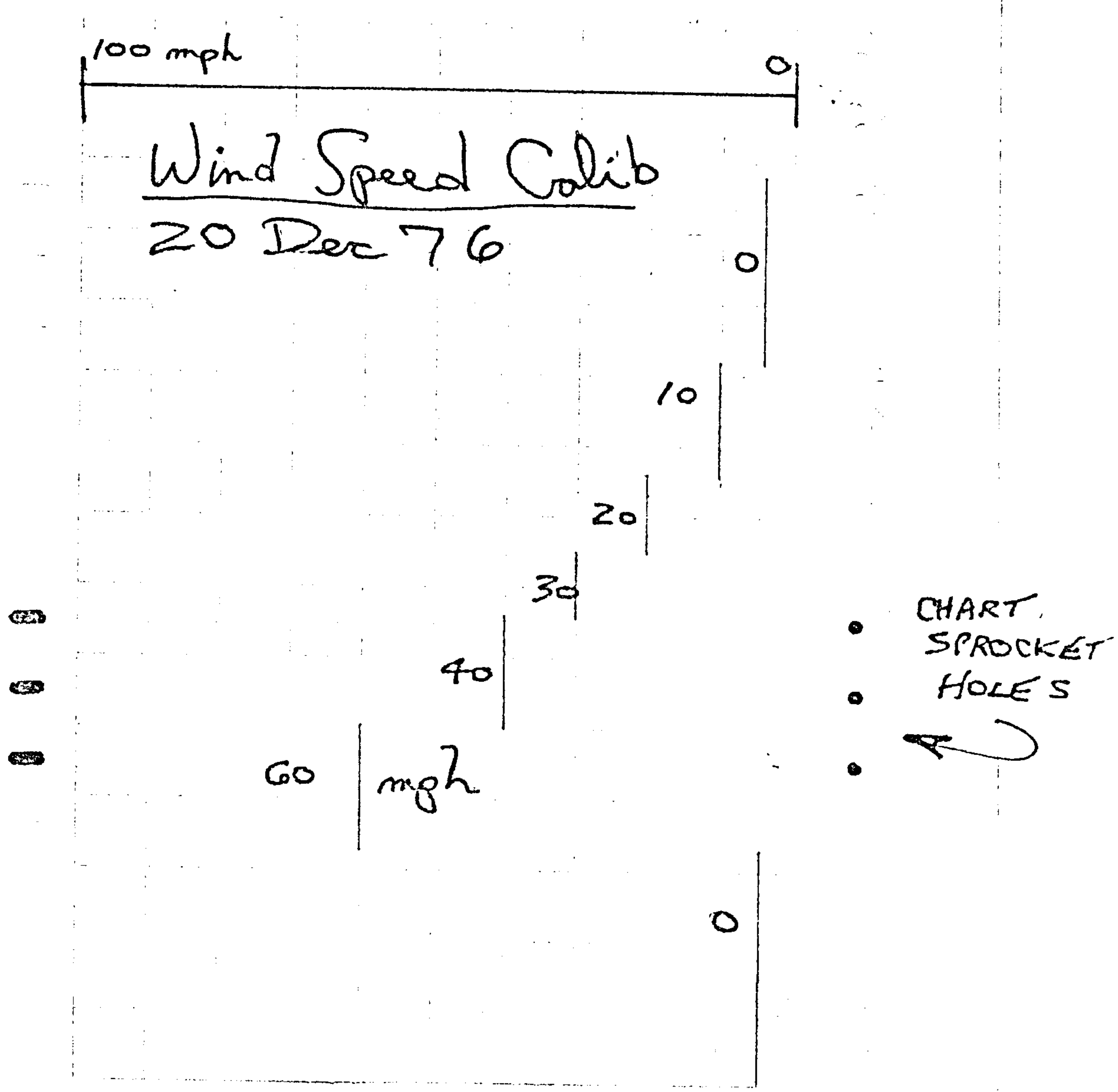

100 mph
0
Wind Speed Calib
20 Dec 76
0
10
20
30
40
60 mph
0
CHART SPROCKET HOLES

WIND SPEED CALIB

30 Sept '76
PLT

STORM ANEM #1 (U of W DISK ROTOR) WS-301 #2310
U of W WIND TUNNEL STANDARD B&T ANEM #8
GR STROBTAC, DATA PREC 245 DVM

WIND SPEED		ROTOR	ANEM VOLTAGE OUT	
m/sec	mph	RPM	OPEN CKT.	432Ω LOAD
		△		⊙
4.0	8.8	*	.47 V.	.41 V.
5.0	11.0	137	.70	.643
7.0	15.9	220	1.12	1.025
10.0	22.5	350	1.79	1.63
12.0	26.8	428	2.19	2.00
15.0	33.5	550	2.79	2.55
18.	37.4	654	3.32	3.04
	46	790	4.05	3.71
	51	900	4.57	4.18

DATA PLOTTED ON ATTACHED SHEET.

* THRESHOLD, SLIGHTEST TOUCH STARTS

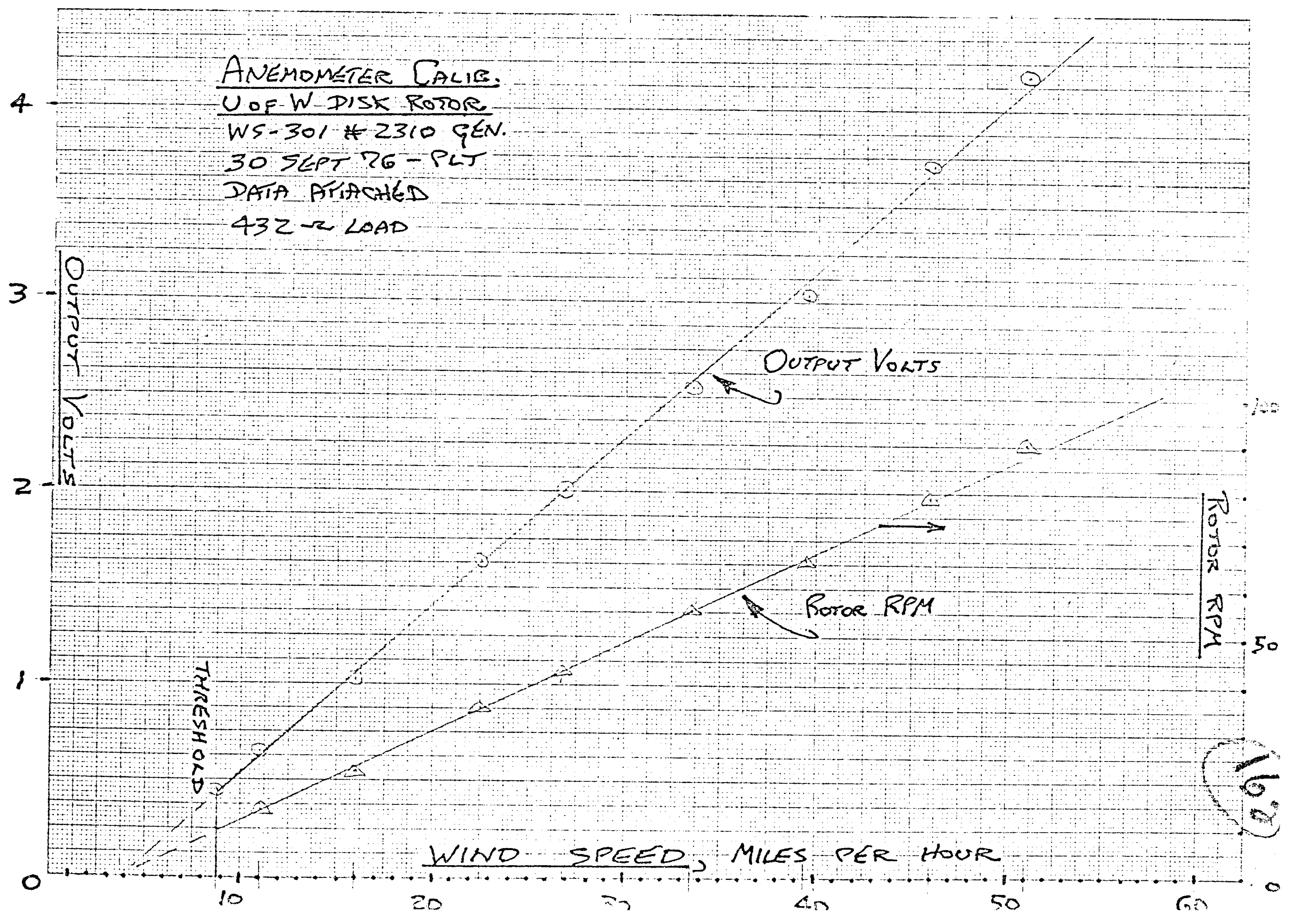
FROM BEST LINE THRU CALIB DATA, THE CALIB EQUATION WAS DETERMINED TO BE:

$$\text{VOLTS}_{(432\Omega\ \text{LOAD})} = .088\left(\text{AIR SPEED}_{(\text{mph})}\right) - .35$$

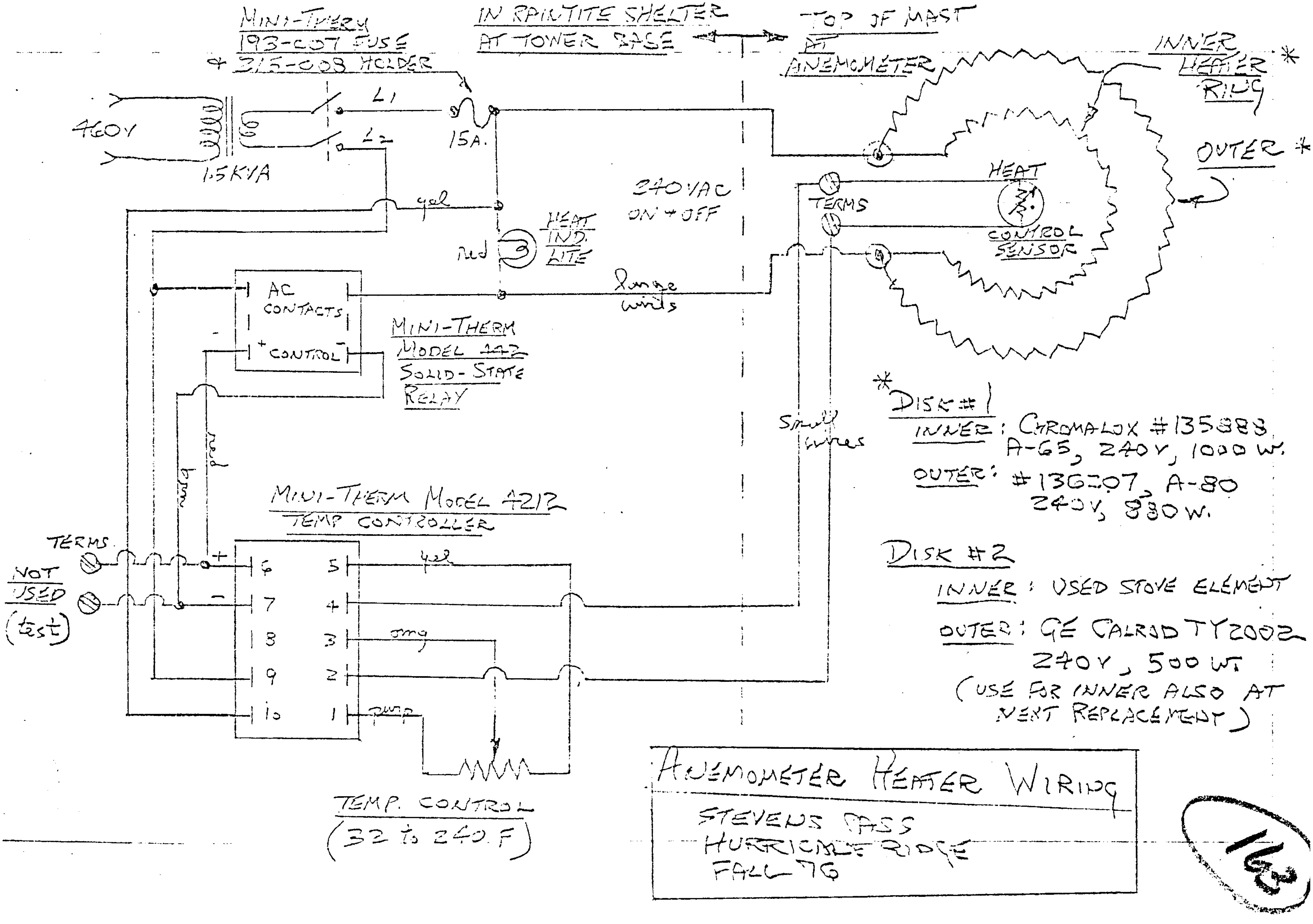
AIR SPEED mph	VOLTS
0	—
10	.53 V.
20	1.41
30	2.29
40	3.17
60 } *	4.93
80 } *	6.69
100 } *	8.45

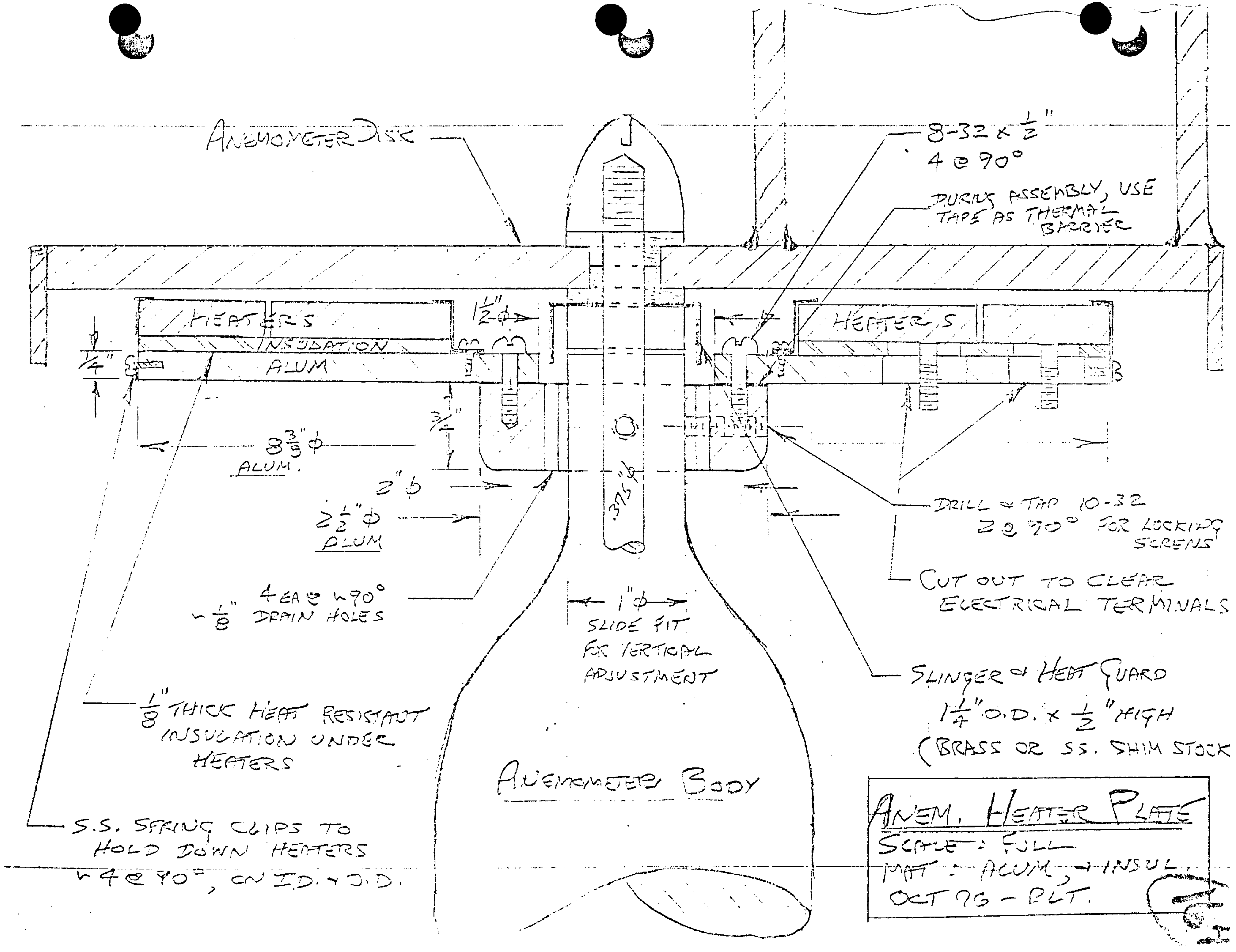
* EXTRAPOLATED

SEE ATTACHED CALIB. PLOTS.



ANEMOMETER CALIB.
U of W DISK ROTOR
WS-301 # 2310 GEN.
30 SEPT 76 - PLT
DATA ATTACHED
432 Ω LOAD
OUTPUT VOLTS
ROTOR RPM
THRESHOLD
WIND SPEED, MILES PER HOUR
162


MINI-THERM
193-CO7 FUSE
+ 315-008 HOLDER
460V
1.5KVA
L1
L2
15A.
IN RAINTITE SHELTER
AT TOWER BASE
TOP OF MAST
AT
ANEMOMETER
INNER
HEATER
RING *
OUTER *
240VAC
ON + OFF
HEAT
IND.
LITE
red
yel
AC
CONTACTS
+ CONTROL
MINI-THERM
MODEL 442
SOLID-STATE
RELAY
large wires
TERMS
HEAT
CONTROL
SENSOR
Small wires
red
brn
MINI-THERM MODEL 4212
TEMP CONTROLLER
TERMS.
NOT
USED
(test)
yel
org
pur
TEMP. CONTROL
(32 to 240 F)
*DISK #1
INNER: CHROMALOX #135883, A-65, 240V, 1000 W.
OUTER: #136207, A-80 240V, 880 W.
DISK #2
INNER: USED STOVE ELEMENT
OUTER: GE CALROD TY2002 240V, 500 WT.
(USE FOR INNER ALSO AT NEXT REPLACEMENT)
ANEMOMETER HEATER WIRING
STEVENS PASS
HURRICANE RIDGE
FALL 76
163



ANEMOMETER DISK
8-32 x 1/2"
4 @ 90°
DURING ASSEMBLY, USE TAPE AS THERMAL BARRIER
HEATERS
INSULATION
ALUM
HEATERS
1 1/2" ϕ
1/4"
3/4"
8 3/8" ϕ
ALUM.
2" ϕ
2 1/2" ϕ
ALUM
.375 ϕ
4 EA @ 90°
1/8" DRAIN HOLES
1" ϕ
SLIDE FIT
FOR VERTICAL
ADJUSTMENT
DRILL & TAP 10-32
2 @ 90° FOR LOCKING SCREWS
CUT OUT TO CLEAR
ELECTRICAL TERMINALS
SLINGER & HEAT GUARD
1 1/4" O.D. x 1/2" HIGH
(BRASS OR SS. SHIM STOCK
1/8" THICK HEAT RESISTANT
INSULATION UNDER
HEATERS
ANEMOMETER BODY
S.S. SPRING CLIPS TO
HOLD DOWN HEATERS
4 @ 90°, ON I.D. & O.D.
ANEM. HEATER PLATE
SCALE: FULL
MAT: ALUM, & INSUL.
OCT 76 - PLT.

AVAIL. HAZ.

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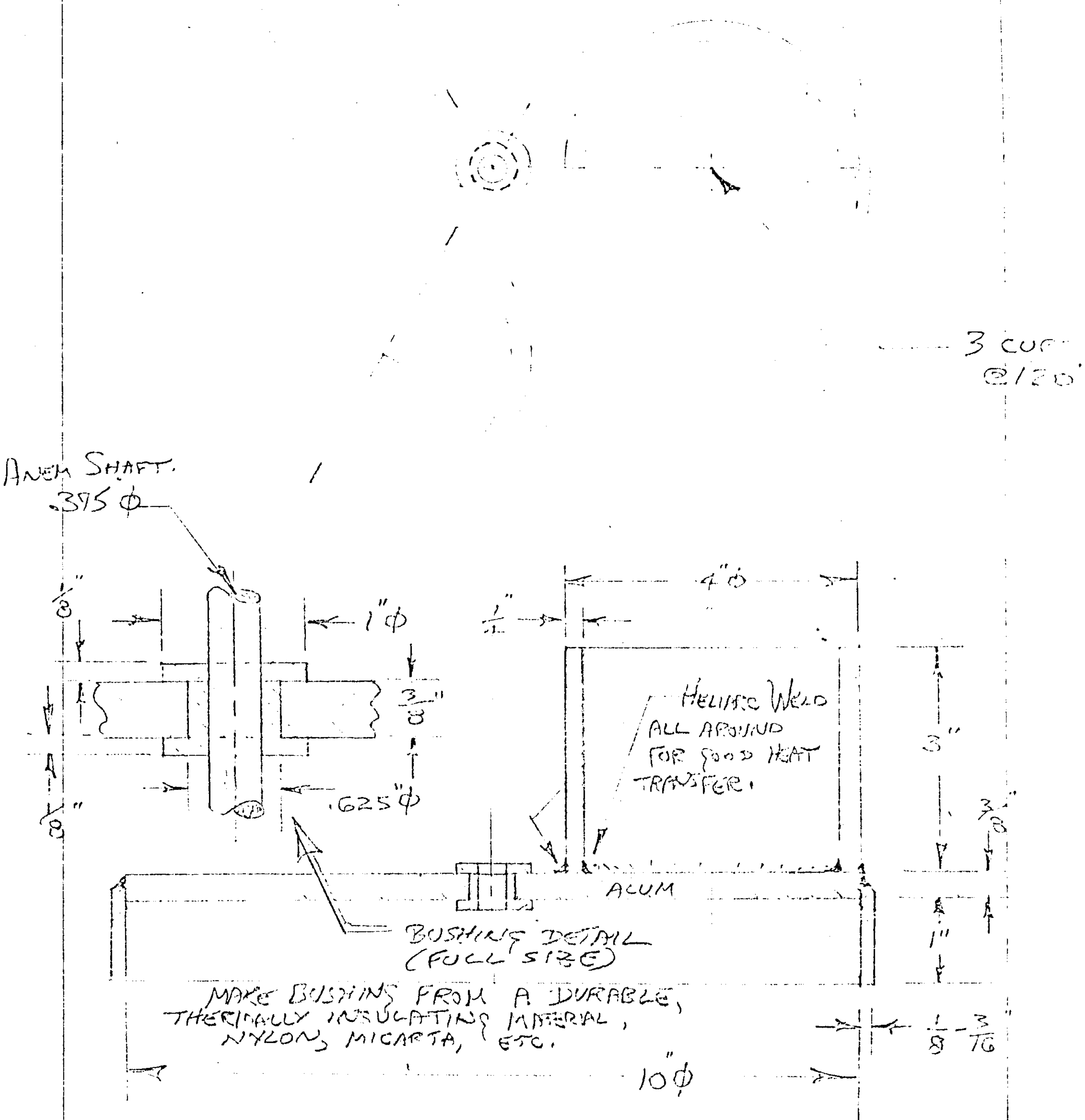
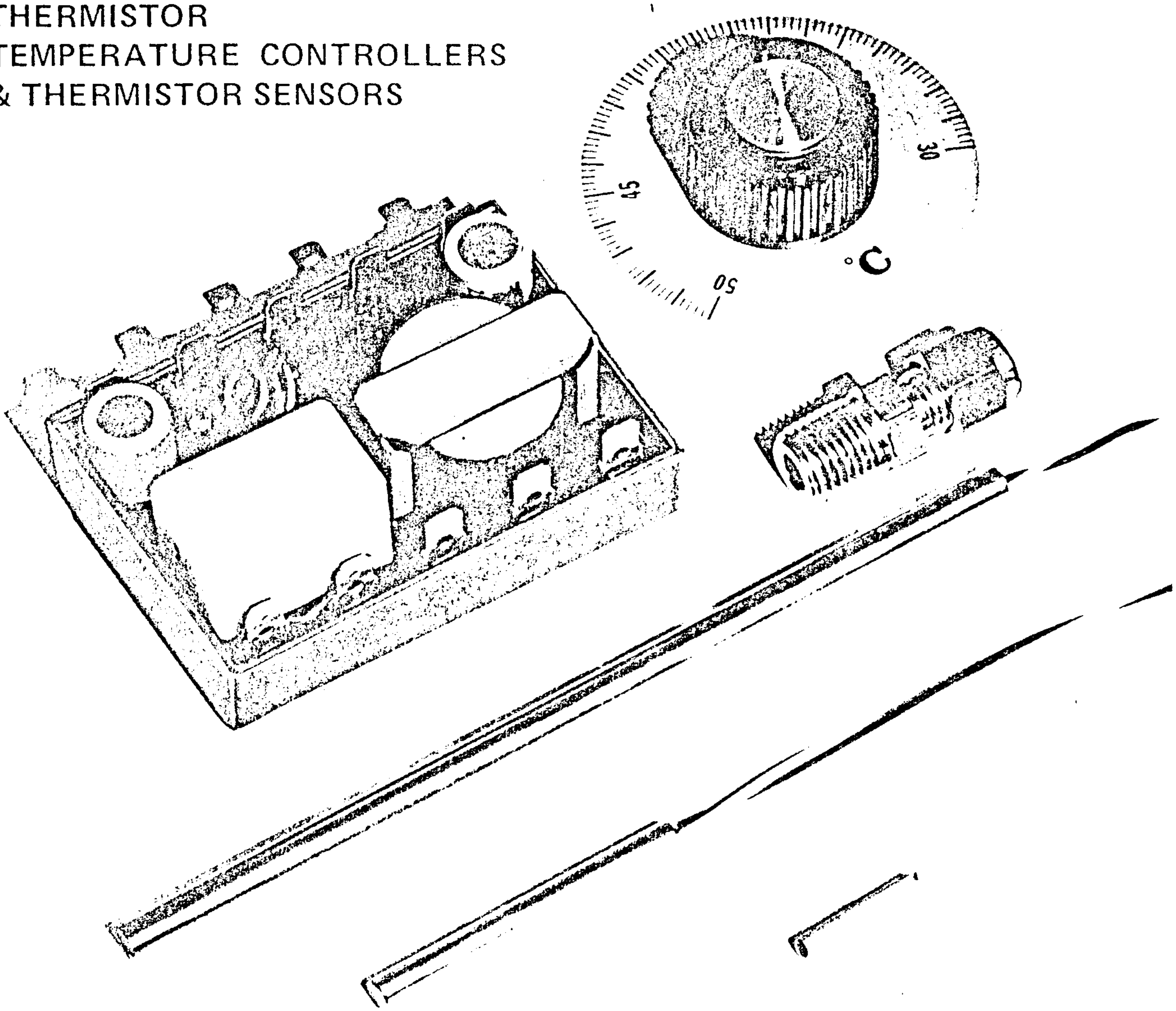


ANEMOMETER DISK
SCALE: 1" = 2"
MAT: ALUM
PLT OCT 76

NOTE:
BALANCE AFTER WELDING

THERMISTOR
TEMPERATURE CONTROLLERS
& THERMISTOR SENSORS



TEMPERATURE CONTROLLERS
SERIES 3201 (ON–OFF)
& SERIES 4201 (PROPORTIONAL)
THERMISTOR SENSORS
SERIES 1000

Thermalogic
Division of DYTRON, Inc.

TELEPHONE (617) 891-9496

241 CRESCENT STREET, WALTHAM, MASS. 02154

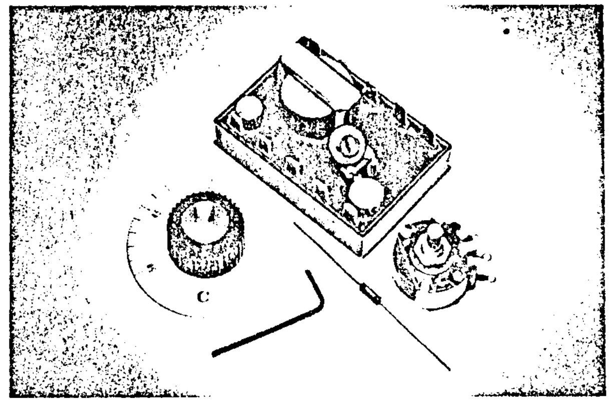
December 1975

MINI• THERM

SERIES 4200

PROPORTIONAL CONTROLLERS

INPUT - Thermistor Sensors
OUTPUT - Logic Voltage



PRECISE, PROPORTIONAL CONTROL

Accurate logic-voltage output controls Thermalogic Series 400 isolated, solid-state zero-switching relays — integral control with high-visibility dial permits precise temperature settings.

UPGRADES EXISTING SYSTEMS

Ideal for increasing precision and reliability of present temperature control systems.

DIRECT TEMPERATURE DIALING

Control temperature is set directly on large, high-visibility dial. Typical scale length: 6"

SAFER OPERATION

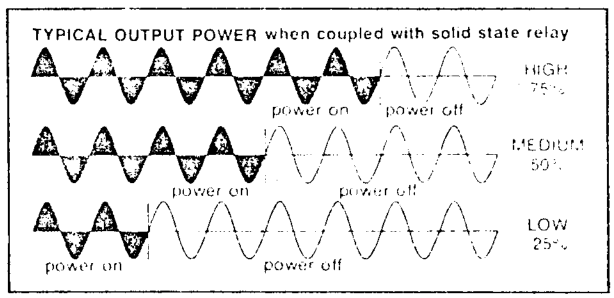
Exclusive ISO-GUARD feature isolates controller from line voltage — protects against shocks and ground faults. Compatible with latest OSHA requirements.

COMPACT AND RUGGED

Ultra-compact, modular controller fits virtually any space requirement. Rugged, encapsulated construction ensures trouble-free service, even in hostile environments.

EXTREMELY LOW COST

Sophisticated, modular design and high production have made possible extremely low prices, particularly in quantity.



BASIC CONTROLLERS (See Page 6 — How to Order)

MODEL	QUANTITY PRICES* 1-9	10-49	50-99	AC VOLTAGE 50 60 Hz	OUTPUT	SPECIAL FEATURES
4211	34.00	30.60	27.20	120	Proportional logic voltage output, isolated (0 to 12 volts DC, 0 to 15 mA)	Used to control Thermalogic's new solid-state, isolated zero switching relays (Series 400). Relays available to 40 Amp., 240 VAC.
4212	36.00	32.40	28.80	240		

For more information on Thermalogic solid-state relays, call FREE LINE [(617) 891-8010] collect for technical assistance Bulletin 400 also available. *For larger quantities, use FREE LINE to contact factory.

GENERAL CONTROLLER SPECIFICATIONS

Adjustable bandwidth: .1°C to 5°C (Screwdriver adjustment)

Resolution: 1/4%

Output: Proportional. Standard duty cycle: 1 sec.

Size: 3.2" x 2.3" x 1.5"

STANDARD ACCESSORIES (no extra charge)

1. Direct Temperature Setting Dial
2. Allen Wrench
3. Potentiometer
4. Calibration Resistor

STANDARD OPTIONS

1. **Fail-Safe Protection**
   Turns heat off if thermistor develops short circuit or open circuit. $5.50
2. **Variable Time Base**
   Varies duty cycle from 1 to 20 sec. (Screwdriver adjustment) $4.50
3. **DC Controllers**
   Controllers are available for DC operation. Consult factory for prices.

MINI® THERM

STANDARD TEMPERATURE RANGES

Thermalogic provides precision thermistor control modules and systems to handle virtually any desired temperature range. Because of the wide selection of thermistors currently in use, it is impossible to list all available thermistor/temperature range combinations. The standard ranges listed below cover a majority of common applications. Special controller/thermistor packages can be provided to meet your specific requirements.

CONTROLLERS TO MATCH YOUR THERMISTOR

If you prefer to use your own thermistors, we can supply control modules to match, regardless of resistance and desired temperature range. Each of the four tables below includes a typical example in which a controller is matched to an existing thermistor. Keep in mind that these are examples only. Regardless of the resistance/temperature ratings of your thermistors, Thermalogic can provide suitable controllers. We can also design dials to cover your special ranges, if needed.

SELECTING TEMPERATURE RANGES

To select standard ranges, consult the tables below. To select a special range, read the typical examples presented, or phone Thermalogic, collect, on our FREE LINE [(617) 891-8010], and our engineers will develop a package to meet your specifications.

NOTE: See Page 5 for Standard Thermistor Sensors

NARROW RANGES (2.25 to 1 Resistance Change)

RESISTANCE RANGE (Ohms)	THERMISTOR RESISTANCE @ 25°C (77°F) (Ohms)	STANDARD TEMPERATURE RANGES		TYPICAL APPLICATIONS
		Celsius	Fahrenheit	
1800 – 800	2252	30° to 50°	85° to 122°	Biomedical Instruments
4050 – 1800	2252	12° to 30°	53° to 86°	Room Temperature
9000 – 4000	2252	–5° to +13°	23° to 55°	Freezing Range (water)
1800 – 800	24000	95° to 125°	203° to 257°	Boiling Range (water)
Example of Range Calculation with Other Thermistors Using the first range above, assume your thermistor's resistance is 1800 ohms @ –25°C and 800 ohms @ –55°C. Then our controller, with your thermistor, will cover from –25° to –55°C.				Narrow ranges are very useful where high accuracy and repeatability are required.

MEDIUM RANGES (20 to 1 Resistance Change)

RESISTANCE RANGE (Ohms)	THERMISTOR RESISTANCE @ 25°C (77°F) (Ohms)	STANDARD TEMPERATURE RANGES		TYPICAL APPLICATIONS
		Celsius	Fahrenheit	
6400 – 320	2252	10° to 70°	50° to 160°	Laboratory Incubators
6400 – 320	24000	60° to 150°	140° to 300°	Glue, Wax, Resins
Example of Range Calculation with Other Thermistors Using the first range above, assume your thermistor's resistance is 6400 ohms @ –70°C and 320 ohms @ –10°C. Then our controller, with your thermistor, will cover from –70° to –10°C.				Excellent general-purpose range.

WIDE RANGE (80 to 1 Resistance Change)

RESISTANCE RANGE (Ohms)	THERMISTOR RESISTANCE @ 25°C (77°F) (Ohms)	STANDARD TEMPERATURE RANGES		TYPICAL APPLICATIONS
		°Celsius	°Fahrenheit	
8000 – 100	2252	0° to 115°	32° to 240°	Freezing through Boiling (water)
Example of Range Calculation with Other Thermistors Using the range above, assume your thermistor's resistance is 8000 ohms @ 200°F and 100 ohms @ 600°F (100,000 ohms @ 77°F). Then our controller, with your thermistor, will cover from 200° to 600°F.				Thermalogic controllers covering this range will retrofit many other controller makes presently in use.

EXTRA WIDE RANGE (200 to 1 Resistance Change)

RESISTANCE RANGE (Ohms)	THERMISTOR RESISTANCE @ 25°C (77°F) (Ohms)	STANDARD TEMPERATURE RANGES		TYPICAL APPLICATIONS
		Celsius	Fahrenheit	
160,000 – 800	2252	–50° to +50°	–58° to +122°	Environmental Control
Example of Range Calculation with Other Thermistors Using the range above, assume your thermistor's resistance is 160,000 ohms @ 0°F and 800 ohms @ 400°F (100,000 ohms @ 77°F). Then our controller, with your thermistor, will cover from 0° to 400°F.				Thermalogic controllers covering this range will retrofit many other controller makes presently in use.

NOTE: At temperatures above 150°C (300°F), Thermalogic recommends the use of Resistance Temperature Detectors for more stable control. [illegible]

HOW TO ORDER A SERIES 1000 MINI-THERM SENSOR

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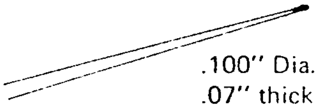
STEP 1.
Select required thermistor resistance at 25°C from Page 4.

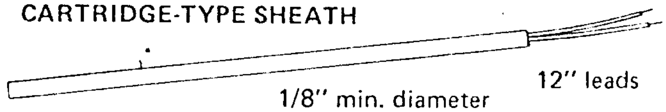
STEP 2.
Construct Part Number and compute price, following example below. If thermistor bead only is required, Part Number will be only five characters long.

SERIES 1000 THERMISTOR BEADS



MODEL 1122
2252 ohms @ 25°C (77°F)
MODEL 1142
24000 ohms @ 25°C (77°F)

CARTRIDGE-TYPE SHEATH



CONSTRUCTING PART NUMBER

FULL PART NUMBER

1122 H 060 K 2

THERMISTOR BEAD ONLY

MODEL NUMBER

1122	Base Price	$3.00	3.00
1142	Base Price	$3.00	

INTERCHANGABILITY AT 25°C

Range "G" is .25°C	Add	$5.00	
Range "H" is 1.25°C		N/C	0

If only bead is required, STOP HERE.

If Sheath is necessary, continue on

SHEATH LENGTH*

"010" is 1 inch	Add	$8.00	
"020" is 2 inches	Add	$8.00	
"060" is 6 inches	Add	$10.00	10.00
Lengths over 6 inches	Add	$.50/in.	

*Code is in tenths of an inch ("075" is 7 1/2 in.)

END SEAL TEMPERATURE

"K": 105°C maximum	N/C	0
"L": 200°C maximum	$2.00	

DIAMETER OF SHEATH

"2": 1/8" diameter	N/C	0
"3": 3/16" diameter	N/C	
"4": 1/4" diameter	N/C	

TOTAL 13.00 List Price

SPECIAL PURPOSE SENSORS

For special-purpose sensors and compression fittings, refer to Thermalogic Catalog 100A, or call the factory, collect, on our FREE LINE - [(617) 891-8010].

QUANTITY DISCOUNTS

1 - 9 List
10 - 49 List less 10%
50 - 99 List less 20%
100 and up - Consult factory

Prices subject to change without notice.

SERIES 400 SOLID-STATE, ISOLATED, RELAYS

UNIQUE DESIGN
Specifically designed to provide high performance with Thermalogic Controllers. Not for use in other applications. Uses 500-Volt triac – can withstand RMS line voltage surges up to 350 Volts. Quick-connect terminals simplify installation.

LOW NOISE
Series 400 solid-state relays help keep RFI and EMI at a minimum.

LARGE CURRENT CAPACITY
Units available to handle up to 40 Amps at 24 thru 240 VAC.. Must be mounted on a heat-dissipating surface for full current-handling capability.

EXTRA LONG LIFE
The operating life of Series 400 relays is virtually unlimited in normal service.

COMPACT SIZE
Only 2.75" x 2" x 1.65"

MODEL	AC VOLTS	AMPS	QUANTITY PRICES 1 - 9	10 - 49	50 - 99
432	24 thru 240	10	$19.50	$17.55	$15.60
442	24 thru 240	15	24.50	22.05	19.60
462	24 thru 240	40	39.50	35.55	31.60

FUSES & FUSE HOLDERS

MODEL	AMPS	QUANTITY PRICES 1–9	10–49	50–99
193-007	5	$3.00	$2.85	$2.70
193-008	10	3.00	2.85	2.70
193-009	15	3.00	2.85	2.70
193-010	20	3.00	2.85	2.70
193-012	30	3.00	2.85	2.70
193-013	40	8.50	8.00	7.50
Fuse Holders				
215-008	5-30	2.00	1.90	1.80
215-009	40	4.00	3.75	3.50

All solid-state relays need short circuit protection. The fuses listed above are special high-speed units specifically selected to give your relays maximum protection against heater faults. We strongly recommend their use with Thermalogic relays.

Heavy-Duty, Electro-Mechanical AUXILIARY RELAYS

MODEL	COIL	CONTACTS	QUANTITY PRICES 1-9	10-49	50-99
191-012	120 VAC	25 Amp @ 120 VAC	$9.50	$9.00	$8.60
191-013	240 VAC	25 Amp @ 120 VAC	11.50	10.90	10.30

Quality electro-mechanical units for use with Series 3200 Controllers.

HOW TO ORDER MINI-THERM CONTROL SYSTEMS

1. Select Controller desired from Page 2 or 3.

2. Select appropriate standard temperature range (or special range, as required) from Page 4. List model number of controller, range and price.

   (Example) **Model No. 3211/30° to 50°C** — $29.00

3. Select thermistor sensor from Page 5, and list composite number and total price.

   (Example) **Model No. 1122 H 060 K 2** — **$13.00**

4. Select appropriate relay from this page and list corresponding model number and price.

   (Example) **Model No. 442** — **$24.50**

5. Select correct fuse from this page and list model number and price.

   (Example) **Model No. 193-009** — **$3.00**

6. Select corresponding fuse holder from this page and list model number and price.

   (Example) **Model No. 215-008** — **$2.00**

(15 Amp System) TOTAL PRICE — **$71.50**

All prices and specifications subject to change without notice.

FOR ANY SALES OR TECHNICAL INFORMATION CALL COLLECT ON OUR

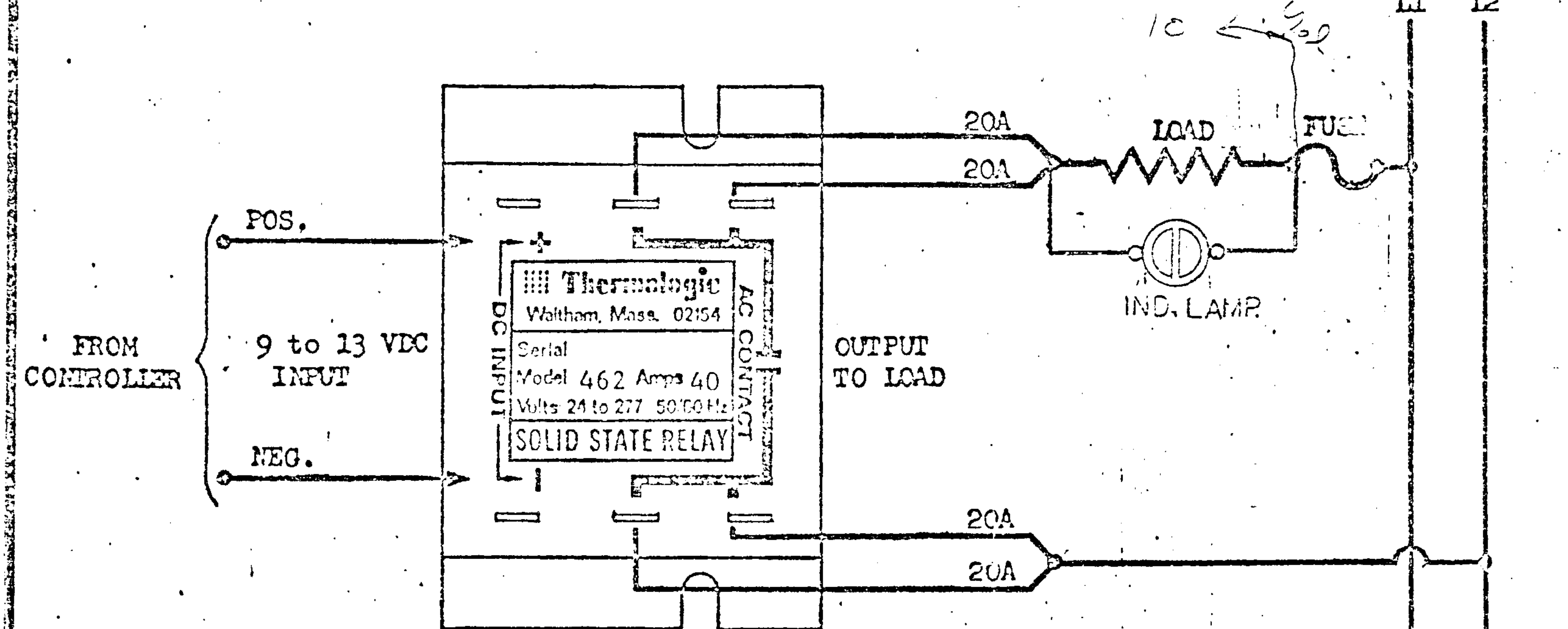
FREE LINE
(617) 891-8010

YOUR LOCAL REPRESENTATIVE IS:

For complete engineering data on Solid State Relays consult our COMPLETE TEMPERATURE CONTROL SYSTEMS catalog Bulletin #715-033.

FORM A715-029

SOLID STATE RELAY, TYPICAL WIRING DIAGRAM
FOR MODELS: #432, #442, #462.



FUSES & FUSE HOLDERS	
MODEL	AMPS
193-007	5
193-008	10
193-009	15
193-010	20
193-012	30
193-013	40
Fuse Holders	
215-008	5-30
215-009	40

All solid-state relays need short circuit protection. The fuses listed above are special high-speed units specifically selected to give your relays maximum protection against heater faults. We strongly recommend their use with Thermalogic relays.

NOTE:
1. ABOVE DRAWING IS FOR TYPICAL 40A LOAD.

2. FOR 40A OUTPUT, BOTH TERMINALS ON BOTH SIDES OF AC CONTACTS MUST BE USED AS PER ABOVE EXAMPLE.

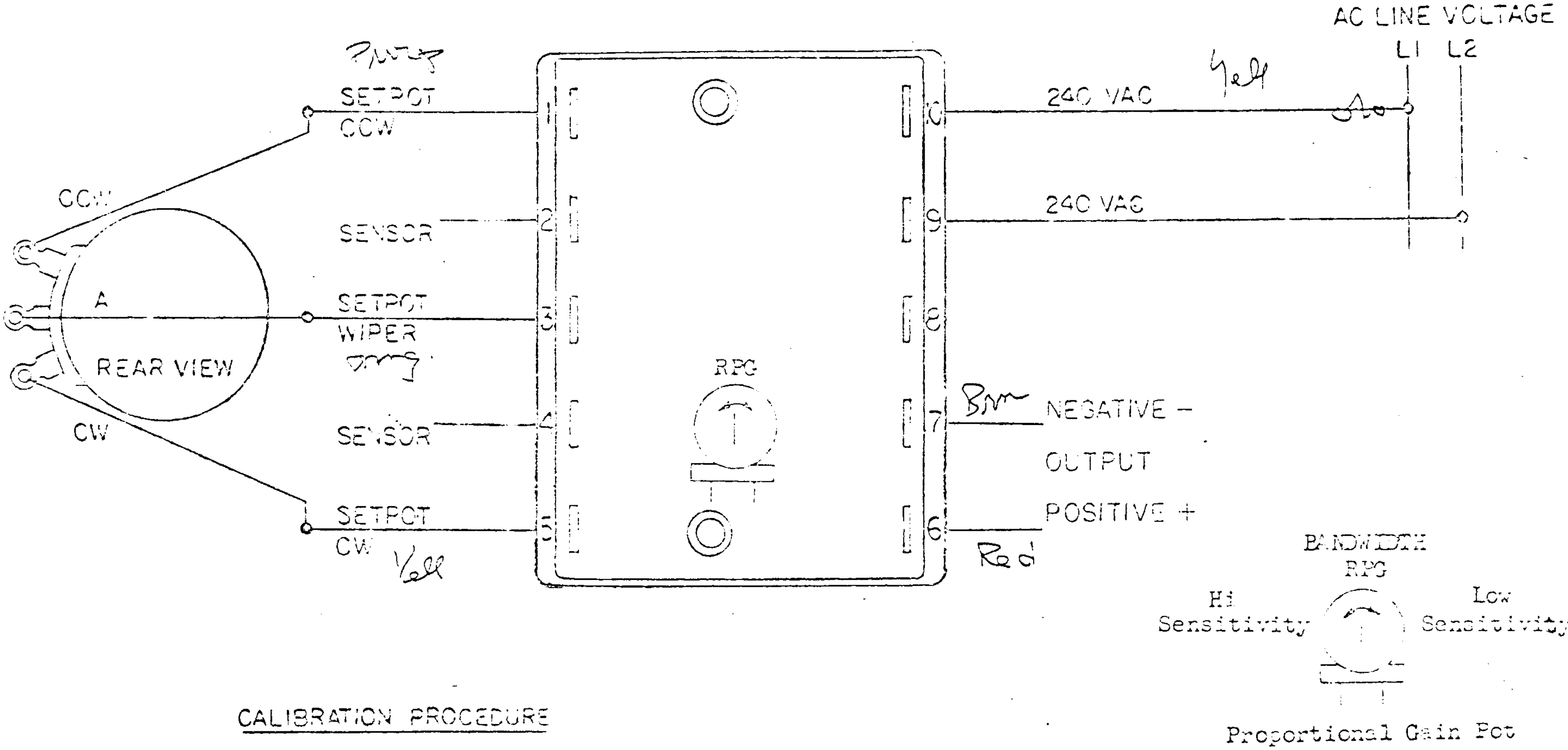
3. EACH AC TERMINAL MUST BE WIRED NOT TO EXCEED 20 AMPS.

4. MAXIMUM CASE TEMPERATURE MUST NOT EXCEED 65°C (149°F).

Thermalogic
Division of DYTRON, Inc.
241 CRESCENT STREET, WALTHAM, MASS. 02154

TITLE SOLID STATE RELAY		
BY	MODEL NO.	NUMBER 462
APP'D	DATE 1-24-75	

MODEL 4212 TEMPERATURE CONTROLLER
RANGE: 32° TO 240°F

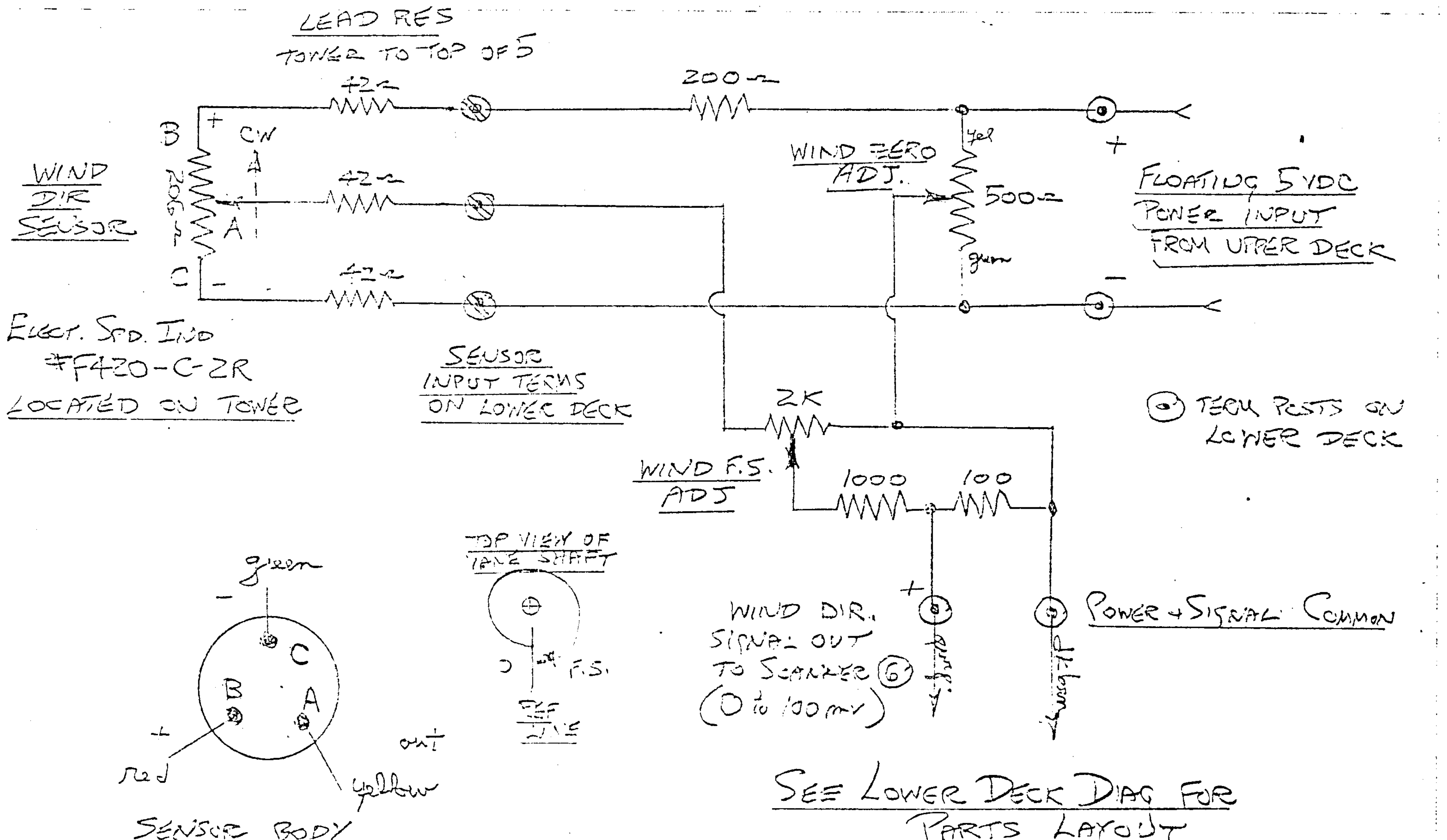


CALIBRATION PROCEDURE

1. Connect the ULTRA-THERM MODULE and its accessories as shown in the wiring diagram.
2. Connect the 562 ohm calibration resistor in place of Sensor.
3. Place an indication mark on the panel the setpot is mounted to.
4. Connect dial to setpot.
5. Turn power on and slowly rotate dial until relay just turns on and off.
6. Loosen the dial set screw and rotate the dial only until the calibration point on the dial coincides with the indication mark on the panel. (140°F)
7. Tighten the set screw.
8. Turn power off and reconnect sensor in place of calibration resistor.
9. Calibration is now complete and controller ready for operation.

Thermalogic
Division of DYTRON, Inc.
241 CRESCENT STREET, WALTHAM, MASS. 02154

TITLE WIRING DIAGRAM		
BY	MODEL NO. 4212	NUMBER 4212
APP'D	DATE 4-24-75	
REV	SHEET 1 OF 1	



WIND DIRECTION CKT
OCT 77 - PLT

173

177

Encapsulated Power Supplies

FEATURES:

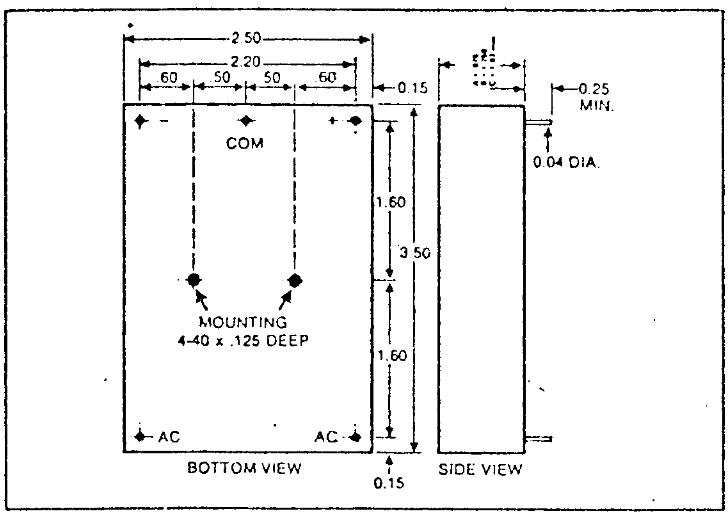
- LOW COST
- RUGGED ENCAPSULATION
- SHORT CIRCUIT PROTECTION

SPECIFICATIONS:

INPUT VOLTAGE: 115 ± 10 vac.
OUTPUT VOLTAGE: See ratings chart.
OUTPUT CURRENT: See ratings chart.
OUTPUT SET: ±2%.
OPERATING TEMPERATURE: −25°C to 71°C
FREQUENCY: 50 to 400 Hz.
TEMPERATURE COEFFICIENT: 0.02% / °C.
INPUT ISOLATION: 50 Megohms.
OUTPUT IMPEDANCE @ 10 KHz: 200 Milliohms.
STORAGE TEMPERATURE: −25°C to 85°C.

RIPPLE: 1.0mV RMS

MODEL SINGLES	OUTPUT VOLTAGE Vdc	OUTPUT CURRENT mA	REGULATION LINE	REGULATION LOAD	CASE SIZE
S-5-250	5	250	0.05%	0.1%	A
S-5-500	5	500	0.05%	0.1%	A
S-5-1000	5	1000	0.05%	0.1%	B
S-5-2000	5	2000	0.05%	0.1%	C
DUALS					
D-12-100	±12	±100	0.05%	0.05%	A
D-15-100	±15	±100	0.05%	0.05%	A
D-12-200	±12	±200	0.05%	0.05%	B
D-15-200	±15	±200	0.05%	0.05%	B
D-12-300	±12	±300	0.05%	0.05%	C
D-15-300	±15	±300	0.05%	0.05%	C



ELECTRIC SPEED INDICATOR CO.
12234 Triskett Rd.
Cleveland 11, Ohio

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INSTRUCTION BOOK
FOR TYPE F420-C AND TYPE FAA-277
WIND MEASURING EQUIPMENT

(A) GENERAL DESCRIPTION:

(A-1) Wind Speed System. The wind speed transmitter (Fig. 8) is essentially a direct current, permanent magnet generator, with a cup-wheel directly attached to its armature shaft. The output voltage of this unit, which is directly proportional to the rate of cup-wheel rotation, is applied to a remotely located voltmeter indicator which has been calibrated to indicate wind speed in terms of miles per hour or knots, depending upon the system of measure selected. The output of the transmitter has been set up at such a value that an additive constant can be used for all wind speeds. This constant correction is applied by changing the rest position of the indicator pointer from zero to 2.0. The transmitter-indicator system is entirely self contained and requires no external source of electrical power for operation.

(A-2) Wind Direction System. The wind direction transmitter (Fig. 9) contains a resistance coil in toroid form, around the edge of which move two brushes spaced 180° apart. The brushes are attached to the wind vane shaft and turn with the shaft. The energizing voltage, 12 volts DC, is introduced into the coil by means of these brushes and movement of the brushes causes varying voltages to appear at the three equally spaced taps on the toroid coil. These voltage changes are transferred to the indicator, wherein are located three coils mounted at equally spaced intervals around a circular iron core. A small permanent magnet located at the center of the iron core, and supporting the indicator pointer shaft, follows the magnetic field resulting from the current through the coils, causing the pointer to indicate the direction of the wind. Prime power for operation of the wind direction system is obtained from a 115 volt, 60 cycle source. This is converted to the required 12 volts, DC power through a step down transformer and dry disc rectifier located in the power supply and distribution assembly.

(B) INSTALLATION:

(B-1) Supporting Structure Transmitters. Detailed instructions for the type of support will be supplied by the ordering agency. The transmitters are designed for mounting on unthreaded IPS 1-1/4" pipe.

(B-2) Speed Transmitter Installation. Unpack the cup-wheel and transmitter body with care. This is especially important in the case of the cup-wheel, which, although capable of withstanding wind speeds of 170 mph without damage, can be easily thrown out of balance and calibration if subjected to rough handling. After inspecting the components for loose screws and possible damage in shipment, remove the adaptor from the case of the transmitter body and install it on the supporting structure. Do not remove the length of two conductor cord soldered to the connector in the adaptor. Use it to splice to the connecting cable when that cable is installed. With the adaptor installed remove the cap nut from the top of the transmitter body shaft and place the cup-wheel in position on the shaft. Tighten the lateral set screw in the cup-wheel hub and replace cap-nut firmly. The transmitter is then placed on the adaptor and rotated until proper engagement of the coupling connectors takes place, which is indicated by a sudden lowering of the transmitter body to a full seated depth on the adaptor. Lock the transmitter body in place on the adaptor by securing the two hexagonal lock screws in the body.

(B-3) Direction Transmitter Installation: As with the speed transmitter components, exercise care in unpacking the wind vane and transmitter body comprising the direction transmitter. This is particularly important in the case of the wind vane, which although capable of withstanding high winds without damage, can easily be thrown out of alignment if subjected to rough handling. After inspecting the equipment for loose screws and possible damage in shipment remove the adaptor from the transmitter body and place it on the 1-1/4" pipe support. Rotate the adaptor until the orientation mark scribed on the adaptor side is directed to true or magnetic north as directed by the issuing office, and lock firmly in place by means of the two hexagonal cap screws. Use the length of five conductor cord attached to the adaptor to splice to the main connecting cable as outlined for the speed transmitter. Remove the cap nut from the transmitter shaft and place wind vane in position on the shaft. Tighten the locking screw on the wind vane hub, taking care that the screw binds firmly on the flat side of the transmitter shaft.

NOTE: It is very important that the locking screw be set properly as the wind vane will be oriented correctly with respect to the transmitter of the direction system only if the locking screw is set normal to the flat surface of the transmitter shaft. This will automatically be done on new model wind vanes whose hubs have been broached with a "D" shaped hole which matches the flat on the shaft and permits assembly in one position only.

Replace cap nut and tighten securely. After checking the alignment of the vane tail, the transmitter is ready for installation.

NOTE: If the tail is noted to be unsymmetrical or skewed with respect to the arrow of the vane, correct the deformity by gradually applying pressure to the tip of the tail until yielding is observed at the point where the tail is secured to the arrow. Do not bend the tail section sharply at this point, but rather produce a smooth curve by small pressures applied successively.

Mount the transmitter on the adaptor and engage and secure it to the adaptor in a manner similar to that outlined for the speed transmitter. In this case though the alignment marks on the transmitter body will match the mark on the adaptor when in proper position for engagement of the coupling connectors, and the transmitter will be properly oriented. Securely tighten the locking screws which fasten the transmitter body to the adaptor.

(B-4) Conductors. Seven conductors are required to connect the speed and direction transmitters. The wiring diagram, Figure 6, indicates the connections to be made. While a fifty foot length of seven conductor cable is supplied with each assembly, the transmitters may be located at any distance from the indicators, providing the loop resistance of the speed transmitter-indicator circuit does not exceed 4.6 ohms. The conductors used in the direction circuit should be the same size as those used in the speed circuit. Maximum distances recommended with several common sizes of wire are shown below:

B & S Gauge	8	3500'
B & S Gauge	10	2000'
B & S Gauge	12	1500'
B & S Gauge	14	1000'
B & S Gauge	16	500'
B & S Gauge	19	250'

(B-4-a) Splices. All joints shall be made by soldering and taping in an approved manner.

(B-4-b) Connections at Transmitters. Pull the wires attached to the transmitters through the pipe support to the "T" condulet and there splice on to the wires which lead to power supply and distribution assembly. The wires from the transmitter adaptors are labeled to correspond with the letters on the 8-circuit terminal block on the power supply and distribution assembly.

NOTE: In order to reduce radio interference and to afford mechanical protection to the conductors, it is recommended that conductors be run through conduit and that the supporting mast be electrically connected to ground.

(B-5) Indicators. To suit the requirements of the particular installation, the indicator and power supply and distribution assembly are supplied in two arrangements:

(1) For the Weather Bureau; the wind speed and wind direction indicators are supplied mounted on a 7" x 19" standard panel which has the power supply and distribution assembly mounted on the rear of the panel.

(2) For the Federal Aviation Agency; the wind speed and wind direction indicators are supplied unmounted and the power supply and distribution assembly (See Figure 7) is mounted in a small metal box.

(B-5-a) Connections at Indicators.

NOTE: Knots or miles per hour - See instructions in Section C-5

(B-5-a-1) Wind Speed. The supply and distribution assembly contains a resistance network to present to the wind speed transmitter a resistance of 428.6 ohms. This resistance represents the sum of one 1500 ohm indicator, two 1500 ohm resistors and one 3,000 ohm resistor, connected in parallel.

This 428.6 ohms resistance must remain unchanged as more indicators are added. The indicators are provided with taps so that three internal resistance may be obtained, namely 500 ohms, 1,000 ohms and 1,500 ohms. Indicators should be wired into the circuit as shown on the wiring diagram Figure 1. Earlier models of indicators with only the 1,500 ohm terminals may be used but only one of these indicators may be substituted for a 1,500 ohm jumper on the supply and distribution assembly, instead of 2 or 3 of the multi-resistor type, as shown on the wiring diagram.

The jumper marked 3,000 on the supply and distribution assembly (Figures 6 & 7) is for use of a 3,000 ohm wind speed recorder. When such a recorder is used, it should be connected to one pair of the terminals marked "L" and "M", and the 3,000 ohm jumper should be opened.

(B-5-a-2) Wind Direction. Wind direction indicators should be connected to the 3 terminals marked "H", "J" and "K", (Figures 6 & 7). Four sets of these 3 terminals are supplied on the power supply and distribution assembly for the connection of indicators. Where more than four indicators are used, connect two indicators to one set of terminals.

(B-5-b) Installation of Indicators.

(B-5-b-1) Weather Bureau Type Installation. Pull the connecting wires or cable into the base of the instrument panel cabinet or console containing the indicators, and lead the conductors up to the indicator. Make the conductor connections to the main connection block on the panel as indicated on the appropriate wiring diagram. The speed unit will be in operation as soon as connections are made at the indicator. The direction will align to the direction of the wind vane when the power supply is energized. This is accomplished by plugging the power cord into the plug-in strip, which, in the instrument panel cabinet, is located in the back left-hand corner, and in the console is located on the back wall under the desk top.

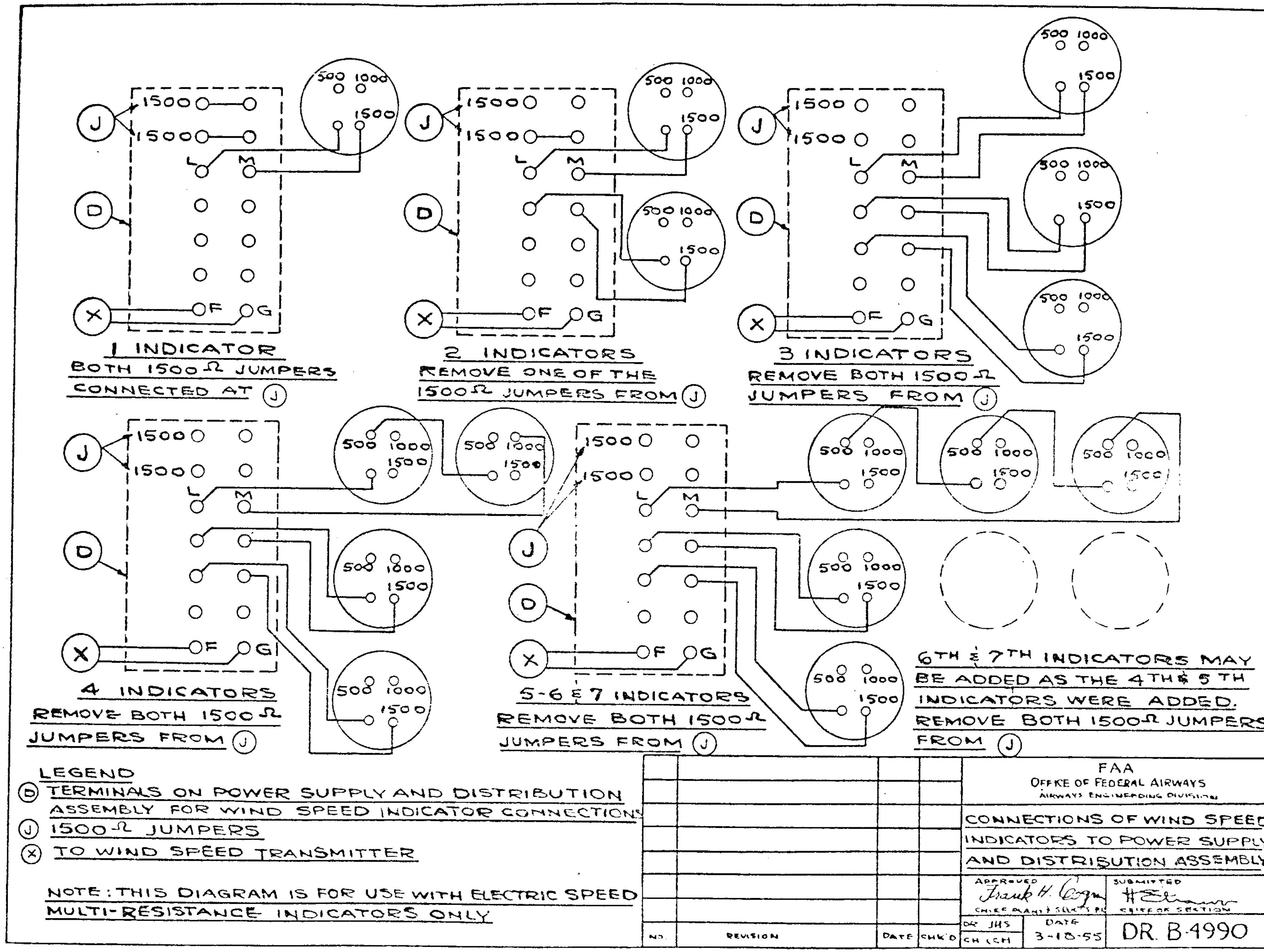


Figure 1 - Connections of Wind Speed Indicators to Power Supply and Distribution Assembly.

(B-5-b-2) FAA Type Installation. Detailed instructions for locating and mounting these indicators are shown on the layout drawings furnished by the regional office. However, it is suggested that during the mounting procedure, undue handling and unnecessary strains on the meters be avoided in consideration of the jeweled movements contained in the indicators. Generously proportioned mounting holes and only moderately tightened mounting screws are sensible precautions.

The five connections to be made between indicators and terminal block mounted on power supply and distribution assembly are as indicated in the wiring diagram (see Figure 6). All indicators terminals are marked with a letter designating the corresponding terminal block connection to be made. Wind direction indicators have in addition to marked terminals a three foot cord and plug already attached and properly labeled. It should be noted that terminal "A" and terminal "H", on the wiring diagram Figure 6 and on the supply and distribution assembly illustrated in Figure 7, connect to a common bus. This is also true of terminals "B" & "J" and "C" and "K".

A cable with leads marked ABC may be connected to terminals marked "H", "J", and "K", respectively.

Note: Internally Illuminated Indicators. Indicators equipped for internal illumination are supplied with the necessary lights in snap-in sockets mounted on the rear of the indicator cases. The sockets are of the single wire and ground type, requiring that all lights of each meter be connected in parallel to the 6 volts AC power source marked "P" on the power and distribution assembly.

The single wires must be joined together and connected to one side of the 6 volt supply, while the other side is connected to the grounded solder terminal attached to a screw holding the receptacle on the rear of the meter.

When furnished, a 12 ohm, 50 watt potentiometer can be connected across the supply voltage to adjust the brightness of the illumination to suit the observers preference. The service life of the bulbs used can be greatly extended by operation at less than full brilliance.

Use type 44 or 47 bayonet base, 6-8 volt pilot lights for replacement. The wind speed unit will be in operation as soon as the two connections are made to the indicator. The wind direction indicator will align to the direction of the wind vane when the power supply is energized by plugging the 8-foot cord attached to the power supply and distribution assembly into a 105-125V, 60 cycle A.C. source.

(B-5-c) Orientation of Wind Direction System. The wind direction system, is calibrated so that the needle will point to North when the arrow vane on the wind direction transmitter is directly over the scribed line on the side of the direction transmitter housing

Therefore, if the transmitter housing upon installation is oriented to true north, the indicator readings will be in terms of true geographic compass points. Similarly, if the transmitter is oriented to magnetic north, the indicator readings will be magnetic. Weather Bureau type F-420-C-ROWA indicators are supplied with a manually adjustable external compass ring which can be rotated to suit local conditions and indicate magnetic readings.

If magnetic readings are desired when the transmitter has been oriented to true north and it is not preferred to change the transmitter orientation, then the calibration of the indicator pointer can be changed as follows:

1) Disconnect indicator from circuit and open the case by removing the four screws holding the mounting flange on the rear case assembly.

2) Connect together wires "B" and "C" of cord attached to the plug on the rear of the case.

3) Apply 3-6 volts of direct current (flashlight cells will do) to wire marked "A" and to junction of "B" and "C", making "A" positive. This will cause pointer to swing to "North" on dial.

4) Remove pointer by lifting directly upward at hub. The pointer is held by a friction fit on a tapered shaft.

5) Replace pointer on shaft loosely. With hub of pointer freely pivoting on shaft, position the tip over the indication desired on dial corresponding to magnetic North and affix in position by pressing lightly but firmly on the hub.

6) Reassemble mounting flange on rear case assembly and reconnect to the circuit.

(B-6) Faults. If the wiring has been properly executed, no adjustments other than that of orienting the vane will be required.

If the wind speed indicator fails to operate as the cups rotate, the circuit is open. Test connecting wiring, indicators and transmitter for continuity.

If the wind speed indicator reads off scale below zero, the polarity of the connections between the wind speed indicator and transmitter is at fault.

If the wind speed reading is obviously in error, the conductors between the indicator and transmitter should be checked for poor or corroded connections.

If the wind direction indicator fails to operate, check continuity of conductors between transmitter and indicator. Be sure that the "D" and "E" connections are not attached to wrong terminals. Check the fuse to the receptacle furnishing a-c power.

If the wind direction indicator shows an error of 180^o relative to the wind vane, the "D" and "E" connections are reversed.

If a 120^o error is observed, there is an error in the connection of "A", "B", and "C" circuits. An open circuit in the "A", "B", or "C" lead will cause erratic operation without stopping all response of the wind direction indicator.

(C) MAINTENANCE

(C-1) Transmitter, Wind Speed.

(C-1-a) Routine Maintenance. Maintenance of the wind speed transmitter will consist of checking the calibration, lubrication, and replacing defective parts where practicable at regular intervals. The calibration of the transmitter should be checked at six month intervals, and the bearings should be cleaned and lubricated at yearly intervals. The calibration may be checked without opening the transmitter case. The calibration check will be performed as indicated in the calibration instructions paragraph C-1-d. In the event that the transmitter does not meet the calibration check, it will be necessary to open the transmitter case, and an attempt made to recalibrate the transmitter.

(C-1-b) Adjustment and Replacement of Parts. To open the transmitter case proceed as follows: Loosen the 4 screws that hold the upper and lower case sections together, about 4 full turns, and grasping firmly, separate the sections to the amount permitted by the loosened screws. Next, remove the screws and open the case, taking care not to strain the two small wires that connect the adapter receptacle in the lower section to the terminals on the brush ring in the upper section. Then with case open, carefully unsolder the wire leads from the ceramic insulated terminals on brush ring. This will permit separation of the two parts of the case.

(C-1-c) Cleaning Commutator and Brushes. Most changes in calibration will be caused by worn and/or dirty commutator and brushes. Clean the commutator by wiping it off with a piece of clean lintless cloth such as viscose rayon twill, repeating until the cloth ceases to be soiled. Do not use cleaning solvents. In cleaning the brushes, lift one of the brush arms off the commutator by applying slight pressure near its mounting end, and slip a small narrow cloth underneath the contact end. Allow the brush to seat on the cloth, and work the cloth back and forth, replacing cloths as necessary, until the brush contact is clean. Examine the brush contacts and commutator for excessive wear and pitting. If the commutator has become excessively roughened, it will need to be refaced in a lathe. It should be noted that the commutator and brushes are made of a precious metal alloy, hence care should be used so that the precious metal will not be wasted. If the brushes and commutator are in good condition, proceed with calibration. Calibration procedure will be as follows:

(C-1-d) Calibration. Using a synchronous motor and the necessary reducing gear combination, drive the transmitter shaft at one of the speeds tabulated below and adjust output of generator as described later to obtain the proper reading on the Wind Speed Meter. The Wind Speed Meter must be properly connected, as for normal service, that is, it must present a resistance load of 428.6 ohms plus or minus 1 percent to the generator, and have the rest position of the pointer as noted in table below.

DRIVEN SPEED R.P.M.	MILES PER HOUR	KNOTS
0	2.3	2.0
300	32.4±1	28.1±1
600	62.4±1	54.2±1
900	92.5±1	80.3±1
1800	182.7±2	158.6±2

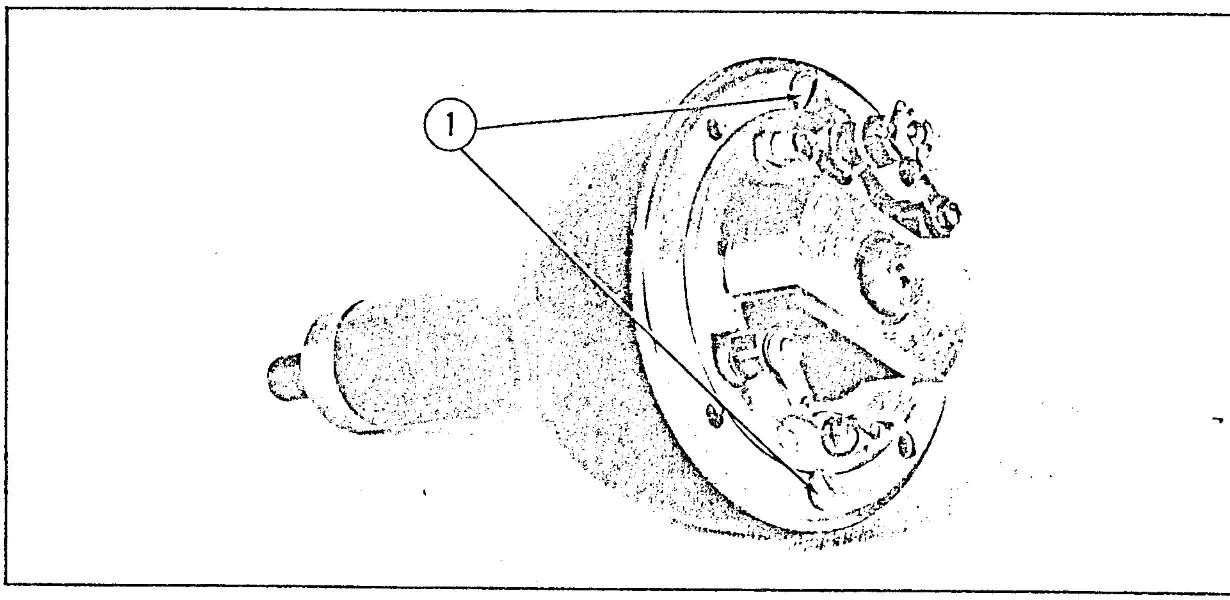


Figure 2

Wind Speed Transmitter Calibration Adjustment.

NOTE: Should it be necessary to replace the bearings, armature or brush ring and thus disturb calibration under conditions where a calibration motor with the speeds listed above is not available, the work can still be undertaken with a resultant inaccuracy of less than 10 percent if the brush ring is carefully marked with an index pencil line extending onto the adjacent surface of the aluminum housing before taking apart. Upon completion of the work intended, reassemble parts and realign marks on brush ring and case, taking care to maintain original set of brush pressure and position. At the first opportunity, such transmitters should be carefully rechecked for true calibration with the proper calibration equipment, or replace when a replacement is available. Adjustment of the generator output during calibration should be as follows: Loosen the two binder head screws, (1) in Figure 2, that overlap the metal brush mounting ring. Turning the ring will change the output voltage of the transmitter, and thus also change the calibration of the unit. With the wires from the adapter receptacle connected to the brush terminals and the transmitter coupled to and driven by the calibrator in accordance with calibrator instructions, adjust the brush ring until the proper indication is obtained. Secure the ring in this position by tightening the binder screws. Recheck calibrations after securing ring because in tightening the screws the ring may rotate slightly. If the transmitter will not calibrate, check the terminal resistance and swamping resistance before proceeding further. The terminal resistance of the speed transmitter should be 40 ohms, and the swamping resistor should have a value of about 8 ohms. If the brushes are badly worn or pitted, they should be replaced with new ones. To replace defective brushes, remove the screws that secure the brush arm to the brush post. Install new brushes, taking care to provide proper tension by rotating the spring tension lever about mid way between zero tension position and maximum. Tighten lever locking screw securely on top of post. It is important that the contact pressure be as light as possible consistant with steady readings. Heavy contact pressure will cause undue wear. Brush pressure should be from 25 to 30 grams. Check calibration after installing new brushes.

(C-1-e) Replacing armature, magnet or cleaning bearings. It is earnestly recommended that the following procedure be followed in the event that it is necessary to disassemble the transmitter unit for parts replacement or servicing.

1) Remove the 3/8" diameter shaft bushing at top of shaft after removing taper pin. If a snug fit prevents easy separation, a standard 3/8 x 24 threaded capnut may be temporarily threaded on the bushing and used to provide a larger gripping surface.

2) Remove binder head screws (1) in figure 2. This will permit the entire lower bearing bridge to be removed from case along with the armature shaft assembly. It will aid the removal if the opposite end (1/4" dia.) of the armature shaft is pushed in the direction of the removal while the bearing bridge is being pulled out.

3) Remove armature from bearing bridge by loosening # 4 x 40 set screw in retaining collar and removing collar. Using fine cut file, carefully remove burrs from armature shaft, taking care to avoid contaminating open bearing. Withdraw armature from bearing bridge.

4) Magnet removing -- The magnet can be withdrawn after removing the three filister head screws in the magnet retaining ring. Normally this will not be necessary during the service life of the instrument.

5) Cleaning bearings -- bearings furnished should have long life, but when they become defective, they should be replaced using New Departure SS-7034 and SS-7R4, stainless steel types or equivalent. Bearings should be cleaned with a petroleum derivative cleaner and lubricated thoroughly with mixture of 2/3 Dow Corning DC-33 Silicone grease, fluid consistency and 1/3 Hamilton Oil T-3358. Great care should be taken to prevent foreign material from entering the bearing.

6) Reassembly of parts. Once again the suggested sequence should be followed.
   a) Install bearings.

	PART NO.	PART NAME
1	F-420C-1-3	CAP NUT
2	F-420C-1-12	MAGNETO ROTOR ASSEMBLY
3	F-420C-1-60	UPPER BEARING
4	F-420C-1-14A	UPPER HOUSING SHELL
5	F-420C-1-7	FIELD MAGNET
6	F-420C-1-71	MAGNET SCREWS (3)
7	F-420C-1-91	BRUSH POST SCREW
8	F-420C-1-9	BRUSH & BEARING SUPPORT
9	F-420C-2-9	SCREWS, HOUSING (4)
10	F-420C-1-14B	LOWER HOUSING SHELL
11	F-420C-1-92	BRUSH POST ASSEMBLY
12	F-420C-1-61	LOWER BEARING
13	F-420C-1-121	MAGNETO LOCKING COLLAR
14	F-420C-1-141	BASE RECEPTACLE
15	F-420C-1-402	ADAPTOR PLUG
16	F-420C-2-321	LOCK RING
17	F-420C-2-631	BRUSH RING LOCK SCREWS
18	F-420C-1-93	INSULATED TERMINAL
19	F-420C-1-8	BRUSH ASSEMBLY (2)
20	F-420C-1-122	COLLAR SET SCREW
21	F-420C-101A	RECEPTACLE SCREWS (4)
22	F-420C-2-8	CAP SCREWS (2)
23	F-420C-2-33	ALIGNMENT PIN
24	F-420C-1-401	ADAPTOR

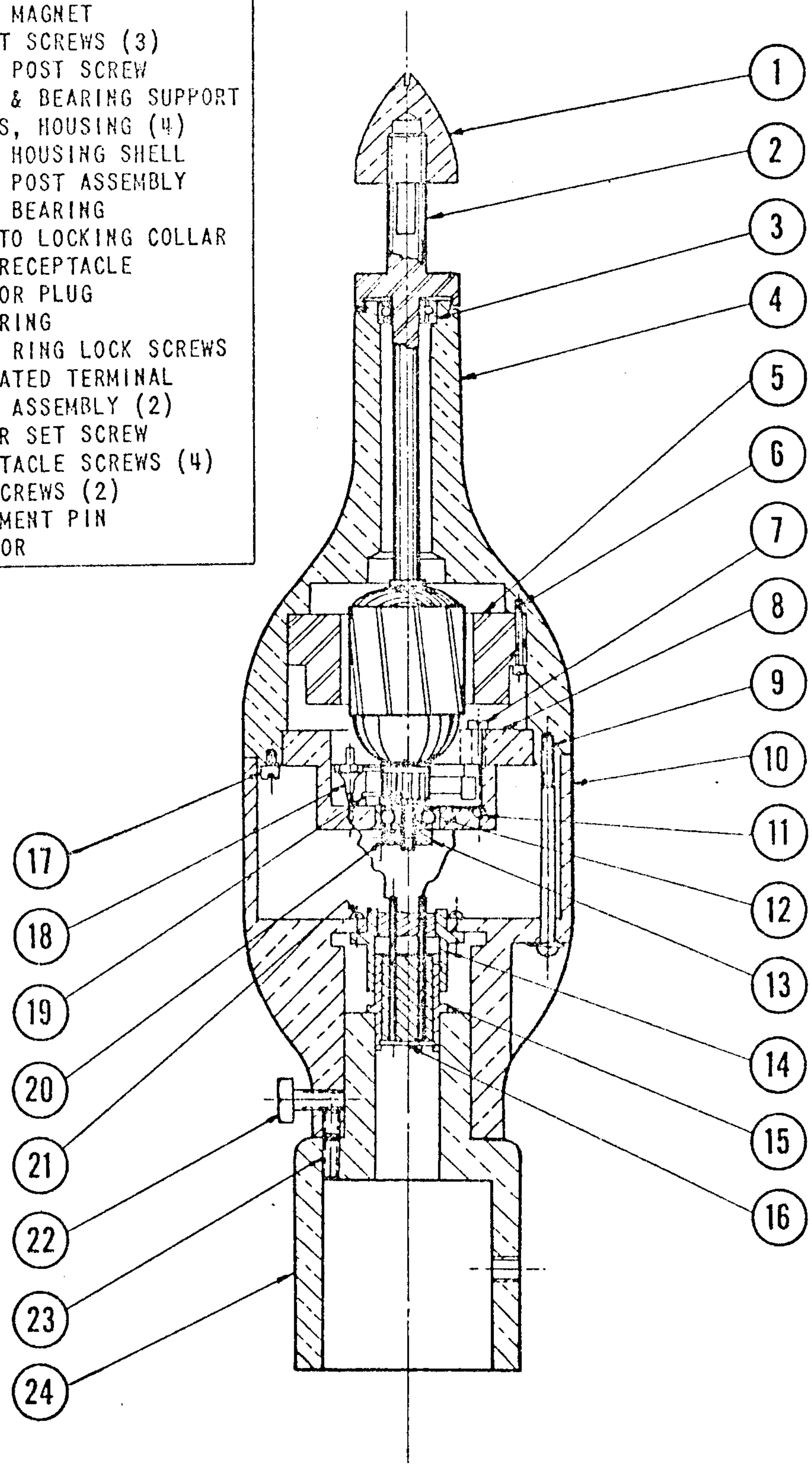


Figure 3

Wind Speed Transmitter Type F-420-C and Type FAA-277

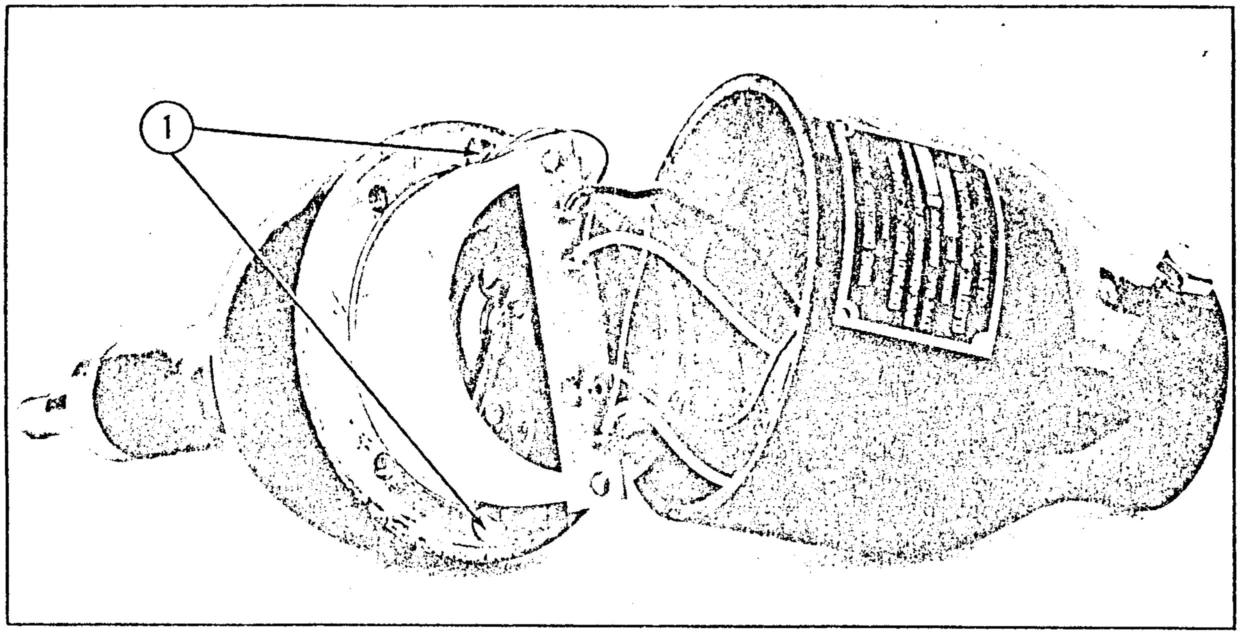


Figure 4 - Wind Direction Transmitter Toroid Mounting Ring.

b) Insert armature through bearing in bearing bridge and lightly fasten locking collar.
c) Holding bearing bridge assembly, guide armature shaft up into case housing and through top bearing, seating bearing bridge into recess provided in case.
d) Re-install top shaft bushing after ascertaining proper alignment of taper pin holes. Insert taper pin flush with shaft.
e) Test for end play, removing any excess by relocating locking collar at bearing bridge. Do NOT remove all end play or shaft will bind. .005" to .015" end play is ideal.

7) Proceed with calibration as outlined in C-1-d

(C-2) Transmitter, Wind Direction.

(C-2-a) Routine Maintenance. Maintenance of the wind direction transmitter will consist of lubrication and examination for worn or defective parts. The commutator toroid resistor unit and contact brushes should be checked for wear at 12 month intervals, and the bearings should be cleaned and lubricated with Dow-Corning, D. C. 33 (fluid consistency) lubricant at that time.

The transmitter case may be opened using the same procedure as that used with the wind speed transmitter, again taking care not to cause undue strain on the connecting wires. After the case has been opened, separation of the two parts will be accomplished by unsoldering the four connecting wires at the small terminal strip.

The condition of the brushes and the commutator surface may be inspected by removing the bakelite tubing wire shield, which is retained by the two 6 x 32 binder head screws (No. 1 in Figure 4). Remove the screws and carefully lift out the tubing, taking care not to break the wires which are coursed in milled slot on the side. The entire surface of the commutator can now be examined, also the fit and condition of the brushes. The commutator should be examined particularly for the amount of wear on the silver bars. Should the silver be worn down flush with the level of the mica separators, the mica will have to be undercut as is customary with commutator devices. Since tests on models indicate long service life expectancy, the commutator should not require undercutting for several years at least.

The brushes are originally supplied having relatively heavy silver wearing contacts which should suffice for many years operation, but of course, will have to be replaced when worn down to the bronze backing strip.

(C-2-b) Adjustment and Replacement of Parts.

(C-2-b-1) Bearing or Shaft Replacement. Proceed with opening case and removing bakelite wire shield as in C-2-a. Loosen set screw in wiper arm assembly which holds the two brushes, and withdraw from shaft. Loosen set screw, using #4 hexagon wrench, and remove collar on shaft next to bearing. Using small file carefully remove burr on shaft caused by set screw, wipe off filings, avoiding bearing contamination, and then pull shaft from top, up and through case. While shaft is out, bearings are readily available for removal for inspection and lubrication or replacement. Should replacement be indicated use New Departure Type SS-7R4 or equivalent.

To re-assemble, proceed in reverse order of the above. Insert bearings, replace shaft down through bearings and fasten in place with collar, tightening set screw after adjusting for end play. End play is not critical, from .005" to .015" being satisfactory. Replace wiper arm and adjust as in calibration below.

(C-2-b-2) Replacement of Commutator Toroid Assembly. Proceed as before, removing wire shield and wiper arm. Loosen the two 6 x 32 binder head screws which hold commutator in place on aluminum support post and remove commutator by firmly grasping on machined surface of commutator bars and lifting directly upwards until entire assembly is clear. Handle the assembly with care after removal, being cautious not to deform wiring from commutator bars to lower bakelite spacer ring. While these apparently bare wires are insulated, an accidental short between adjacent wires would cause erroneous indications.

Should replacement be necessary, the three plastic covered tap wires are unsoldered at their connection to the 1/2" x 2-5/8" terminal strip at points "A","B" and "C". The corresponding leads of the new toroid assembly are soldered to these same terminals, the assembly is lowered carefully onto the support post and fixed in position with the 6 x 32 binder head screws.

(C-2-b-3) Repair of Commutator Toroid Assembly. The system of parts used in this assembly make it possible to readily extend its service life considerably by undercutting the mica separators between the bars as would be done on a conventional motor commutator, when badly worn, and by direct replacement of any wire segments broken by handling or burned out by improper connection. It will be noted upon examination that the commutator has 84 bars, and is electrically tapped at 120 degree intervals (every 28 bars). A careful search with a low range ohmmeter will disclose a shorted section and pin point any open circuits. Normal resistance between bars is approximately 2.5 ohms. Replacement resistance wire of the proper size and alloy can be obtained from the Electric Speed Indicator Co., and can be installed across any defective segment by ordinary soft soldering methods, using a pencil tip iron exercising care to avoid shorting between bars and adjacent wires.

(C-2-b-4) Replacement and Adjustment of Wiper Arms. The wiper arm assembly carrying the two brushes and vertical contact arm is removed and replaced as described previously, that is by loosening the 4 x 40 filister head set screw and pulling the assembly off end of shaft. In replacing the wiper arm, the tension of the brushes should be set to ride the commutator evenly and positively by slight bending of the brush arms.

SPECIAL INSTRUCTIONS

FOR

MODIFICATION KIT

Specification Number SP-001

F420-C-2 Modification Kit   Wind Direction Transmitter
(Grounding Brush Assembly)

Contents: 1 each of the following –
F420C-2-63G Wire Shield Tube Collar
F420C-2-7G Grounded Brush Assembly Complete
F420C-2-65G Grounded Terminal Strip
4-1/2" Brown hook-up wire

Instructions:

Remove 4 housing screws. Separate housing shell. Unsolder base receptacle wires at contacts A, B, C, and D. Unsolder thin lead wires from commutator at A, B, and C terminal contacts. Remove 2 screws which hold the bakelite wire shield tube and terminal strip assembly. Loosen the 4-40 fillister head set screw in wiper arm assembly which holds the two brushes and remove from the shaft. Replace with new grounded wiper arm assembly – the tension of the commutator brushes should be set to ride the commutator evenly and positively by slight bending of the brush arms (refer to paragraph C-2-B4). Replace with new bakelite wire shield collar, lining up the scribe line of case approximately with "C" contact terminal on the new terminal strip, being careful not to damage thin wire leads that pass through the collar slot. Install collar with two screws. Remove the three screws holding new terminal strip to the collar to complete the setting of the two grounding brushes. Holding a flat ruler or other smooth surface horizontally across the collar, set the two grounding brushes to an even and positive light tension against the ruler. Replace new terminal contact strip with three screws. See "Calibration" page 12, C-2-B-5. Solder commutator and base wires to new contacts: A-Black, B-Blue, C-Yellow, D-Red. Add a new wire from solder lug terminal in base receptacle to contact E on terminal strip.

(C-2-b-5) Calibration.

Method I. To calibrate the transmitter, place vane on shaft with arrow head shaft directly over the scribed line on side of case, then rotate wiper arm assembly so that resistance between terminal "A" on small terminal strip and the vertical contact arm on wiper arm assembly is at minumum resistance. Fasten wiper arm assembly in that position securely by means of the 4 x 40 filister head set screw. Recheck calibration after tightening screw. The low range "ohms" scale on the usual Volt-Ohm-Milliameter will be sufficiently accurate for this adjustment.

Method II. Field Calibration. An alternate method of calibration which can be done in the field without recourse to an Ohmmeter and the measuring of the resistance is one that can be done visually, but with a possible error of only 4 degrees plus or minus is as follows. Set vane on shaft and rotate over scribed line as before. Then rotate the wiper arm assembly to position the contact tip on the ungrounded brush arm directly on the center of that commutator bar to which has been soldered the black wire tap. This wire ultimately is connected to "A" on the small terminal strip. Fasten set screw firmly in wiper arm hub. Recheck again for position and then reassemble.

(C-3) Indicator, Wind Direction and Speed:

(C-3-a) Wind Speed Indicator. The indicator should be checked for proper operation at 6 month intervals. The wind speed indicator is subject to the faults of any sensitive electrical meter. If the jewels become cracked, or the pivots bent, or foreign material enters into the flux patch, erroneous readings will result. It has a sensitivity of 21.7 graduations per volt for knot indicators and 25.0 graduations per volt for M.P.H. Indicators, with an accuracy of 1-1/2 percent or better. It should be noted that any testing of these values must be done by equipment having accuracy greater than 1-1/2 percent. The wind speed indicator case should not be opened in the field. The repair of such an instrument should be undertaken only by one skilled in meter repairs.

(C-3-b) Wind Direction Indicator. The wind direction indicator will lose linearity if the three coils embodied in the indicator movement become unbalanced. The resistance between any two of the terminals on the indicator should be equal and approximately 80 ohms. The resistance between any two of the leads "A", "B", and "C" which lead to the transmitter, with leads disconnected from the indicator panel, should be 50 ohms. The resistance between leads "D" and "E" should be approximately 55 ohms.

(C-4) Power Supply and Distribution Assembly.

(C-4-a) The wiring diagram of the Power Supply and Distribution Assembly is shown on Figure 6. The wind speed circuit consists essentially of two 1500 ohm & one 3000 ohm resistors connected in parallel. Connection of the indicators to this circuit is described in Paragraph B-5-a. The wind direction circuit consists of a transformer, and the rectifier forming a power supply, which should deliver not less than 10 volts or not more than 18 volts d.c. The rectifier is a dry-disc copper oxide type having a reasonably long life, depending considerably upon temperature of operation. Eventually the internal resistance of the rectifier will gradually increase with a corresponding decrease in the output voltage. When the output voltage falls below 10 volts, the rectifier should be replaced. The output current, with the system in operation, will be approximately 125 milliamperes, with the output voltage at 14 volts. There will be a current increase, with the addition of repeater indicators of about 50 milliamperes per indicator, with a corresponding drop in output voltage.

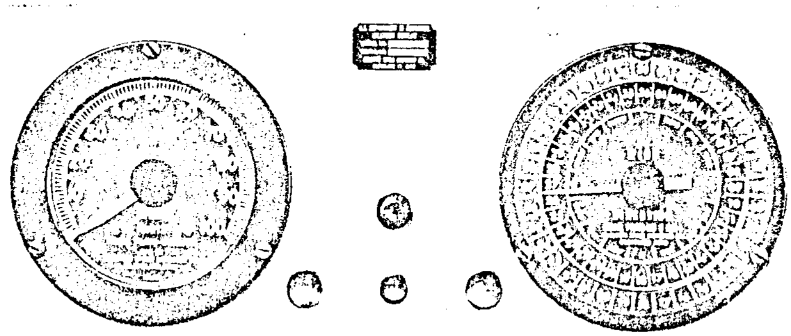
A 6-volt tap is provided on the transformer for dial lights on the indicators. The capacity of this lighting source is 13 amperes, sufficient for all indicators and altimeter setting indicators at one location.

(C-5) Knots or Miles Per Hour Calibrations.

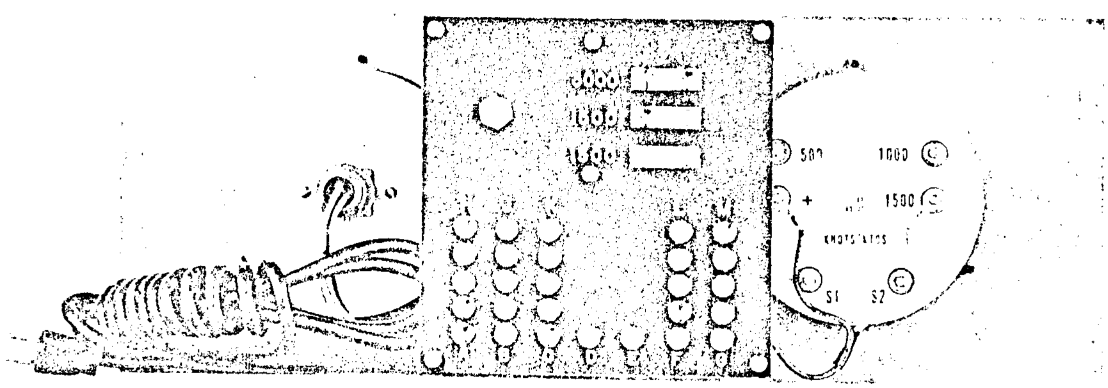
Weather Bureau indicators, as supplied, indicate wind speed in terms of KNOTS. Additional terminals marked "S-1" and "S-2" are provided to permit use of a "KNOTS or DOUBLE SCALE KNOTS" switch assembly.

Federal Aviation Agency indicators, as supplied, indicate only in KNOTS and are not equipped with extra terminals for double scale readings. Earlier Civil Aviation Administration indicators were calibrated in Miles per Hour, but had extra terminals to permit readings in KNOTS by the use of an accessory switch.

It should be noted that the output voltage of all wind speed transmitters remains the same, regardless of which system of measurement is used, the required changes being made in the indicators only. It follows then that when a number of indicators and repeaters are connected to a given wind speed transmitter, Miles per Hour and Knots meters may be mixed at random with no interaction. Of course, the resistance of the system must still be adjusted as noted in (B-5-a-1).



Front View



Rear View

Weather Bureau Model F-420C-M4 Panel Mounted Indicators

	PART NO.	PART NAME
1	F-420C-1-3	CAP NUT
2	F-420C-2-5	SHAFT & BUSHING ASSEMBLY
3	F-420C-2-4	BEARINGS (2)
4	F-420C-2-10A	UPPER HOUSING SHELL
5	F-420C-2-61	ELEMENT SUPPORT POST
6	F-420C-2-62	POST RETAINING SCREWS (3)
7	F-420C-2-63	WIRE SHIELD TUBE
8	F-420C-2-9	SCREWS, HOUSING (4)
9	F-420C-2-10B	LOWER HOUSING SHELL
10	F-420C-2-6	TRANSMITTING ELEMENT
11	F-420C-2-64	ELEMENT RETAINING SCREWS(2)
12	F-420C-2-7	BRUSH ASSEMBLY COMPLETE
13	SEE NO. 3	
14	F-420C-2-51	SHAFT LOCKING COLLAR
15	F-420C-2-65	TERMINAL STRIP
16	F-420C-101	BASE RECEPTACLE
17	F-420C-2-32	ADAPTOR PLUG
18	F-420C-2-321	LOCK RING
19	F-420C-2-102	WASHER
20	F-420C-2-631	TUBE RETAINING SCREWS (2)
21	F-420C-2-511	COLLAR SET SCREW
22	F-420C-2-651	TERMINAL STRIP SCREWS (2)
23	F-420C-2-71	BRUSH LOCKING SCREW
24	F-420C-101A	RECEPTACLE SCREWS (4)
25	F-420C-2-8	CAP SCREWS (2)
26	F-420C-2-33	ALIGNMENT PIN
27	F-420C-2-401	ADAPTOR, SCRIBED

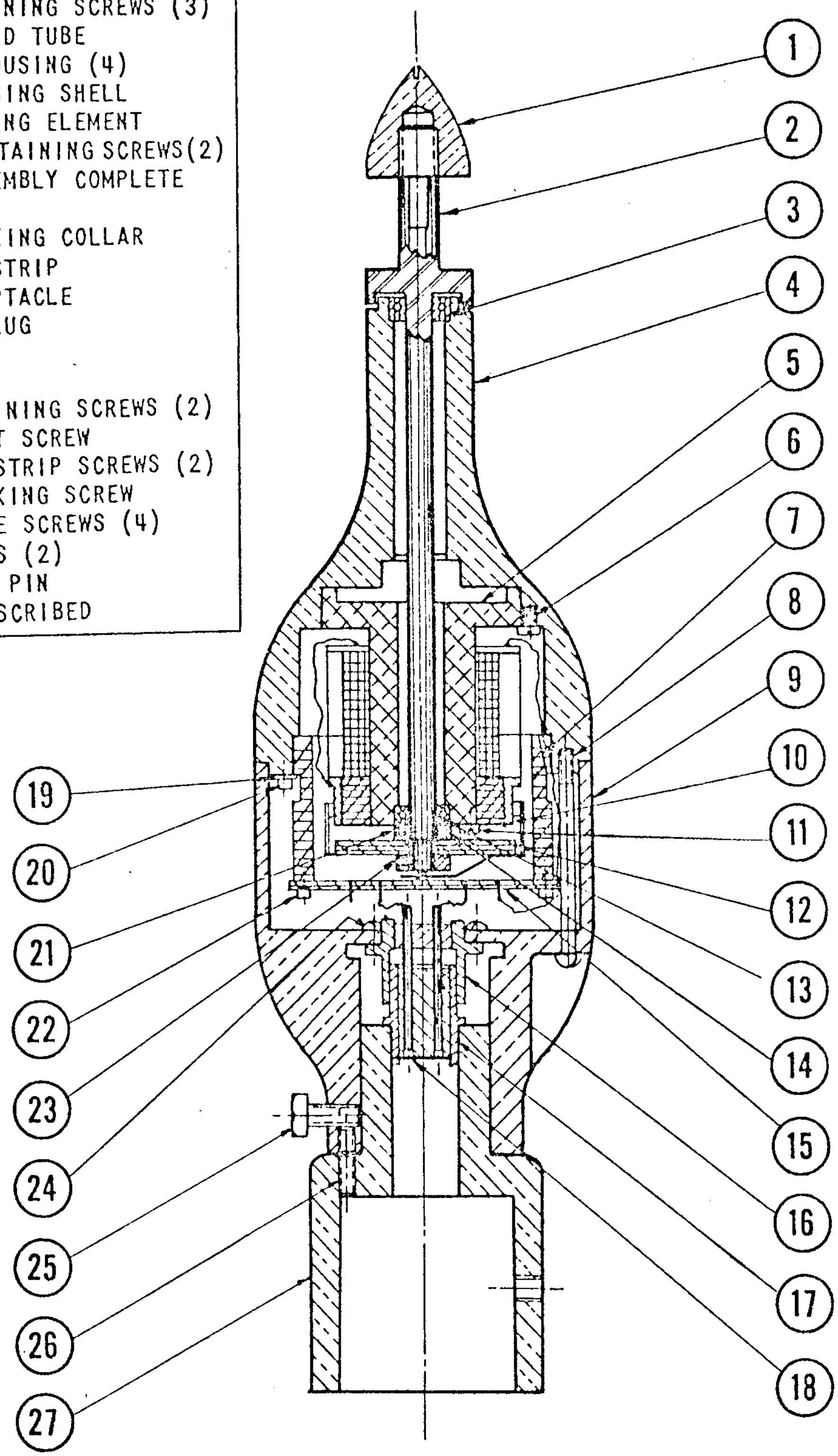


Figure 5

Wind Direction Transmitter Type F-420-C and FAA-277

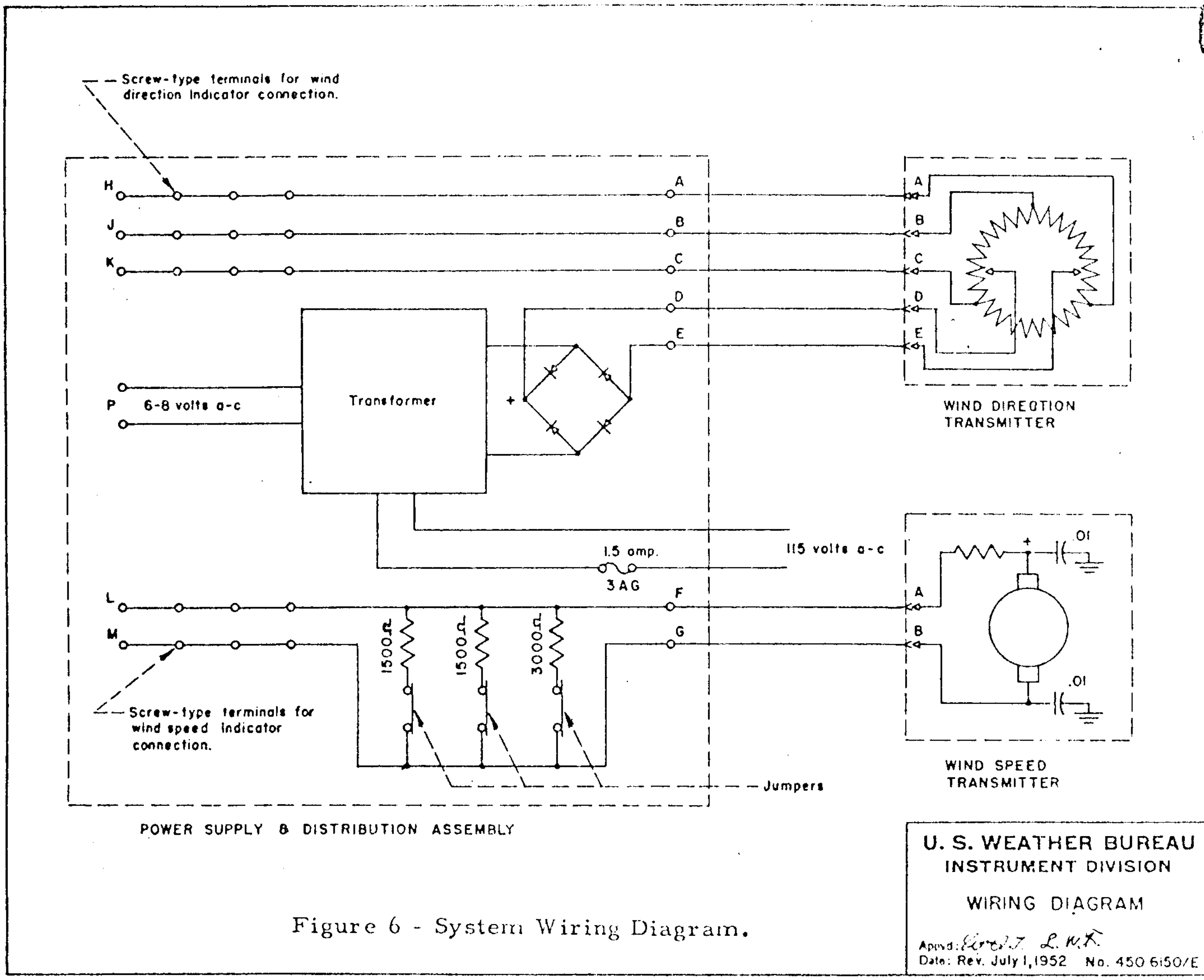
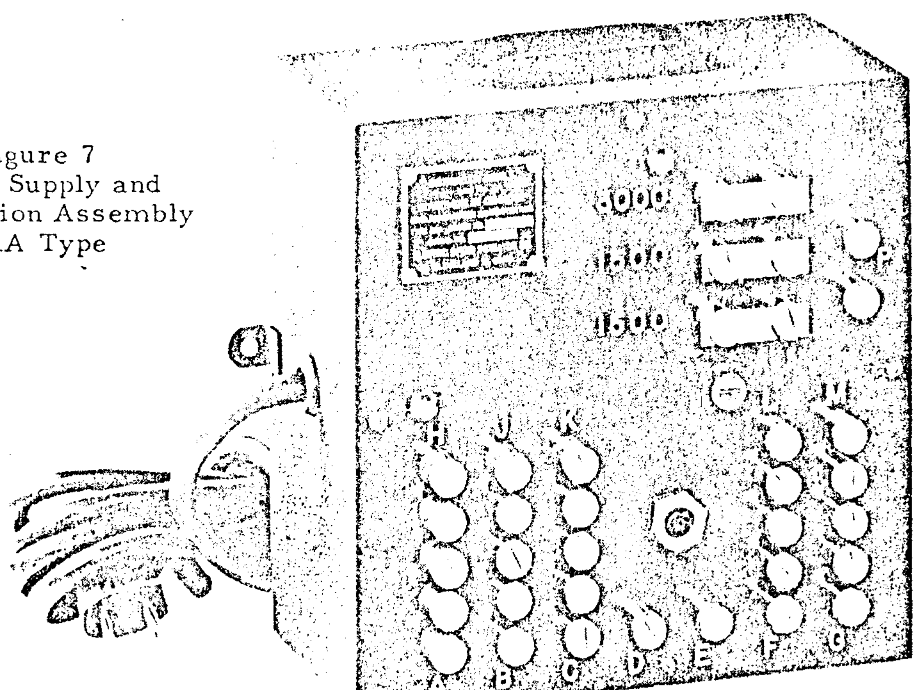


Figure 6 - System Wiring Diagram.

Figure 7
Power Supply and
Distribution Assembly
FAA Type



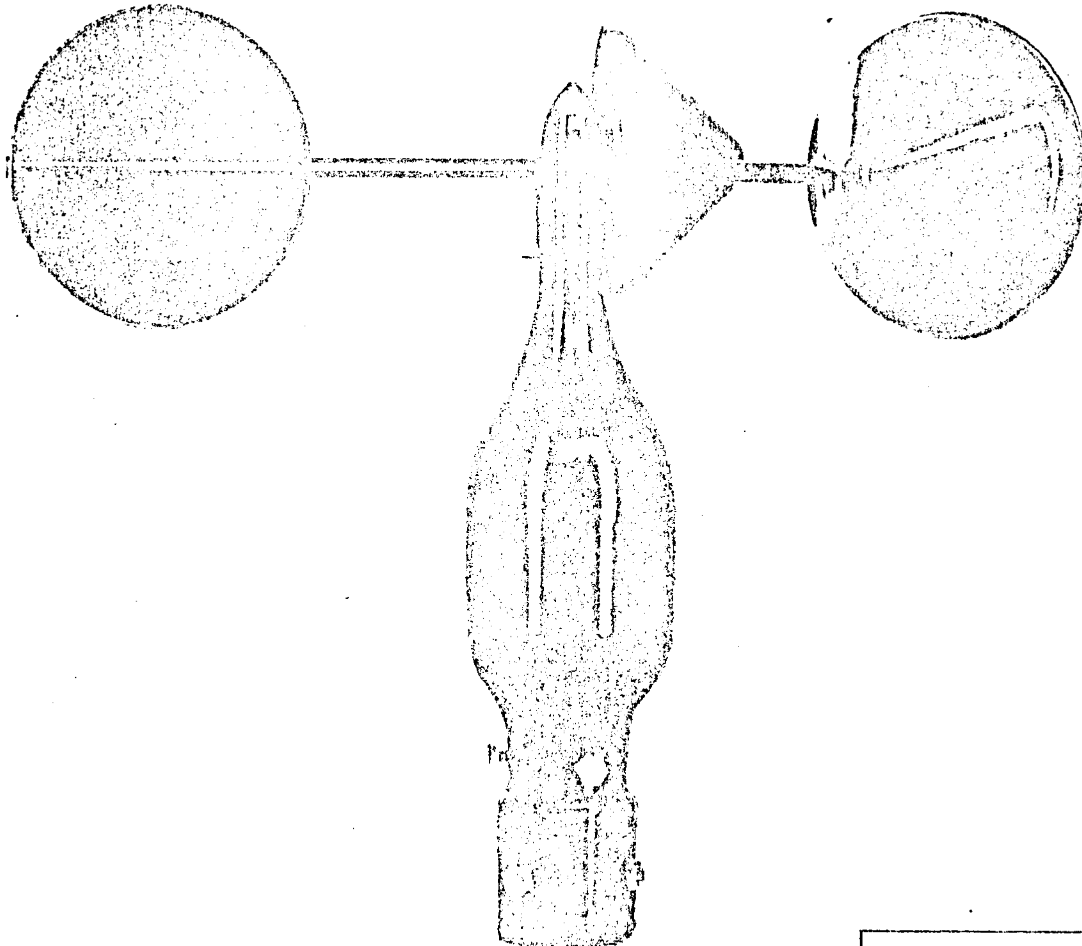


Figure 8
Wind Speed Transmitter

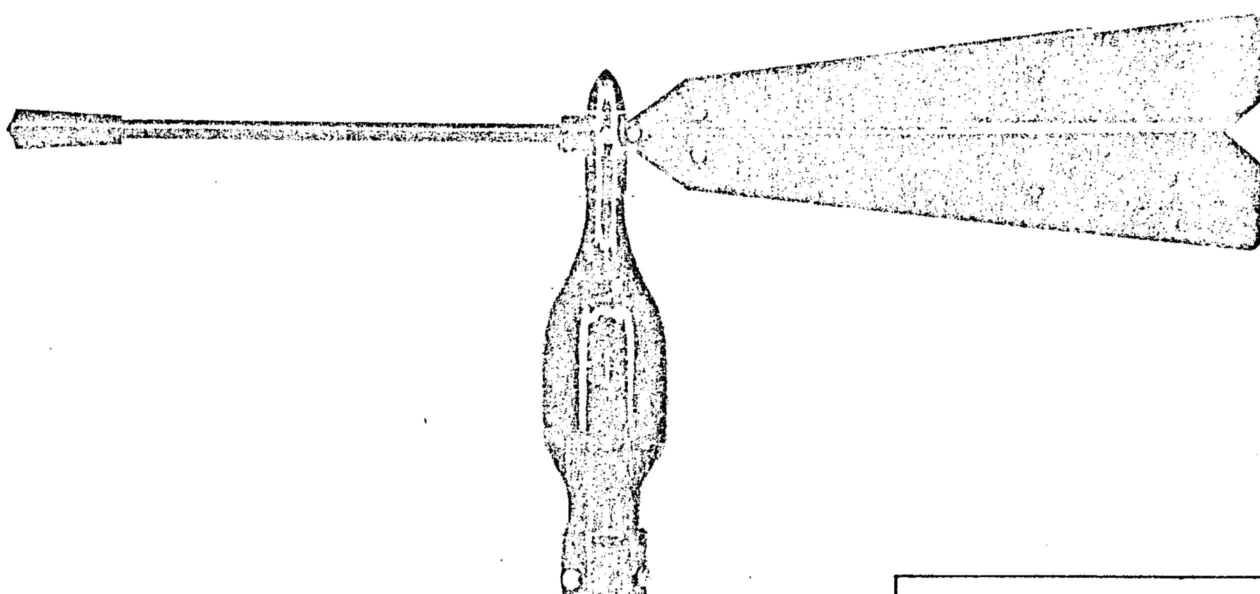
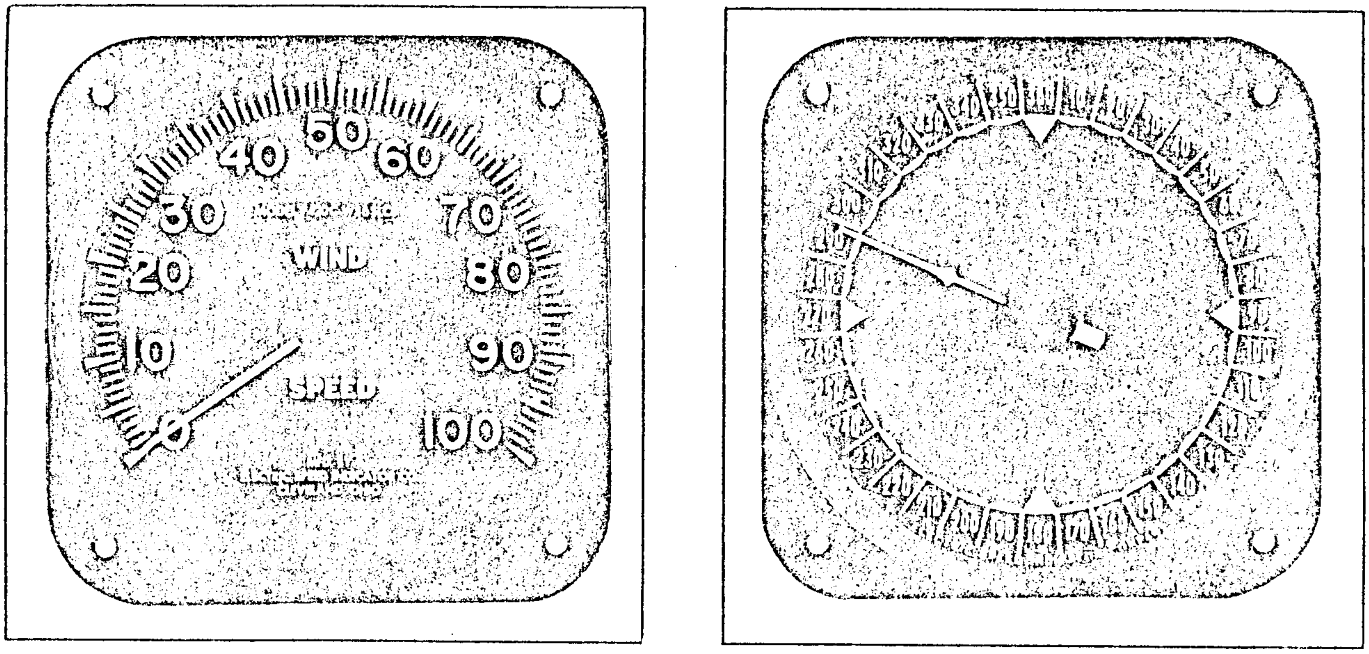
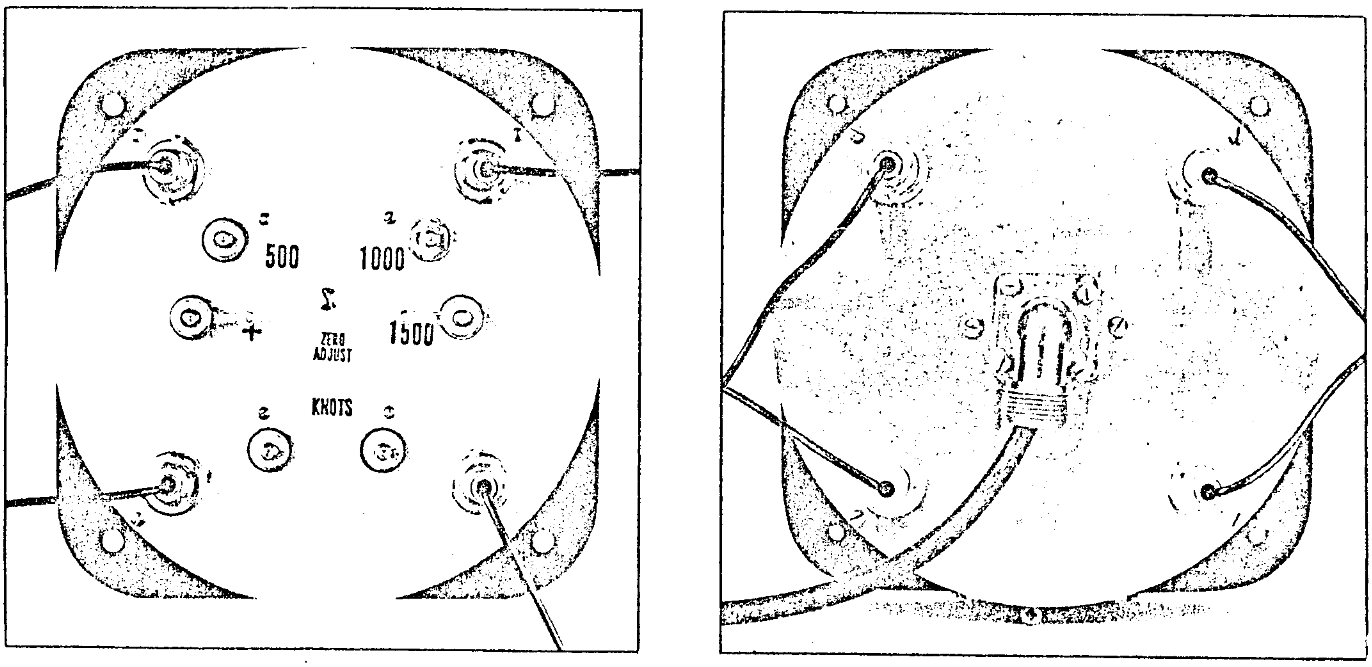


Figure 9
Wind Direction Transmitter

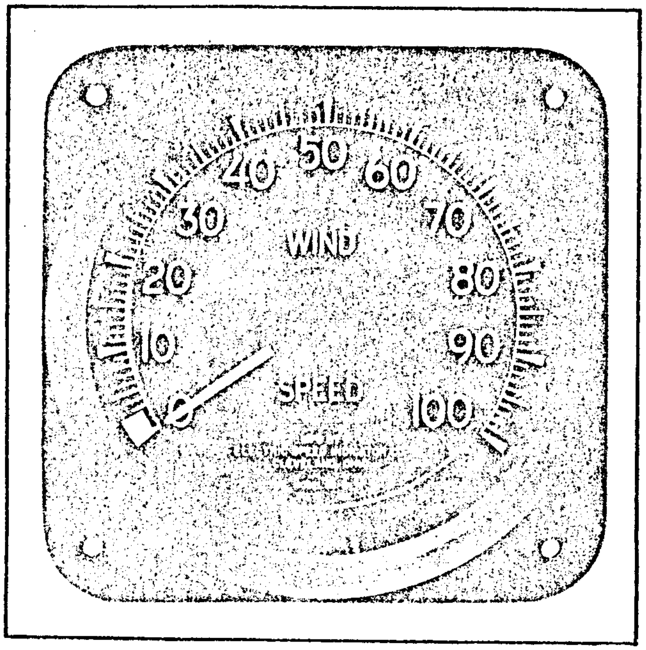


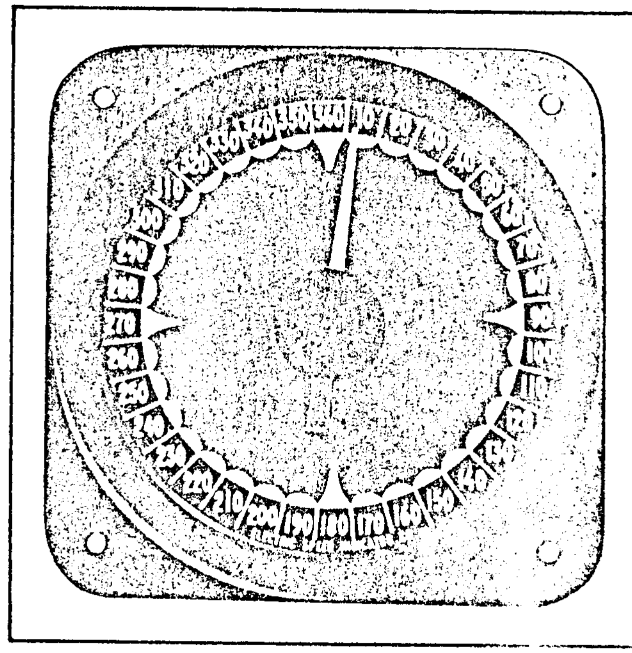
Wind Speed Front View Wind Direction



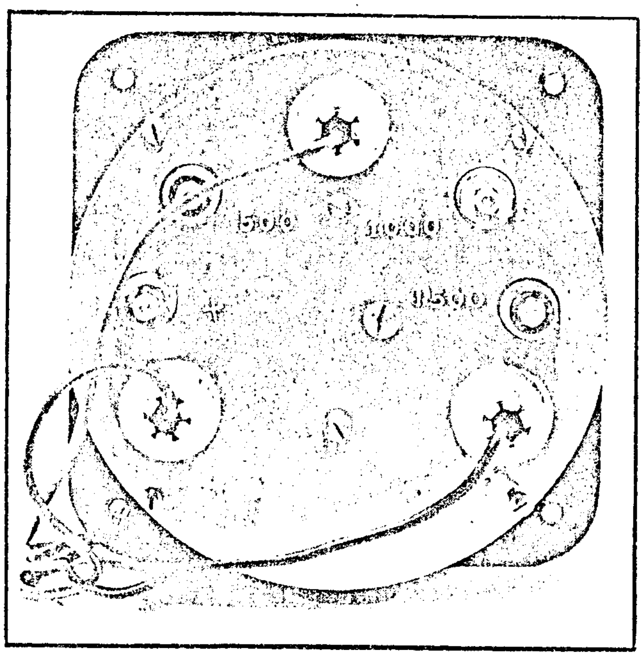
Wind Speed Rear View Wind Direction

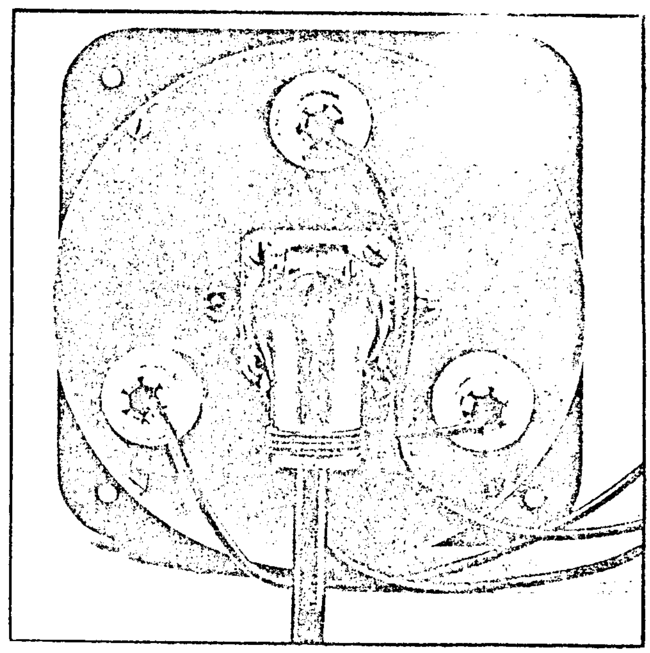
Figure 11 - 6 inch Indicators, FAA Type, Square Flange





Wind Speed　　　Front Views　　　Wind Direction





Wind Speed　　　Rear Views　　　Wind Direction

Figure 12 - 4 inch Indicators, Square Flange, Unmounted, FAA Type

A.) SYSTEM OPERATION

1. Wind Speed System - Please refer to F420C Instruction Book for description and operational information.
2. Wind Direction System - The standard F420C wind direction transmitter as described in the Instruction Book has been modified in this recording system to a potentiometer type transmitter. When a constant voltage from the power supply is applied to the end terminals of the resistance coil, the moveable arm, attached to the wind vane, will yield a linear voltage output directly proportional to shaft position. This voltage is then fed to a recorder suitably calibrated to indicate vane position in degre

B.) INSTALLATION

1. Speed Transmitter - As in F420C Instruction Book.
2. Direction Transmitter - As in F420C Instruction Book.
3. Recorders - Please refer to separate Instruction Manual for Recorders for mounting, chart installation, pen adjustments etc. Note that when adjusting pointer to zero position after pen installation, the correct "zero" or "rest position" of the speed recorder should be set at 2.3 miles per hour per Calibration Table C-1-d, page 7 of F420C Instruction Book.
4. Conductors and Wiring - Please refer to Wiring Diagram F420C-2. Note that only five conductors are required for a recording system. Simply connect leads to join tagged wires from transmitters to similarly marked terminals on Power Supply terminal strip, "A" to "A","B" to "B" etc.

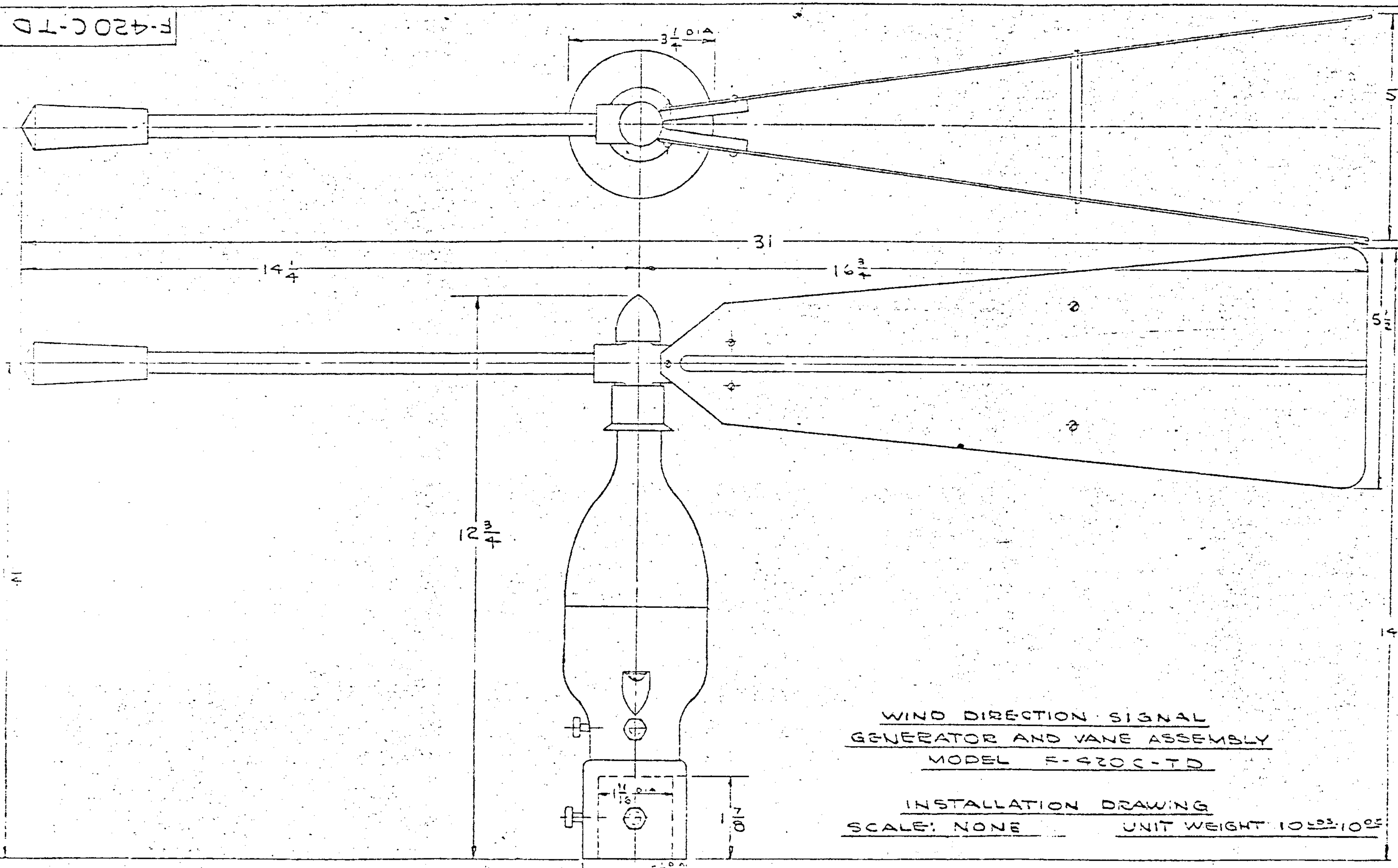
   Connections to the recorders are made by installing wires from terminal strip, as indicated wiring diagram F420CR 2 to appropriate recorder terminals, such as, DR + and DR to direction recorder terminals, as well as, SR+ and SR to speed recorder terminals with polarity as shown.

C.) FINAL ADJUSTMENTS AND CALIBRATION

1. Power Supply Features - The power supply components have been chosen to properly actuate the recorder used and has been equipped with a variable voltage adjustment labeled " Full Scale Adjustment Potentiometer " of the Wiring Diagram to permit exact calibration of the direction recorder regardless of minor variations of recorder sensitivities encountered.

   To complete calibration:

   a) After completing recorder installation and wiring, plug cord from Power Supply into 115 v.a.c. outlet.
   b) Press down red colored momentary contact switch - this applies full transmitter potentiometer voltage to recorder and should cause recorder pen to swing to maximum deflection.
   c) While holding switch down, adjust shaft of potentiometer adjacent to switch to cause recorder pen to read exactly full scale.
   d) Release switch and system will be in full operation correctly calibrated.



WIND DIRECTION SIGNAL
GENERATOR AND VANE ASSEMBLY
MODEL F-420C-TD

INSTALLATION DRAWING

SCALE: NONE UNIT WEIGHT 10 LBS. 10 OZ.

ELECTRIC SPEED INDICATOR COMPANY CLEVELAND 11, OHIO

F-420C-TD

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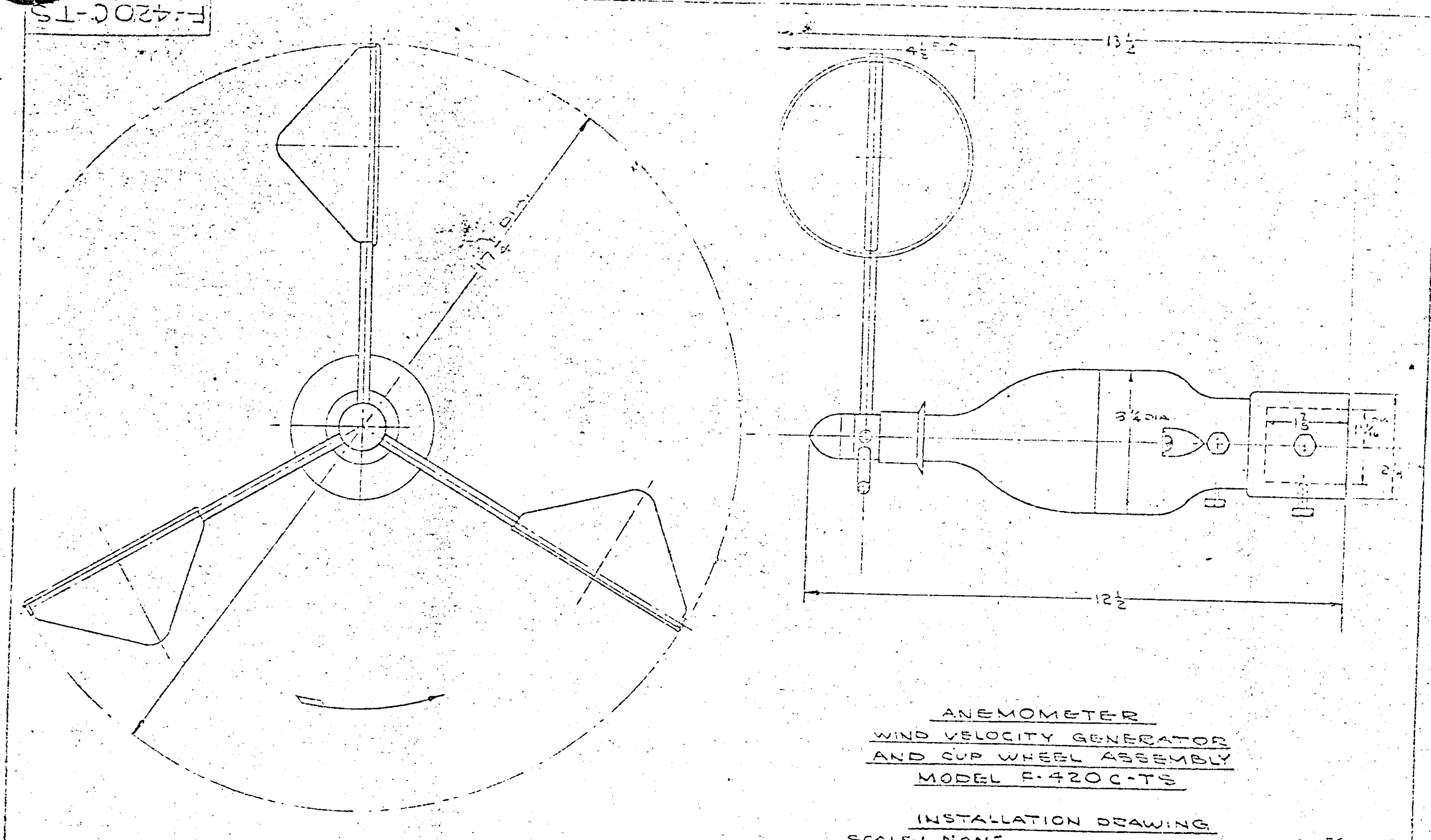


ANEMOMETER
WIND VELOCITY GENERATOR
AND CUP WHEEL ASSEMBLY
MODEL F-420C-TS

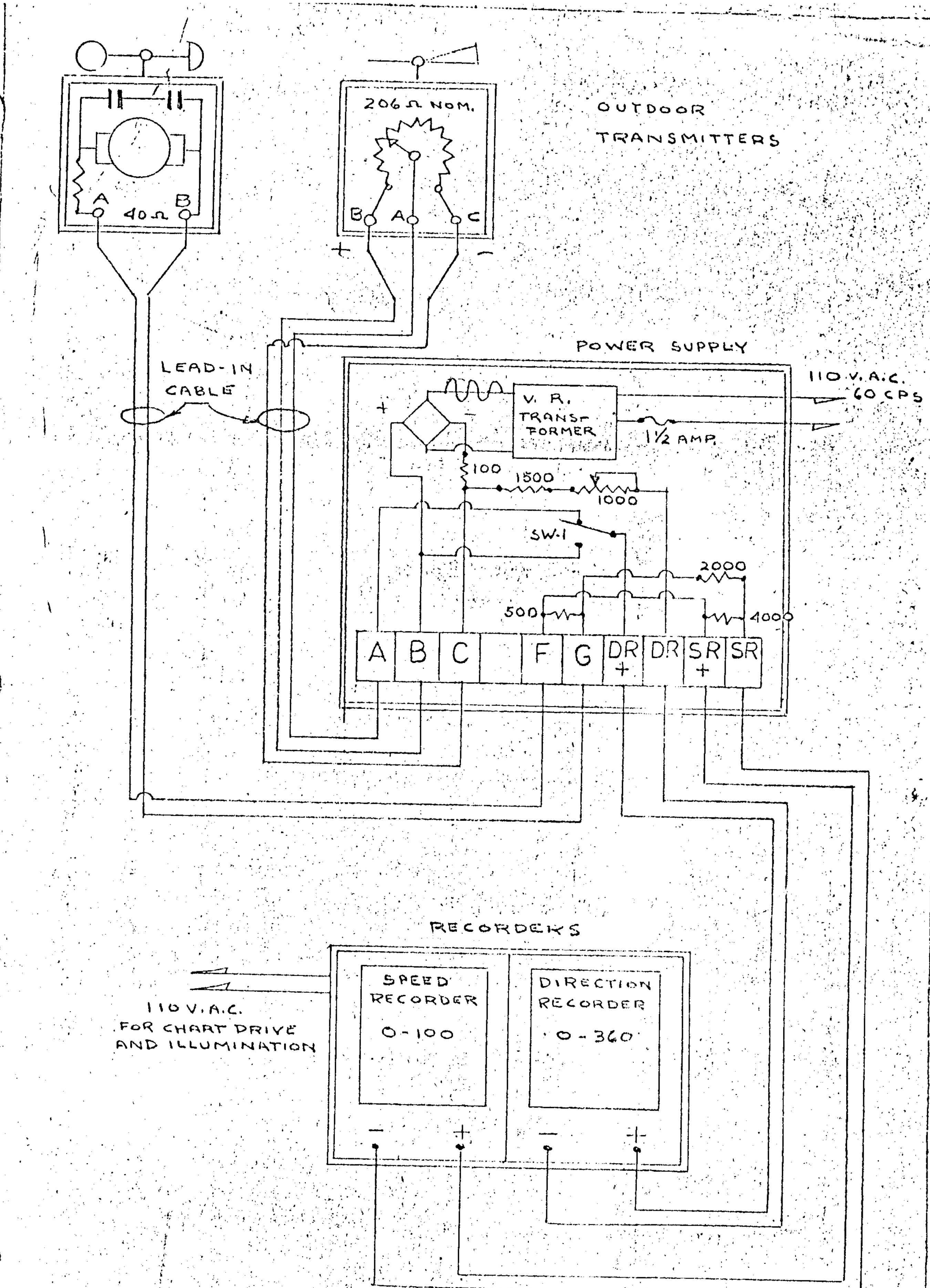
INSTALLATION DRAWING

SCALE: NONE

UNIT WEIGHT 9 LBS. 3 OZ.

ELECTRIC SPEED INDICATOR COMPANY — CLEVELAND 11, OHIO

F-420C-TS



F420-CR2	FOR:	ELECTRIC SPEED INDICATOR CLEVELAND, OHIO

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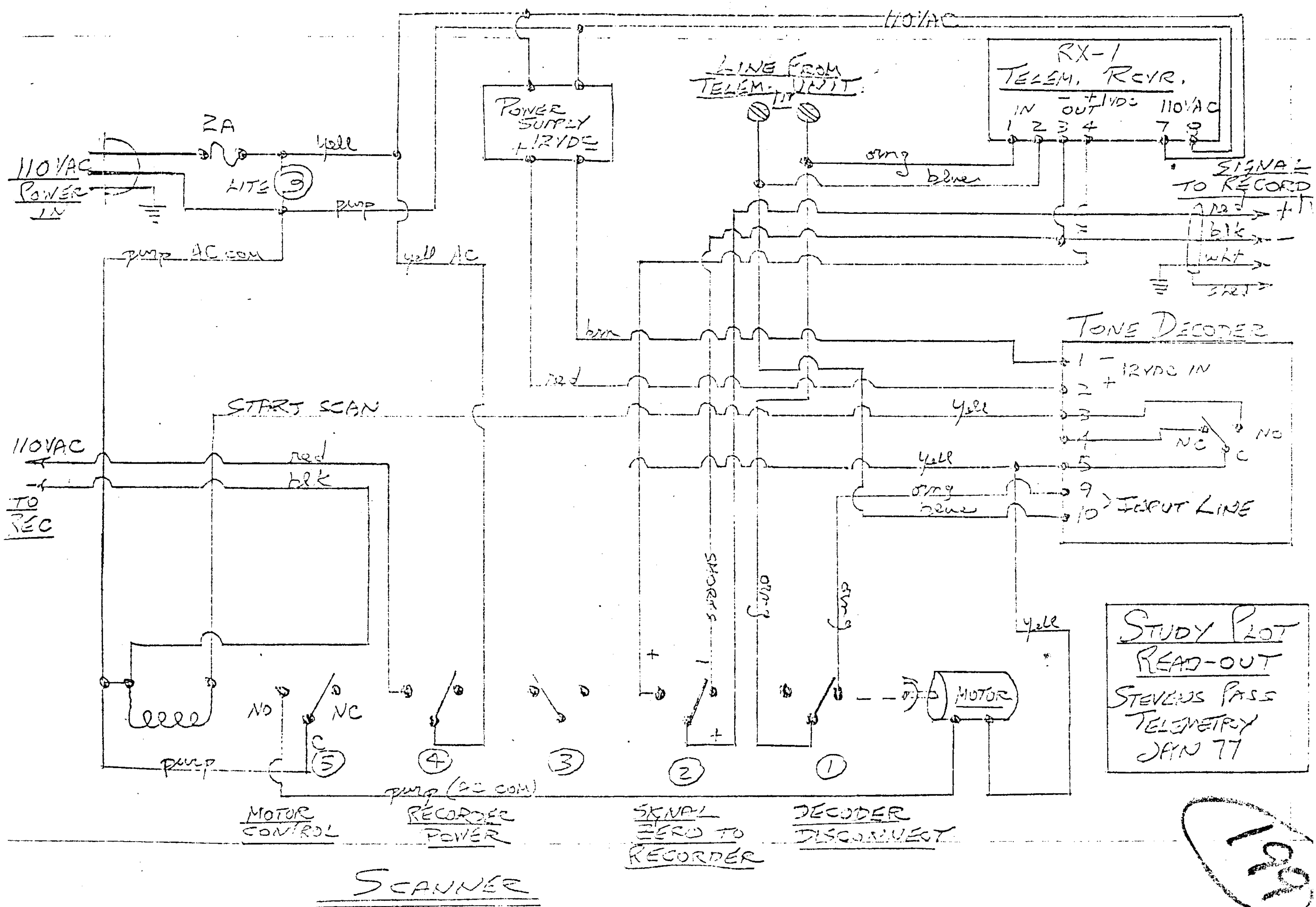
WSDT STUDY PLOT READOUT

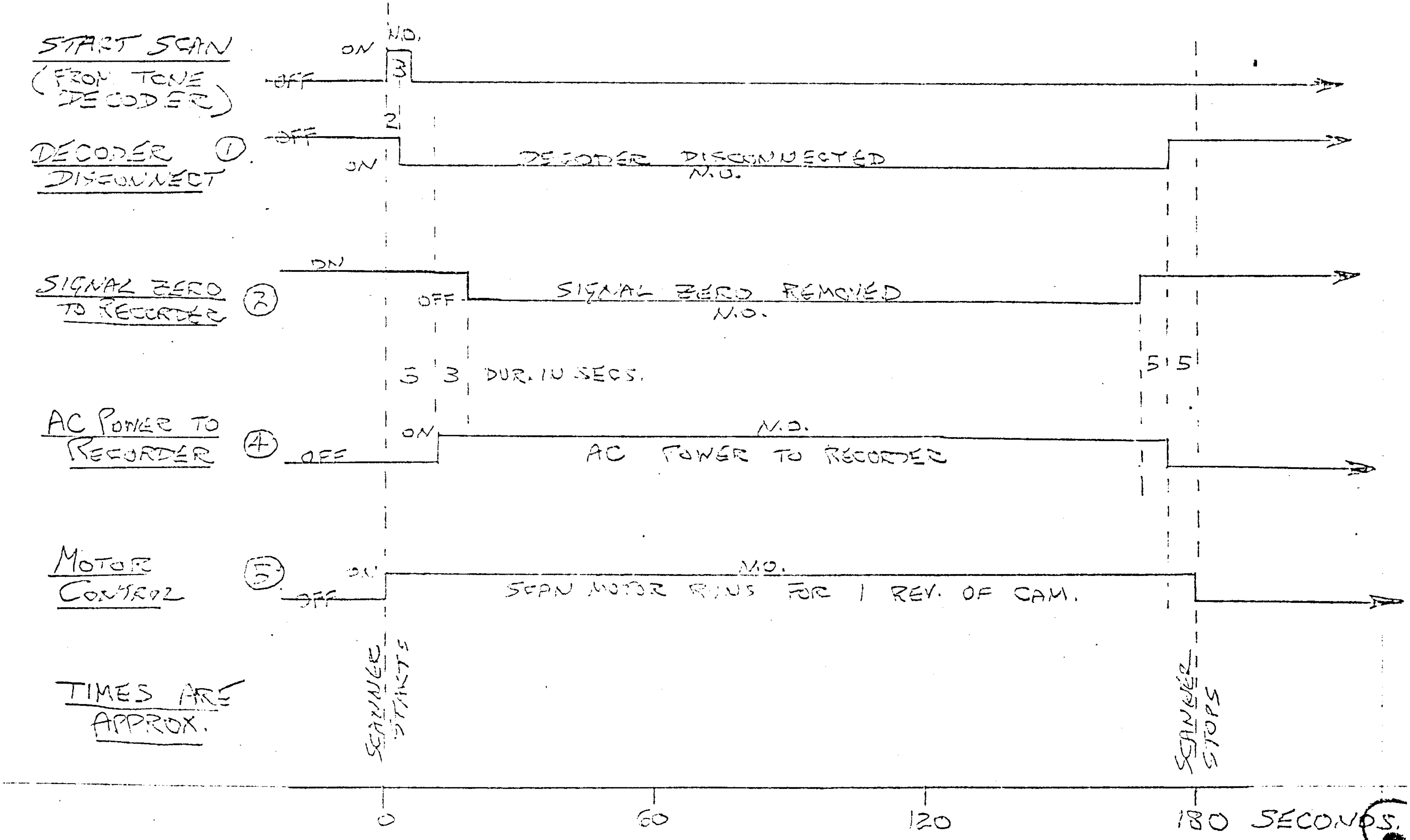
(road level Stevens Pass)

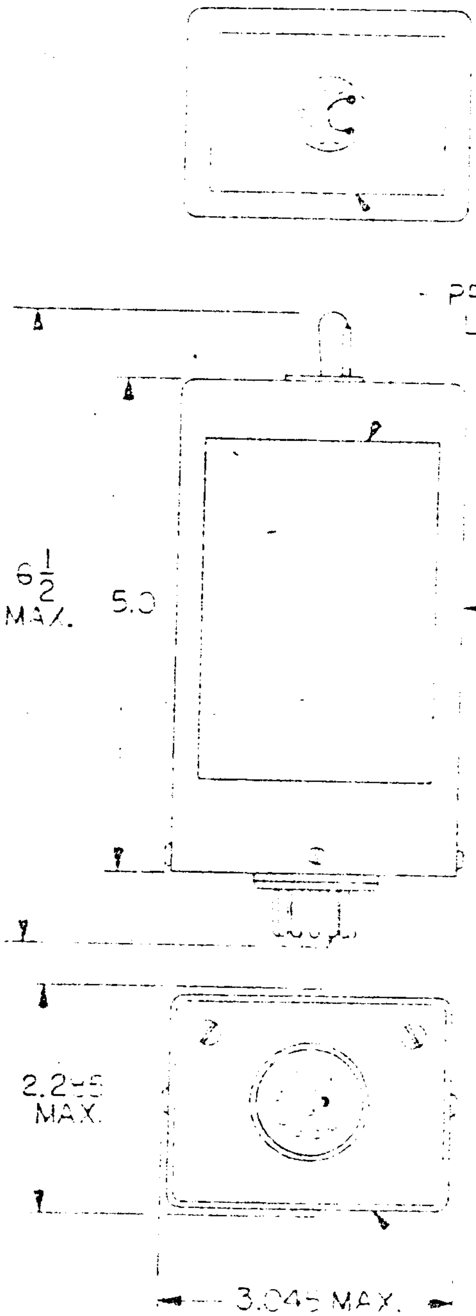


STUDY PLOT
READ-OUT
STEVENS PASS
TELEMETRY
JAN 77

199

TIMING DIAG FOR STUDY PLOT READOUT





SPECIFICATIONS:

1. Tone Input:
   a. Balanced and isolated
   b. 20K ohms impedance
   c. Dynamic range: 25 db (-25 to 0 dbm per tone)
   d. Sensitivity: -28dbm (.031 volts per tone) at design frequency.
   e. Bandwidth: ±2.5 min.
2. Relay Output: (plug in relay)
   a. Two form C contacts (DPDT)
   b. Rating: 1 amp @ 28 VDC or 117 VAC resistive
3. Signalling Speed: 10 pulses/sec (-25 to 0 dbm)
4. Temperature Range: -30 to + 60°C
5. Input Power:
   12 volt unit: 10.5 to 14 VDC, 25 ma. max.
   24 volt unit: 21 to 28 VDC, 25 ma. max.
   48 volt unit: 42 to 56 VDC, 33 ma. max.

Plug Connections

1. (-) } Supply voltage
2. (+) }
3. N.C.
4. N.O. } 1st Form C contact
5. C
6. N.C.
7. N.O. } 2nd Form C contact
8. C
9. } Telephone Line
10. }
11. [illegible] delay capacitor for longer than 50 [illegible] relay [illegible] contacts to pin 1.

PIN CONNECTION LABEL

1	[illegible]	ABL-XC
Ckt B13756-00001		
SCALE 1:2		

BRAMCO CONTROLS DIV.
LEDEX INC.
[illegible]

TITLE: PROGRAMMABLE TOUCH-TONE* [illegible] DIGIT DECODER

2 | 402345-[illegible]

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6. Explanation of Suffix: -1000' denotes a 12 VDC power supply
-2000 denotes a 24 VDC power supply
-4000 denotes a 48 VDC power supply

7. Programming Procedure: Determine positions to be connected from label for desired digit. Insert program leads (leads are interchangeable) to the appropriate positions in the socket. Diagram below illustrates socket program for Digit 1.

DIGIT	CONNECT PINS TO:
1	A AND J
2	B AND J
3	C AND J
4	A AND H
5	B AND H
6	C AND H
7	A AND G
8	E AND G
9	C AND G
*	A AND F
0	B AND F
#	C AND F
I	D AND J
II	D AND H
III	D AND C
IV	D AND F

TO PROGRAM: SEE

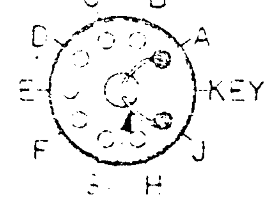


CHART ON SIDE

Program leads

MATERIAL

FINISH

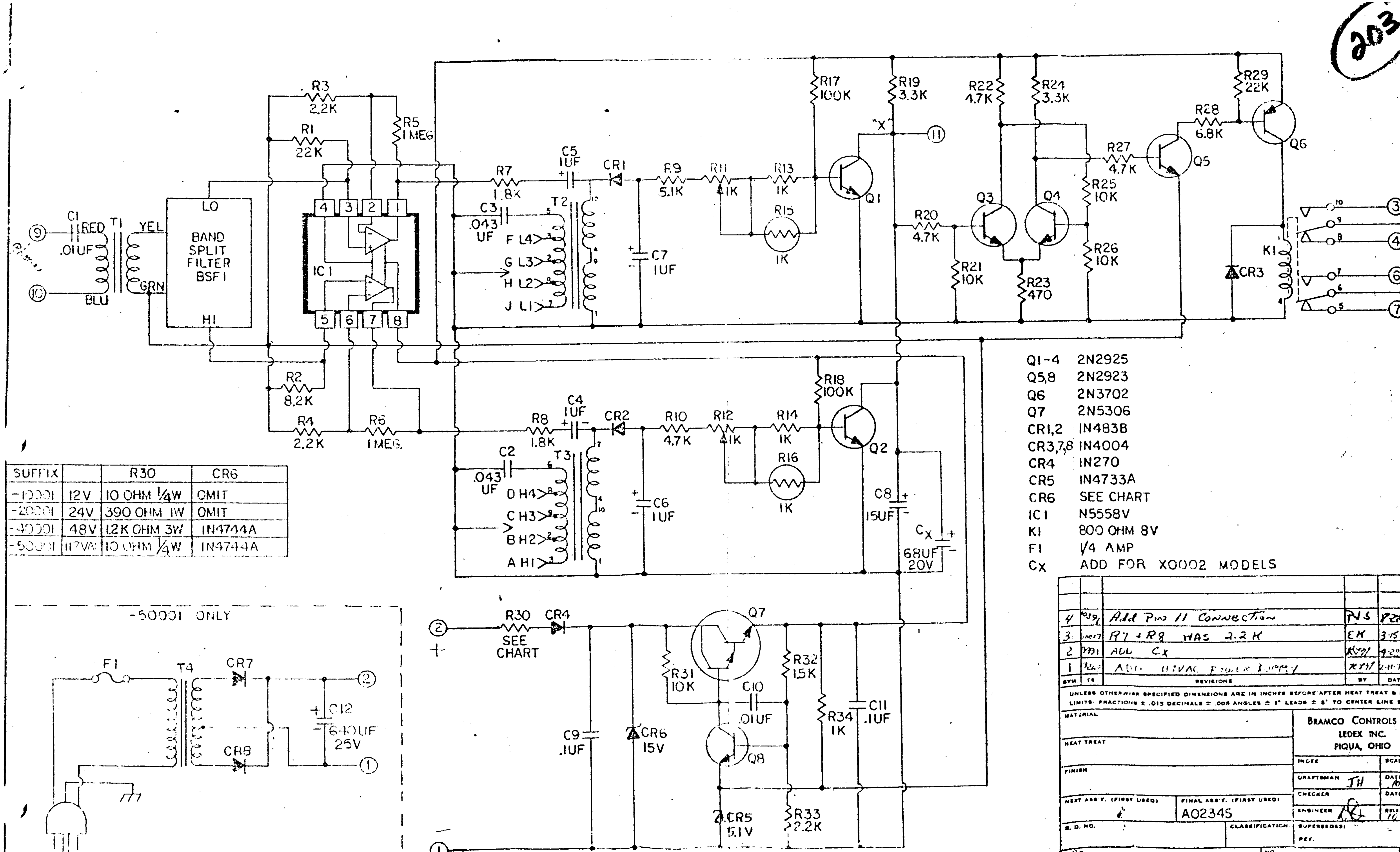
DFT. / CKR. / ENGR. / FINAL ASSY / NEXT ASSY

BRAMCO CONTROLS DIV.

TITLE: PROGRAMMABLE TOUCH-TONE* SINGLE

SHEET 2 OF 2

NO. A02345-X000X



SUFFIX		R30	CR6
-10001	12V	10 OHM 1/4W	OMIT
-20001	24V	390 OHM 1W	OMIT
-40001	48V	1.2K OHM 3W	1N4744A
-50001	117VAC	10 OHM 1/4W	1N4744A

Q1-4	2N2925
Q5,8	2N2923
Q6	2N3702
Q7	2N5306
CR1,2	1N483B
CR3,7,8	1N4004
CR4	1N270
CR5	1N4733A
CR6	SEE CHART
IC1	N5558V
K1	800 OHM 8V
F1	1/4 AMP
Cx	ADD FOR X0002 MODELS

SYM		REVISIONS	BY	DATE
4		Add Pin 11 Connection		
3		R7 + R8 WAS 2.2 K	EK	3-15-76
2		ADD Cx		
1		ADD 117VAC POWER SUPPLY		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES BEFORE/AFTER HEAT TREAT & FIN[illegible]
LIMITS: FRACTIONS ± .015 DECIMALS ± .005 ANGLES ± 1° LEADS ± 8° TO CENTER LINE SHO[illegible]

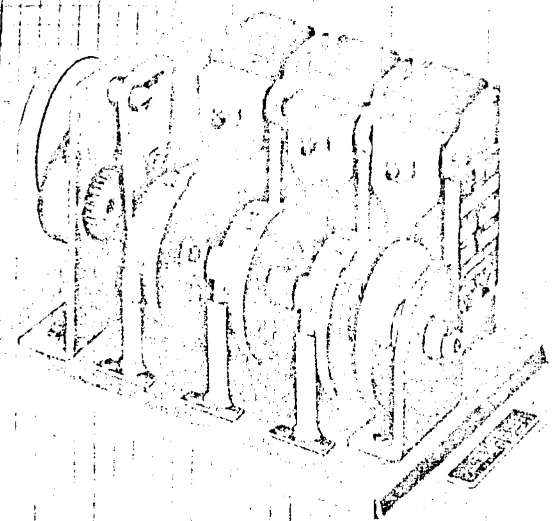
BRAMCO CONTROLS DI[illegible]
LEDEX INC.
PIQUA, OHIO

DRAFTSMAN JH

FINAL ASS'Y. (FIRST USED) A02345

TITLE: PROGRAMMABLE TOUCH TO[illegible] DECODER CIRCUIT

NO. B13756-X0001



OPERATING INSTRUCTIONS

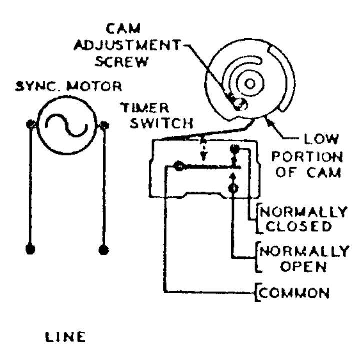
Series CM, MC, RA & RC

PROGRAMMING CAM TIMERS

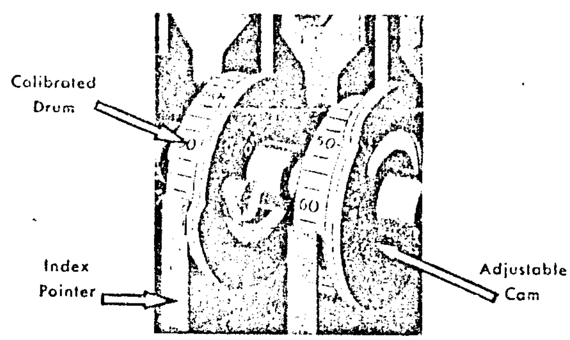
for

Catalog Bulletin #206

The switches used on the Cam Timer Series are Snap Action, Single Pole Double Throw totally enclosed micro switches, each switch is marked Normally Open (N.O.), Normally Closed (N.C.) and Common (C). These markings designate the condition of the switch in relation to the low or detent portion of the cam. A circuit is completed between the Common and the Normally Closed contact of the switch when actuator arm is in detent. Therefore, by setting the cam opening at 10%, the contacts will be closed for 10% and opened for 90% of the total time cycle. By wiring the switch to either N.O. or N.C. the load "on time" can be adjusted for a total of 2% to 98% of the total overall time cycle.



WIRING DIAGRAM ONE OR MORE CAMS



The cam opening may be adjusted by loosening the cam screw and turning the movable cam to the required degree of opening and then re-tightening the screw.

Refer to Catalog Bulletin #206 for gear rack chart and dimensions.

INDUSTRIAL TIMER
A UNIT OF ESTERLINE CORPORATION

programming cam timers concluded

gear rack chart

MODEL	RA 0	RA 1	RA 2	RA 3	RA 4	RA 5	RA 6	RA 7	RA 8	RA 9	RA 10	RA 11	RA 12
MODEL	CM 0	CM 1	CM 2	CM 3	CM 4	CM 5	CM 6	CM 7	CM 8	CM 9	CM 10	CM 11	CM 12
MODEL	MC 0	MC 1	MC 2	MC 3	MC 4	MC 5	MC 6	MC 7	MC 8	MC 9	MC 10	MC 11	MC 12
MODEL	RC 0	RC 1	RC 2	RC 3	RC 4	RC 5	RC 6	RC 7	RC 8	RC 9	RC 10	RC 11	RC 12
GEAR RACKS	SEE NOTE 2*												
E-12	40c	4 sec	10 sec	20s	40s	2m	3m20s	10m	20m	40m	2h	3h20m	8h
E-14	46.7c	4.67s	11.67s	23.33s	46.67s	2m20s	3m53s	11m40s	23m20s	46m40s	2h20s	3h53m	9h20m
D-12	48c	4.8s	12s	24s	48s	2m24s	4m	12m	24m	48m	2h24m	4h	9h36m
E-15	50c	5 sec	12.5s	25s	50s	2m30s	4m10s	12m30s	25m	50m	2h30m	4h10m	10h
E-16	53.3c	5.33s	13.33s	26.67s	53.3s	2m40s	4m27s	13m20s	26m40s	53m20s	2h40m	4h27m	10h40m
D-14	56c	5.6s	14s	28s	56s	2m48s	4m40s	14m	28m	56m	2h48m	4h40m	11h12m
C-12	1 sec	6 sec	15s	30s	60s	3m	5m	15m	30m	60m	3h	5h	12h
D-16	64c	6.4s	16s	32s	64s	3m12s	5m20s	16m	32m	64m	3h12m	5h20m	12h48m
E-20	66.7c	6.67s	16.67s	33.33s	66.67s	3m20s	5m33s	16m40s	33m20s	66m40s	3h20m	5h33m	13h20m
C-14	70c	7s	17.5s	35s	70s	3m30s	5m50s	17m30s	35m	70m	3h30m	5h50m	14h
D-18	72c	7.2s	18s	36s	72s	3m36s	6m	18m	36m	72m	3h36m	6h	14h24m
E-22	73.3c	7.33s	18.33s	36.67s	73.33s	3m40s	6m7s	18m20s	36m40s	73m20s	3h40m	6h7m	14h40m
C-15	75c	7.5s	18.75s	37.5s	75s	3m45s	6m15s	18m45s	37m30s	75m	3h45m	6h15m	15h
B-12	80c	8 sec	20s	40s	80s	4m	6m40s	20m	40m	80m	4h	6h40m	16h
E-26	86.7c	8.67s	21.67s	43.33s	86.67s	4m20s	7m13s	21m40s	43m20s	86m40s	4h20m	7h13m	17h20m
D-22	88c	8.8s	22s	44s	88s	4m24s	7m20s	22m	44m	88m	4h24m	7h20m	17h36m
C-18	90c	9 sec	22.5s	45s	90s	4m30s	7m30s	22m30s	45m	90m	4h30m	7h30m	18h
B-14	93.3c	9.33s	23.33s	46.67s	93.33s	4m40s	7m47s	23m20s	46m40s	93m20s	4h40m	7h47m	18h40m
D-24	96c	9.6s	24s	48s	96s	4m48s	8m	24m	48m	96m	4h48m	8h	19h12m
B-15	100c	10 sec	25s	50s	100s	5m	8m20s	25m	50m	100m	5h	8h20m	20h
D-26	104c	10.4s	26s	52s	104s	5m12s	8m40s	26m	52m	104m	5h12m	8h40m	20h48m
B-16	106.7c	10.67s	26.67s	53.33s	106.7s	5m20s	8m54s	26m40s	53m20s	106m40s	5h20m	8h54m	21h20m
C-22	110c	11 sec	27.5s	55s	100s	5m30s	9m10s	27m30s	55m	110m	5h30m	9h10m	22h
D-28	112c	11.2s	28s	56s	112s	5m36s	9m20s	28m	56m	112m	5h36m	9h20m	22h24m
E-34	113.3c	11.33s	28.33s	56.67s	113.3s	5m40s	9m27s	28m20s	56m40s	113m20s	5h40m	9h27m	22h40m
A-12	2 sec	12 sec	30s	60s	2m	6m	10m	30m	60m	2h	6h	10h	24h
D-32	2s8c	12.78s	32s	64s	128s	6m24s	10m40s	32m	64m	2h8m	6h24m	10h40m	25h36m
C-26	2s10c	13 sec	32.5s	65s	130s	6m30s	10m50s	32m30s	65m	2h10m	6h30m	10h50m	26h
B-20	2s12c	13.2s	33.33s	66.67s	133.3s	6m40s	11m7s	33m20s	66m40s	2h13m	6h40m	11h7m	26h40m
D-34	2s16c	13.56s	34s	68s	136s	6m48s	11m20s	34m	68m	2h16m	6h18m	11h20m	27h12m
A-14	2s20c	14 sec	35s	70s	140s	7m	11m40s	35m	70m	2h20m	7h	11h40m	28h
D-36	2s24c	14.4s	36s	72s	144s	7m12s	12m	36m	72m	2h24m	7h12m	12h	28h48m
B-22	2s27c	14.7s	36.67s	73.33s	146.7s	7m20s	12m13s	36m40s	73m20s	2h27m	7h20m	12h13m	29h20m
A-15	2s30c	15 sec	37.5s	75s	150s	7m30s	12m30s	37m30s	75m	2h30m	7h30m	12h30m	30h
A-16	2s40c	16 sec	40s	80s	160s	8m	13m20s	40m	80m	2h40m	8h	13h20m	32h
C-34	2s50c	17 sec	42.5s	85s	170s	8m30s	14m10s	42m30s	85m	2h50m	8h30m	14h10m	34h
B-26	2s52c	17.2s	43.33s	86.67s	173.3s	8m40s	14m27s	43m20s	86m40s	2h53m	8h40m	14h27m	34h40m
A-18	3 sec	18 sec	45s	90s	3m	9m	15m	45m	90m	3h	9h	15h	36h
B-28	3s7c	18.7s	46.67s	93.33s	186.7s	9m20s	15m33s	46m40s	93m20s	3h7m	9h20m	15h33m	37h20m
A-20	3s20c	20 sec	50s	100s	200s	10m	16m40s	50m	100m	3h20m	10h	16h40m	40h
B-32	3s33c	21.3s	53.33s	106.7s	213.4s	10m40s	17m47s	53m20s	106m40s	3h33m	10h40m	17h47m	42h40m
A-22	3s40c	22 sec	55s	110s	220s	11m	18m20s	55m	110m	3h40m	11h	18h20m	44h
B-34	3s47c	22.7s	56.67s	113.3s	226.7s	11m20s	18m53s	56m40s	113m20s	3h47m	11h20m	18h54m	45h20m
A-24	4 sec	24 sec	60s	2m	4m	12m	20m	60m	2h	4h	12h	20h	48h
A-26	4s20c	26 sec	65s	130s	260s	13m	21m40s	65m	2h10m	4h20m	13h	21h40m	52h
A-28	4s40c	28 sec	70s	140s	280s	14m	23m20s	70m	2h20m	4h40m	14h	23h20m	56h
A-30	5 sec	30 sec	75s	150s	5m	15m	25m	75m	2h30m	5h	15h	25h	60h
A-32	5s20c	32 sec	80s	160s	320s	16m	26m40s	80m	2h40m	5h20m	16h	26h40m	64h
A-34	5s40c	34 sec	85s	170s	340s	17m	28m20s	85m	2h50m	5h40m	17h	28h20m	68h
A-36	6 sec	36 sec	90s	3m	6m	18m	30m	90m	3h	6h	18h	30h	72h

c-cycles s-seconds m-minutes h-hours

1. ORDERING INFORMATION--Model number selected from top of gear rack chart, gear rack, number of load switches, voltage and frequency.

   ALTERNATE ORDERING INFORMATION--Required time cycle (one complete rotation of cam shaft), number of load switches, ltage and frequency. Since some time cycles are available in 3 del numbers, the use of the ALTERNATIVE ordering informa- n may expedite delivery by allowing us to ship model in stock th required time cycle.

2. Multi-switch cam timers requiring time cycles in shaded area may require high torque timing motor. This is due to increased torque encountered in rapid time cycles. To determine need of larger motor; multiply required time cycle in seconds by 2/3, the answer will be the maximum number of switches that can be operated with a standard timing motor. EXAMPLE: Time cycle 15 seconds. 2/3 x 15s=10. 10 switches can be operated at 15 seconds with a standard timing motor, more than 10 load switches requires the use of a high torque timing motor.

Price added for Hi-Torque motors:

Series	Motor Speed	120/60 Hz
MC-0 RC 0	1 RPS	$45.00
MC-1 RC 1	1/6 RPS	45.00

TIMING SEQUENCE...MC & RC

(Multi-cam Types)

Each cam is individually mounted on the main shaft by means of a heavy duty friction which allows for easy finger adjustment of the timing sequence. The cams also incorporate a drum calibrated from 0% to 100%. Facing each calibrated drum is an index pointer for the cam sequencing.

1. Set first cam at zero on drum using index pointer as a guide.

2. Calculate the percentage of time difference when cam #2, 3, etc. should be operated. For example, if the overall time cycle is 60 seconds, the first cam is set at zero; if the next operation is to be started 15 seconds later, or 25% of the total overall time cycle, the second drum is set at 25%, against its index pointer. If the third operation is 15 seconds later, the third cam will be set at 50%, etc., additional cams are set in a like manner.

The knurled disc at the end of the camshaft should be held to prevent movement of the shaft while setting the sequence of individual cams. It may also be used to rotate the entire shaft for checking out program set-up, prior to timer operation.

CHANGING TIME CYCLE

1. Gear racks are interchanged by removing the gear rack screw. To prevent binding of gears when installing another gear rack, be certain there is a good amount of gear play. NOTE: the number and letter are stamped on the gear rack and should always face the cam shaft.

2. Additional gear rack assemblies for changing overall time cycles are listed in catalog gear rack chart.

ELECTRICAL CHARACTERISTICS

1. Cam Timers rated for 115 volt operation will operate within a range of 100 to 130 volts A.C.

2. 220 volt units will operate within a range of 205 to 240 volts A.C.

3. Switch rating 10 amps.

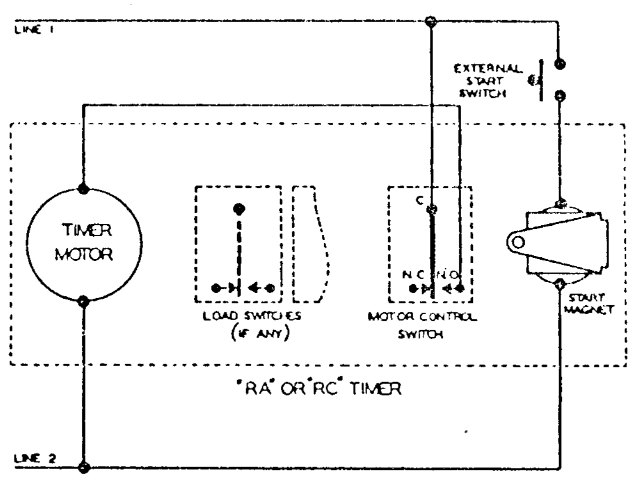
RA AND RC INSTRUCTIONS

For motor control switch and start magnet

Wire motor control switch as shown at right. Start timer by energizing the start magnet which, in turn, mechanically operates the switch.

For single cycle operation, energize the start magnet for a period which is less than the time required for the timer to complete a full cycle.

For continuous recycling the start magnet may be energized for any period of time. When released, the timer will run to the "O" position and stop.



Refer to Catalog Bulletin #206 for gear rack chart and dimensions.

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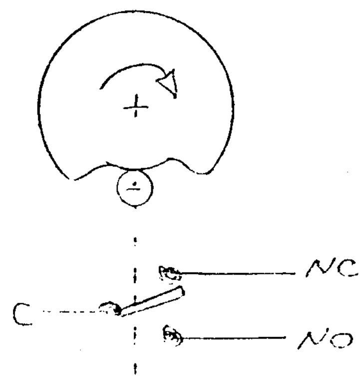
NOTES ON SEQUENCE CAMS

(REFER TO INDUSTRIAL TIMER OPERATING INSTRUCTIONS FOR PROGRAMMING TYPE RC CAM TIMERS)

- CYCLE TIME DEPENDS ON GEAR RACK

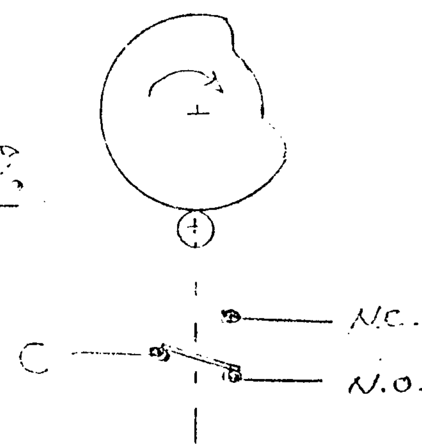
- IF AN ON TIME OF LESS THAN 50% OF THE CYCLE TIME IS DESIRED, USE THE N.O. CONTACT:

ON < 50%



- IF AN ON TIME OF MORE THAN 50% IS DESIRED, USE THE N.O. CONTACT:

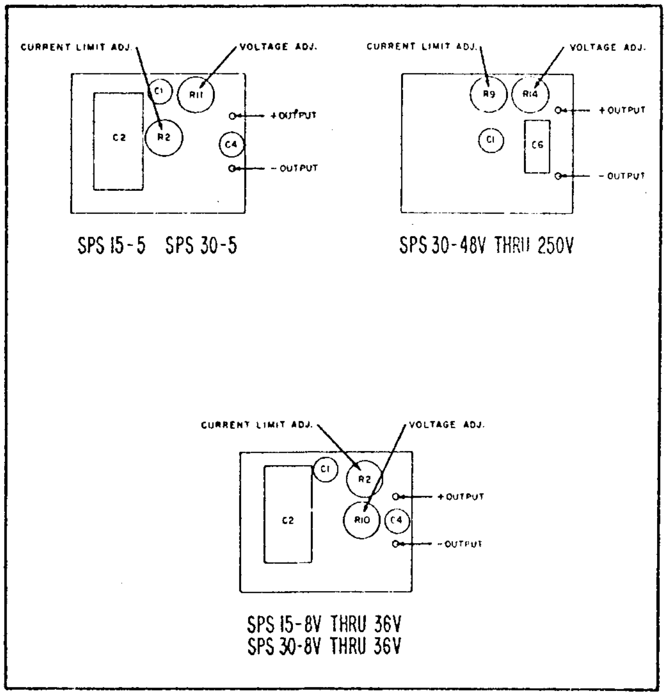
ON > 50%

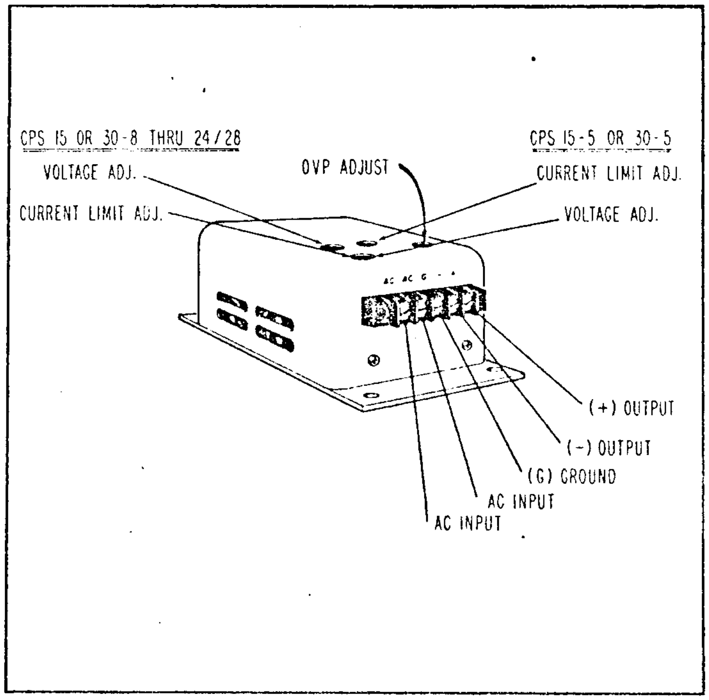


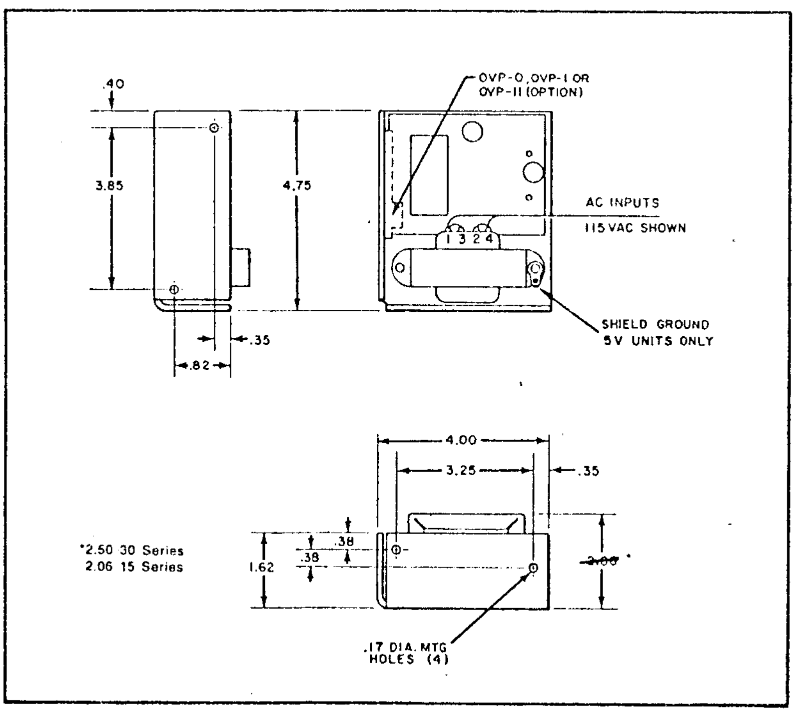
SEE INSTRUCTION SHEET FOR SETTING AND INDEXING CAMS

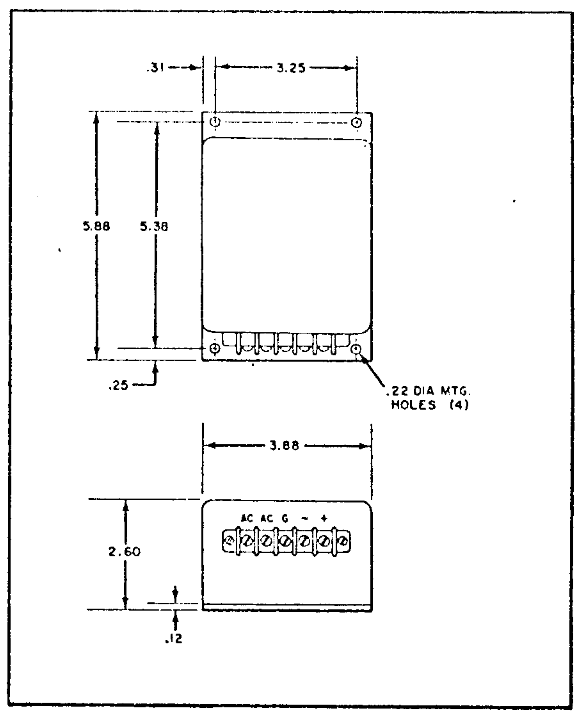
NOTES:

1. Recommended input fuse 1A, Type 3 AG.
2. OVP-1 is compatible with 5V through 28V models.
3. OVP-0 or OVP-11 may be used on 5V models.
4. If problems are encountered in series operation of two power supplies due to a common load connected across the two supplies, contact the factory for application note, AN 101.









STANDARD POWER SUPPLIES

INSTRUCTION SHEET
SPS/CPS SERIES

FEATURES

- Voltage adjustment potentiometer
- Foldback current limiting
- 115/230 Vac, 47-440 Hz input
- 0.1% line/load regulation
- Temperature compensated circuitry
- 0.1% ripple
- Optional overvoltage protection
- Optional square current limiting
- Optional logic inhibit

DESCRIPTION

The SPS and CPS Series are series regulated, solid state power supplies designed to provide closely regulated DC voltages in all popular voltage and current levels. The output is floating, hence any voltage may be plus or minus or referenced to another voltage.

OPERATING PROCEDURE

For 115 Vac, 47-440Hz connect input leads to terminals 1 and 4 of transformer or input terminal block, terminals 1 & 3 and 2 & 4 will be jumpered. (Factory connection)

For 230 Vac input, remove jumpers between 1 & 3 and 2 & 4. Then jumper terminals 2 and 3 together and connect 230 Vac to terminals 1 and 4. Suggest twisted AC input wires if electrical noise reduction is prime concern.

Output terminals identified in figures on back of this sheet are marked + and -. Load should be connected to these terminals with due care to proper wire size and solid electrical connection for best results. Output voltages may be adjusted with the potentiometers identified in the figures located on the back of this sheet

SUGGESTED TEST PROCEDURE

Connect AC input power as outlined in operating procedure. Place a variac between Vac source and input to transformer. Place an AC voltmeter across transformer input terminals 1 and 4. Set input voltage for nominal 115 Vac with variac.

Place resistive load across output, check Vdc output specifications. DC voltmeter should be connected directly across output terminals. Greatest test errors are made at this point.

LINE REGULATION

With output adjusted to rated voltage, reduce input Vac to 104 volts and record or note output voltage. Then increase input Vac. to 126 Vac and note output voltage. Total output voltage change should not exceed .2% or ± .1%.

LOAD REGULATION

Set AC input voltage to 115 Vac. Place DC voltmeter across output terminals and record or note output voltage. A load resistor, equal to the rated load of the supply at selected DC voltage setting, is then applied to output terminals. The voltage change should be noted. This differential change should not exceed .2% or ± .1% of DC output voltage.

Output current adjust is accomplished by placing a load resistor of the desired value across output terminal; adjust current limit potentiometer identified in figures on back of this sheet until voltage starts to drop. This is the fold back point of current limiting, this control is factory set to 120% of rated output and sealed.

RIPPLE

With voltage set at 115 volts and full load across DC output terminals, the measurable AC voltage on output should not exceed 0.1% RMS.

OVERVOLTAGE PROTECTION

Optional overvoltage protection is available on most models. Consult the catalog selection guide or the listing on the next page for appropriate models or contact the factory for application note.

Loads generating high back EMF voltages should be checked with parallel diode, zener, or series diode to reduce detrimental effects on pass elements. It is recommended that the AC input circuit be fused. A suggested fuse rating is listed on the reverse side of this sheet.

SUGGESTED PRACTICES

Moving air is desireable when mounting in a confined area. Chassis may be attached to other heat dissipating surfaces to improve cooling characteristic at maximum ratings.

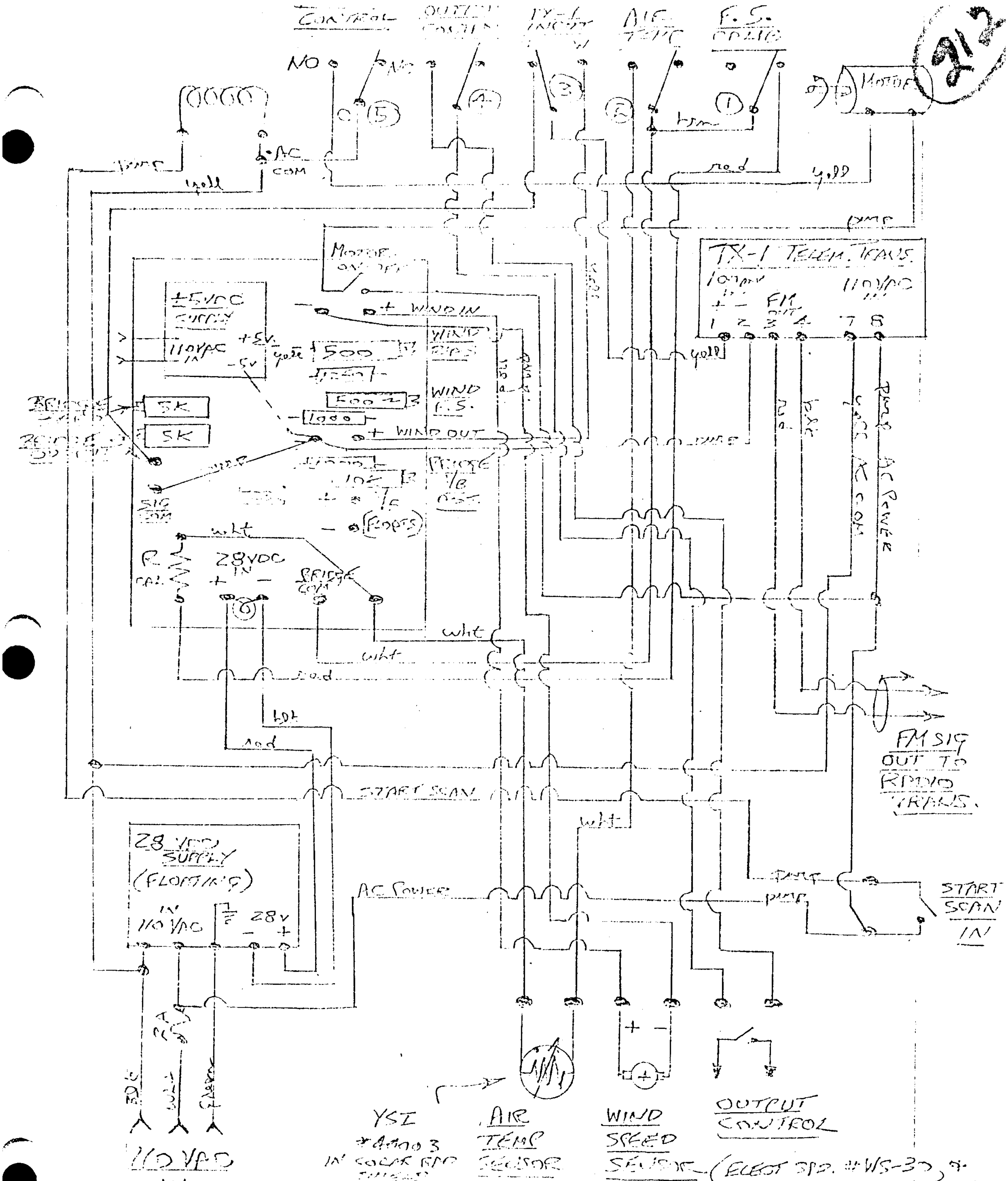
STANDARD POWER, INCORPORATED ■ 1400 South Village Way ■ Santa Ana, Calif. 92705 ■ phone (714) 558 8512

2lC

For Mini Servo Strip Chart Recorder.Instruction Manual see Weather Service Bldg. Readout Section

For RX-1 Data Receiver Specifications see Stevens Pass Telemetry Unit Section

HURRICANE RIDGE TELEMETRY

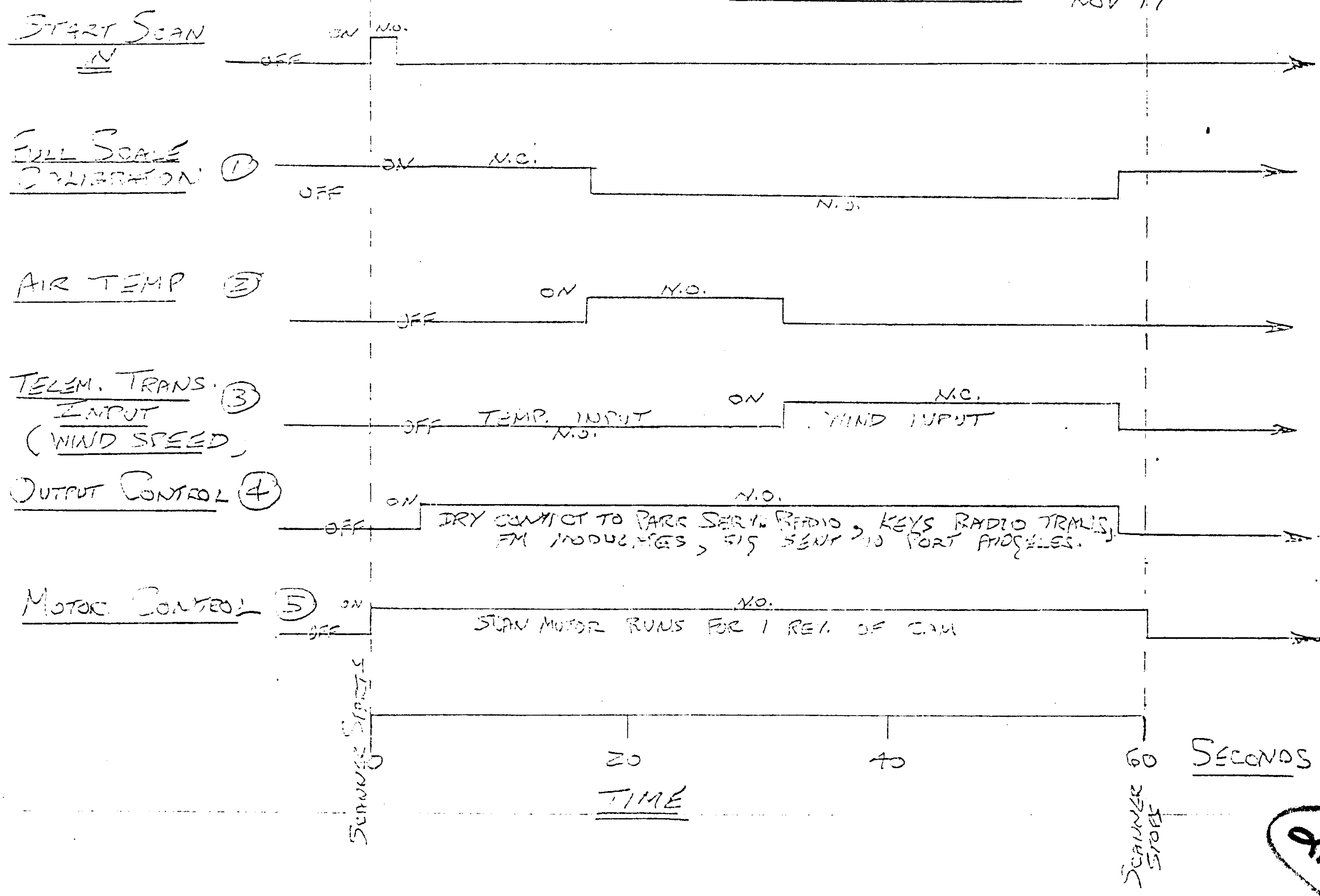


HURRICANE RIDGE TELEMETRY UNIT

NOV 77

TIMING DIAGRAM FOR HURRICANE RIDGE TELEMETRY UNIT

NOV 77



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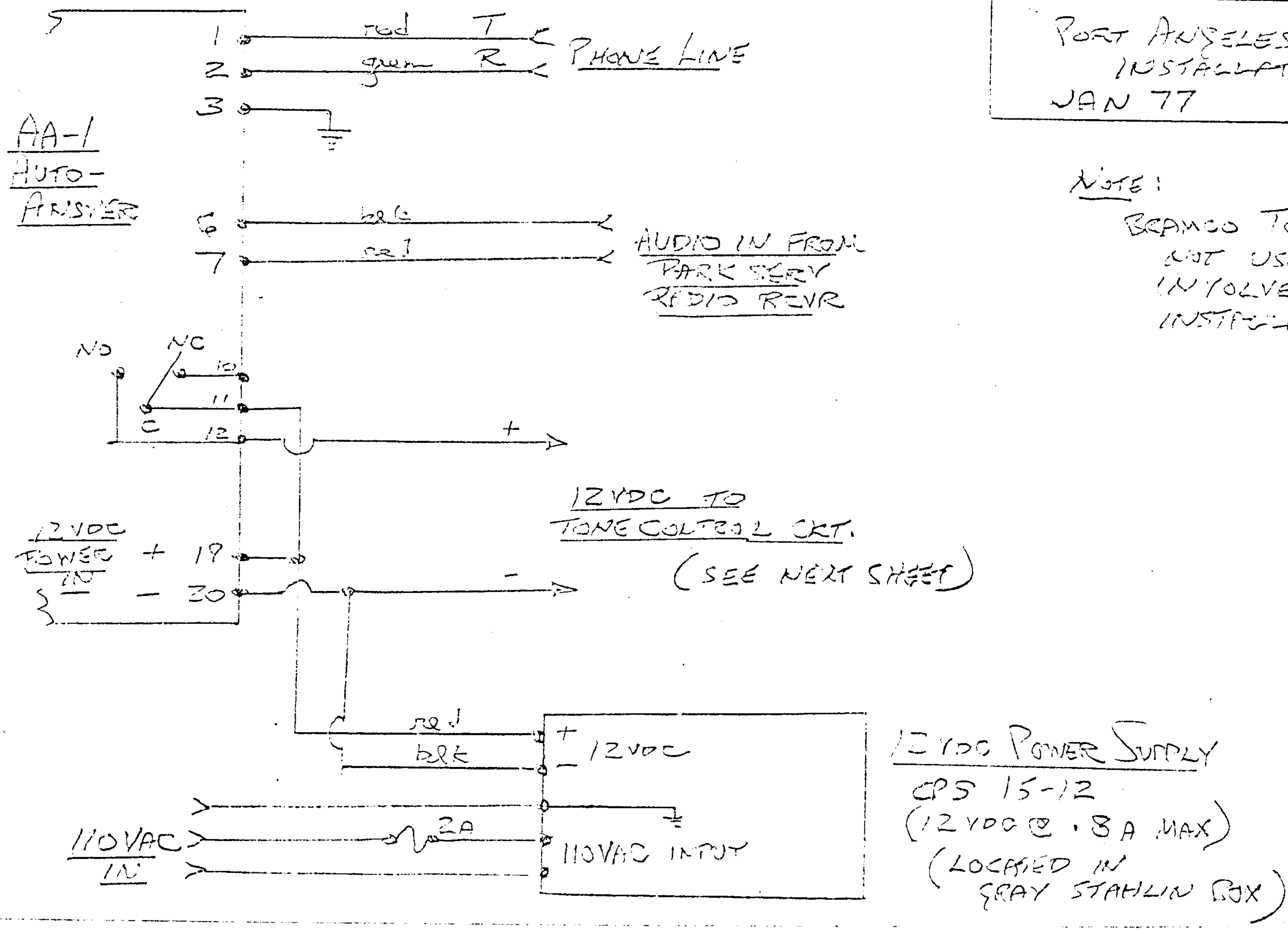
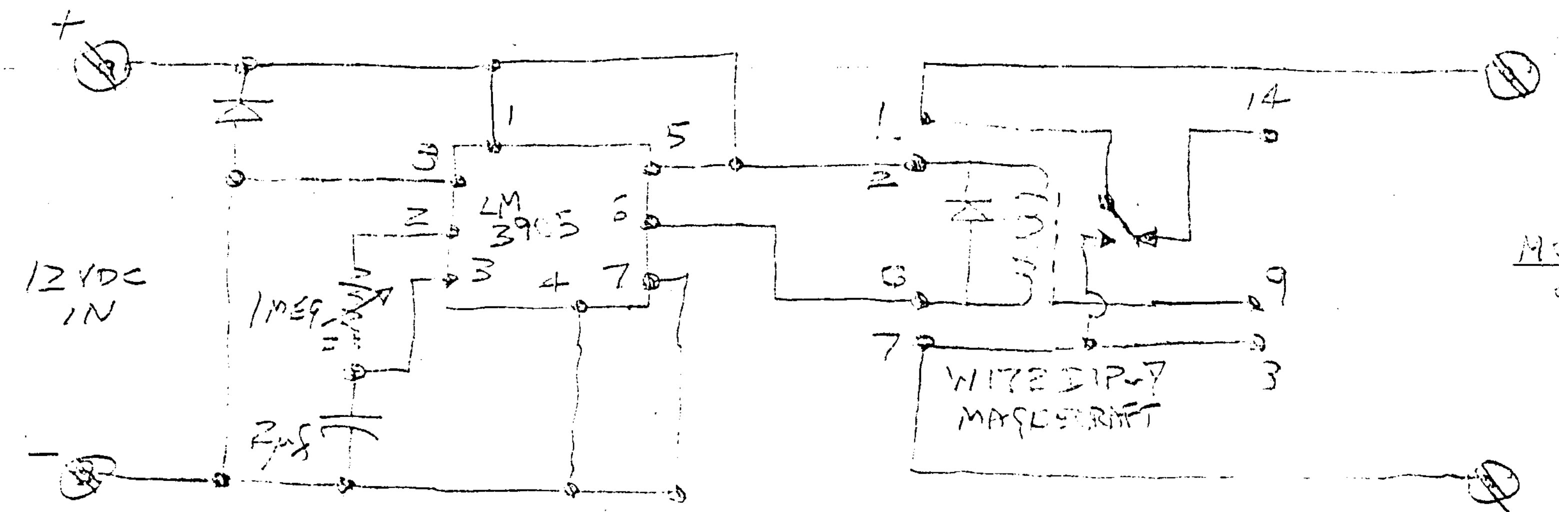
HURRICANE RIDGE TELEMETRY

PORT ANGELES PARK SERV. INSTALLATION ON
JAN 77

NOTE:
BRAMCO TONE DECODER NOT USED, WAS INVOLVED IN FALL 75 INSTALLATION.



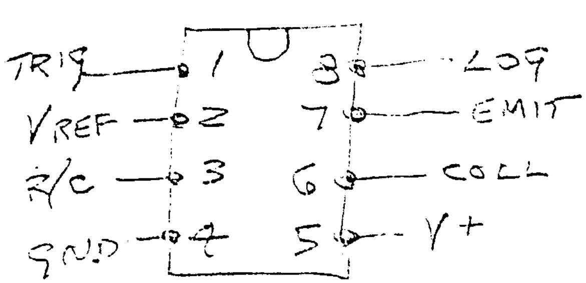


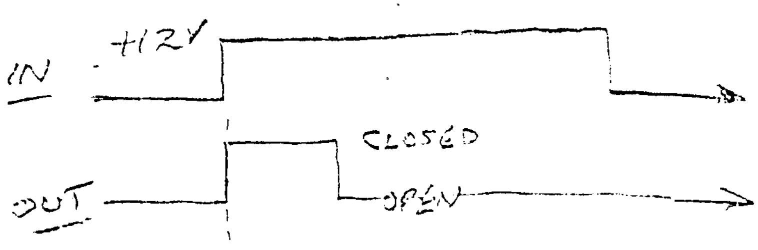
MOMENTARY OUTPUT
CONTACT CLOSURE
TO PARK SERV.
RADIO TRANS.

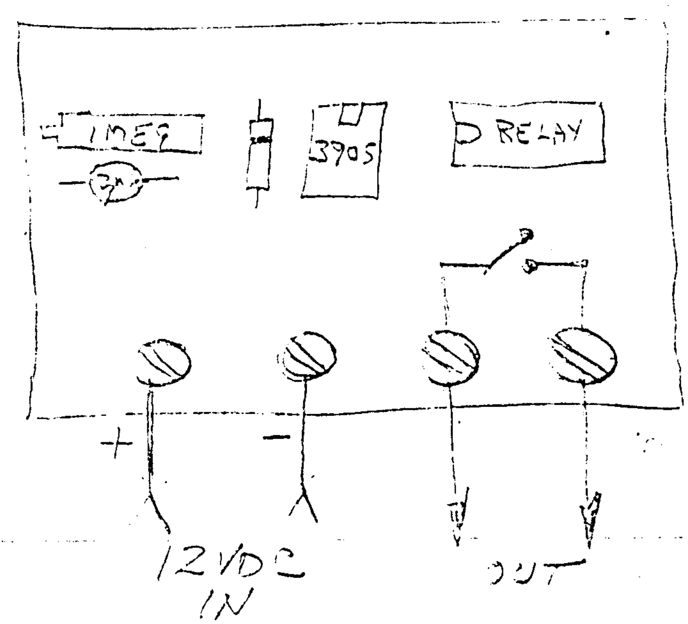
12 VDC
500 Ω
270 MW
SPDT .25 A.

TONE CONTROL
HURRICANE RIDGE
TELEMETRY
MAR 77 – DLT

LM 3905







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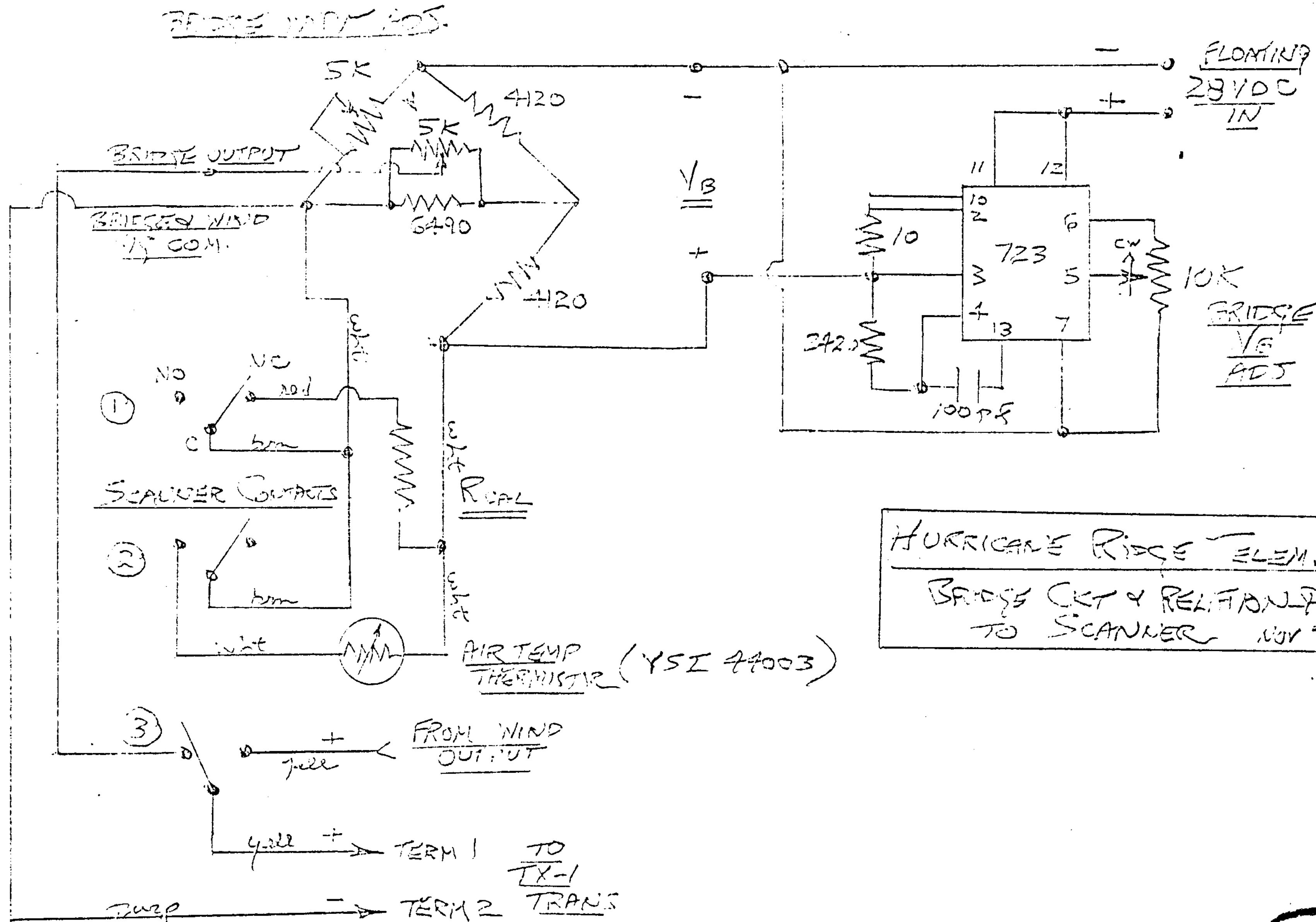


HURRICANE RIDGE TELEM.

BRIDGE CKT & RELATIONSHIP TO SCANNER NOV 77

216

HURRICANE [illegible] TEMP CALIB

[illegible] 97

NO LOAD [illegible]

TEMP	RES	VCO INPUT (TX-1)
-40F	18.55 KΩ	3.1 mV.
-30	13.[illegible] K	11.0
-20	10.33 K	19.6
-10	7808	29.4
0	5787	37.5
+10	46[illegible]	50.0
+20	3600	60.1
+30	2820	70.1
+35	2691	72.0
+40	2236	79.1
+50	1779	87.6
+60	1426	95.1

+35F 2504

PROVIDES [illegible] TEMP SPAN ON W.S. BODY [illegible]
OF THE [illegible] PASS TELEMETRY

YSI Thermistor Resistance Versus Temperature

PART NO.	44001	44002	44003	44004 44033	44005 44030	44007 44034	44006 44031	44008 44032	44011	44014	44015
Ω @ 25°C	100	300	1000	2252	3000	5000	10,000	30,000	100,000	300,000	1 MEG.
BODY	BLACK	BLACK	BLACK	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BLACK ORANGE	BROWN	BROWN	BROWN
END	BROWN	RED	ORANGE	YELLOW ORANGE	GREEN BLACK	VIOLET YELLOW	BLUE BROWN	GRAY RED	BROWN	YELLOW	GREEN
TEMP. °C	RESISTANCE Ω										
−80	11.73K	53.50K	229.0K	1660K	2211K	3685K	3558K				
79	10.97K	49.93K	213.1K	1518K	2022K	3371K	3296K				
78	10.30K	46.62K	198.5K	1390K	1851K	3085K	3055K				
77	9656	43.55K	184.9K	1273K	1696K	2827K	2833K				
76	9061	40.70K	172.4K	1167K	1555K	2592K	2629K				
75	8506	38.06K	160.8K	1071K	1426K	2378K	2440K				
74	7990	35.61K	150.0K	982.8K	1309K	2182K	2266K				
73	7509	33.33K	140.0K	902.7K	1202K	2005K	2106K				
72	7060	31.22K	130.8K	829.7K	1105K	1843K	1957K				
71	6642	29.75K	122.2K	763.1K	1016K	1695K	1821K				
−70	6251	27.42K	114.3K	702.3K	935.4K	1560K	1694K				
69	5886	25.71K	106.9K	646.7K	861.4K	1436K	1577K				
68	5545	24.12K	100.0K	595.9K	793.7K	1323K	1469K				
67	5227	22.65K	93.63K	549.4K	731.8K	1220K	1369K				
66	4929	21.27K	87.70K	506.9K	675.2K	1126K	1276K				
65	4650	19.98K	82.18K	467.9K	623.3K	1039K	1190K				
64	4389	18.78K	77.04K	432.2K	575.7K	959.9K	1111K				
63	4144	17.66K	72.25K	399.5K	532.1K	887.2K	1037K				
62	3915	16.62K	67.80K	369.4K	492.1K	820.5K	968.4K				
61	3700	15.64K	63.64K	341.8K	455.3K	759.2K	904.9K				
−60	3499	14.73K	59.77K	316.5K	421.5K	702.9K	845.9K				
59	3310	13.88K	56.16K	293.2K	390.5K	651.1K	791.1K				
58	3132	13.08K	52.78K	271.7K	361.9K	603.5K	740.2K				
57	2965	12.33K	49.63K	252.0K	335.7K	559.7K	692.8K				
56	2809	11.63K	46.69K	233.8K	311.5K	519.4K	648.8K				
55	2661	10.98K	43.94K	217.1K	289.2K	482.2K	607.8K				
54	2523	10.36K	41.37K	201.7K	268.6K	447.9K	569.6K				
53	2392	9785	38.97K	187.4K	249.7K	416.3K	534.1K				
52	2270	9245	36.72K	174.3K	232.2K	387.1K	501.0K				
51	2154	8738	34.62K	162.2K	216.0K	360.2K	470.1K				
−50	2045	8262	32.64K	151.0K	201.1K	335.3K	441.3K				
49	1942	7815	30.80K	140.6K	187.3K	312.3K	414.5K				
48	1846	7395	29.06K	131.0K	174.5K	291.0K	389.4K				
47	1754	7000	27.44K	122.1K	162.7K	271.3K	366.0K				
46	1668	6629	25.92K	113.9K	151.7K	253.0K	344.1K				
45	1587	6280	24.49K	106.3K	141.6K	236.2K	323.7K				
44	1510	5951	23.15K	99.26K	132.2K	220.5K	304.6K				
43	1438	5642	21.89K	92.72K	123.5K	205.9K	286.7K				
42	1369	5351	20.70K	86.65K	115.4K	192.5K	270.0K				
41	1304	5076	19.59K	81.02K	107.9K	180.0K	254.4K				
−40	1243	4818	18.55K	75.79K	101.0K	168.3K	239.8K	884.6K	3356K		
39	1185	4574	17.56K	70.93K	94.48K	157.5K	226.0K	830.9K	3147K		
38	1130	4344	16.64K	66.41K	88.46K	147.5K	213.2K	780.8K	2951K		
37	1078	4127	15.77K	62.21K	82.87K	138.2K	201.1K	733.9K	2769K		
36	1029	3922	14.94K	58.30K	77.66K	129.5K	189.8K	690.2K	2599K		
35	981.8	3729	14.17K	54.66K	72.81K	121.4K	179.2K	649.3K	2440K		
34	937.6	3546	13.44K	51.27K	68.30K	113.9K	169.3K	611.0K	2292K		
33	895.6	3374	12.76K	48.11K	64.09K	106.9K	160.0K	575.2K	2154K		
32	855.8	3211	12.11K	45.17K	60.17K	100.3K	151.2K	541.7K	2025K		
31	818.0	3057	11.50K	42.42K	56.51K	94.22K	143.0K	510.4K	1904K		
−30	782.1	2911	10.92K	39.86K	53.10K	88.53K	135.2K	481.0K	1791K		
29	748.1	2773	10.38K	37.47K	49.91K	83.22K	127.9K	453.5K	1685K		
28	715.7	2642	9866	35.24K	46.94K	78.26K	121.1K	427.7K	1586K		
27	685.0	2519	9381	33.15K	44.16K	73.62K	114.6K	403.5K	1494K		
26	655.7	2402	8922	31.20K	41.56K	69.29K	108.6K	380.9K	1407K		
25	627.9	2291	8489	29.38K	39.13K	65.24K	102.9K	359.6K	1326K		
24	601.5	2185	8079	27.67K	36.86K	61.45K	97.49K	339.6K	1250K		
23	576.4	2086	7692	26.07K	34.73K	57.90K	92.43K	320.9K	1178K		
22	552.4	1991	7325	24.58K	32.74K	54.58K	87.66K	303.3K	1111K		
21	529.6	1901	6978	23.18K	30.87K	51.47K	83.16K	286.7K	1049K		
−20	507.9	1816	6649	21.87K	29.13K	48.56K	78.91K	271.2K	989.8K		
19	487.3	1736	6338	20.64K	27.49K	45.83K	74.91K	256.5K	934.6K		
18	467.6	1659	6043	19.48K	25.95K	43.27K	71.13K	242.8K	882.7K		
17	448.8	1586	5764	18.40K	24.51K	40.86K	67.57K	229.8K	834.0K		
16	430.9	1517	5499	17.39K	23.16K	38.61K	64.20K	217.6K	788.2K		
15	413.8	1451	5248	16.43K	21.89K	36.49K	61.02K	206.2K	745.2K		
14	397.5	1388	5009	15.54K	20.70K	34.50K	58.01K	195.4K	704.7K		
13	382.0	1329	4783	14.70K	19.58K	32.63K	55.17K	185.2K	666.7K		
12	367.1	1272	4569	13.91K	18.52K	30.88K	52.48K	175.6K	630.9K		
11	352.9	1218	4365	13.16K	17.53K	29.23K	49.94K	166.6K	597.2K		
−10	339.4	1167	4172	12.46K	16.60K	27.67K	47.54K	158.0K	565.5K		
9	326.5	1118	3988	11.81K	15.72K	26.21K	45.27K	150.0K	535.6K		
8	314.1	1072	3813	11.19K	14.90K	24.83K	43.11K	142.4K	507.5K		
7	302.3	1028	3647	10.60K	14.12K	23.54K	41.07K	135.2K	481.0K		
6	291.0	985.5	3489	10.05K	13.39K	22.32K	39.14K	128.5K	456.0K		
5	280.2	945.3	3339	9534	12.70K	21.17K	37.31K	122.1K	432.4K		
4	269.8	907.0	3196	9046	12.05K	20.08K	35.57K	116.0K	410.2K		
3	259.9	870.4	3061	8586	11.44K	19.06K	33.93K	110.3K	389.2K		
2	250.5	835.5	2931	8151	10.86K	18.10K	32.37K	104.9K	369.4K		
−1	241.4	802.3	2808	7741	10.31K	17.19K	30.89K	99.80K	350.7K		
0	232.7	770.5	2691	7355	9796	16.33K	29.49K	94.98K	333.1K	1088K	3966K
+1	224.4	739.9	2579	6989	9310	15.52K	28.15K	90.41K	316.4K	1030K	3740K
2	216.4	710.7	2472	6644	8851	14.75K	26.89K	86.09K	300.6K	975.3K	3529K
3	208.7	682.8	2370	6319	8417	14.03K	25.69K	81.99K	285.7K	923.8K	3330K
4	201.4	656.2	2273	6011	8006	13.34K	24.55K	78.11K	271.6K	875.2K	3144K
5	194.3	630.8	2181	5719	7618	12.70K	23.46K	74.44K	258.3K	829.5K	2969K
6	187.6	606.4	2093	5444	7252	12.09K	22.43K	70.96K	245.7K	786.3A	2804K
7	181.1	583.2	2009	5183	6905	11.51K	21.45K	67.66K	233.8K	745.6K	2649K
8	174.9	561.0	1928	4937	6576	10.96K	20.52K	64.53K	222.5K	707.2K	2504K
9	169.0	539.8	1852	4703	6265	10.44K	19.63K	61.56K	211.9K	671.0K	2367K
+10	163.3	519.4	1779	4482	5971	9951	18.79K	58.75K	201.7K	636.8K	2238K
11	157.8	500.0	1709	4273	5692	9486	17.98K	56.07K	192.2K	604.5K	2117K
12	152.5	481.4	1642	4074	5427	9046	17.22K	53.54K	183.1K	574.0K	2003K
13	147.4	463.6	1578	3886	5177	8628	16.49K	51.13K	174.5K	545.2K	1896K
14	142.6	446.6	1518	3708	4939	8232	15.79K	48.84K	166.3K	518.0K	1795K
15	137.9	430.2	1459	3539	4714	7857	15.13K	46.67K	158.6K	492.3K	1700K
16	133.4	414.6	1404	3378	4500	7500	14.50K	44.60K	151.3K	468.0K	1610K
17	129.1	399.6	1351	3226	4297	7162	13.90K	42.64K	144.3K	444.9K	1525K
18	125.0	385.3	1300	3081	4105	6841	13.33K	40.77K	137.7K	423.2K	1446K
19	121.0	371.5	1251	2944	3922	6536	12.79K	38.99K	131.4K	402.6K	1370K
+20	117.1	358.3	1204	2814	3748	6247	12.26K	37.30K	125.5K	383.1K	1299K
21	113.4	345.6	1160	2690	3583	5972	11.77K	35.70K	119.8K	364.6K	1232K
22	109.9	333.5	1117	2572	3426	5710	11.29K	34.17K	114.5K	347.1K	1169K
23	106.4	321.9	1076	2460	3277	5462	10.84K	32.71K	109.4K	330.6K	1110K
24	103.1	310.7	1037	2354	3135	5225	10.41K	31.32K	104.5K	314.9K	1053K
25	100.0	300.0	1000	2252	3000	5000	10.00K	30.00K	100.0K	300.0K	1000K
26	96.9	289.7	963.4	2156	2872	4787	9605	28.74K	95.51K	285.9K	949.7K
27	94.0	279.8	928.9	2064	2750	4583	9227	27.54K	91.34K	272.5K	902.2K
28	91.1	270.3	895.9	1977	2633	4389	8867	26.40K	87.38K	259.8K	857.2K
29	88.4	261.1	864.1	1894	2523	4204	8523	25.31K	83.60K	247.8K	814.7K
+30	85.7	252.4	833.7	1815	2417	4029	8194	24.27K	80.00K	236.4K	774.5K
31	83.2	244.0	804.5	1739	2317	3861	7880	23.28K	76.58K	225.6K	736.5K
32	80.7	235.9	776.5	1667	2221	3702	7579	22.33K	73.32K	215.3K	700.5K
33	78.4	228.1	749.6	1599	2130	3549	7291	21.43K	70.22K	205.5K	666.4K
34	76.1	220.6	723.8	1533	2042	3404	7016	20.57K	67.26K	196.2K	634.1K
35	73.9	213.4	699.0	1471	1959	3266	6752	19.74K	64.44K	187.4K	603.6K
36	71.7	206.5	675.2	1412	1880	3134	6500	18.96K	61.75K	179.0K	574.6K
37	69.7	199.8	652.4	1355	1805	3008	6258	18.21K	59.19K	171.0K	547.2K
38	67.7	193.4	630.4	1301	1733	2888	6026	17.49K	56.75K	163.5K	521.2K
+39	65.8	187.2	609.3	1249	1664	2773	5805	16.80K	54.42K	156.3K	496.6K

MINCO PRODUCTS, INC.

TEMPERATURE CONVERSION CHART

°F	Reading in °F. or °C. to be converted	°C
....	-458	-272.22
....	-456	-271.11
....	-454	-270.00
....	-452	-268.89
....	-450	-267.78
....	-448	-266.67
....	-446	-265.56
....	-444	-264.44
....	-442	-263.33
....	-440	-262.22
....	-438	-261.11
....	-436	-260.00
....	-434	-258.89
....	-432	-257.78
....	-430	-256.67
....	-428	-255.56
....	-426	-254.44
....	-424	-253.33
....	-422	-252.22
....	-420	-251.11
....	-418	-250.00
....	-416	-248.89
....	-414	-247.78
....	-412	-246.67
....	-410	-245.56
....	-408	-244.44
....	-406	-243.33
....	-404	-242.22
....	-402	-241.11
....	-400	-240.00
....	-398	-238.89
....	-396	-237.78
....	-394	-236.67
....	-392	-235.56
....	-390	-234.44
....	-388	-233.33
....	-386	-232.22
....	-384	-231.11
....	-382	-230.00
....	-380	-228.89
....	-378	-227.78
....	-376	-226.67
....	-374	-225.56
....	-372	-224.44
....	-370	-223.33
....	-368	-222.22
....	-366	-221.11
....	-364	-220.00
....	-362	-218.89
....	-360	-217.78

°F.	Reading in °F. or °C. to be converted	°C.
....	-358	-216.67
....	-356	-215.56
....	-354	-214.44
....	-352	-213.33
....	-350	-212.22
....	-348	-211.11
....	-346	-210.00
....	-344	-208.89
....	-342	-207.78
....	-340	-206.67
....	-338	-205.56
....	-336	-204.44
....	-334	-203.33
....	-332	-202.22
....	-330	-201.11
....	-328	-200.00
....	-326	-198.89
....	-324	-197.78
....	-322	-196.67
....	-320	-195.56
....	-318	-194.44
....	-316	-193.33
....	-314	-192.22
....	-312	-191.11
....	-310	-190.00
....	-308	-188.89
....	-306	-187.78
....	-304	-186.67
....	-302	-185.56
....	-300	-184.44
....	-298	-183.33
....	-296	-182.22
....	-294	-181.11
....	-292	-180.00
....	-290	-178.89
....	-288	-177.78
....	-286	-176.67
....	-284	-175.56
....	-282	-174.44
....	-280	-173.33
....	-278	-172.22
....	-276	-171.11
....	-274	-170.00
-457.6	-272	-168.89
-454.0	-270	-167.78
-450.4	-268	-166.67
-446.8	-266	-165.56
-443.2	-264	-164.44
-439.6	-262	-163.33
-436.0	-260	-162.22

°F.	Reading in °F. or °C. to be converted	°C.
-432.4	-258	-161.11
-428.8	-256	-160.00
-425.2	-254	-158.89
-421.6	-252	-157.78
-418.0	-250	-156.67
-414.4	-248	-155.56
-410.8	-246	-154.44
-407.2	-244	-153.33
-403.6	-242	-152.22
-400.0	-240	-151.11
-396.4	-238	-150.00
-392.8	-236	-148.89
-389.2	-234	-147.78
-385.6	-232	-146.67
-382.0	-230	-145.56
-378.4	-228	-144.44
-374.8	-226	-143.33
-371.2	-224	-142.22
-367.6	-222	-141.11
-364.0	-220	-140.00
-360.4	-218	-138.89
-356.8	-216	-137.78
-353.2	-214	-136.67
-349.6	-212	-135.56
-346.0	-210	-134.44
-342.4	-208	-133.33
-338.8	-206	-132.22
-335.2	-204	-131.11
-331.6	-202	-130.00
-328.0	-200	-128.89
-324.4	-198	-127.78
-320.8	-196	-126.67
-317.2	-194	-125.56
-313.6	-192	-124.44
-310.0	-190	-123.33
-306.4	-188	-122.22
-302.8	-186	-121.11
-299.2	-184	-120.00
-295.6	-182	-118.89
-292.0	-180	-117.78
-288.4	-178	-116.67
-284.8	-176	-115.56
-281.2	-174	-114.44
-277.6	-172	-113.33
-274.0	-170	-112.22
-270.4	-168	-111.11
-266.8	-166	-110.00
-263.2	-164	-108.89
-259.6	-162	-107.78
-256.0	-160	-106.67
-252.4	-158	-105.56
-248.8	-156	-104.44
-245.2	-154	-103.33
-241.6	-152	-102.22
-238.0	-150	-101.11
-234.4	-148	-100.00
-230.8	-146	-98.89
-227.2	-144	-97.78
-223.6	-142	-96.67
-220.0	-140	-95.56

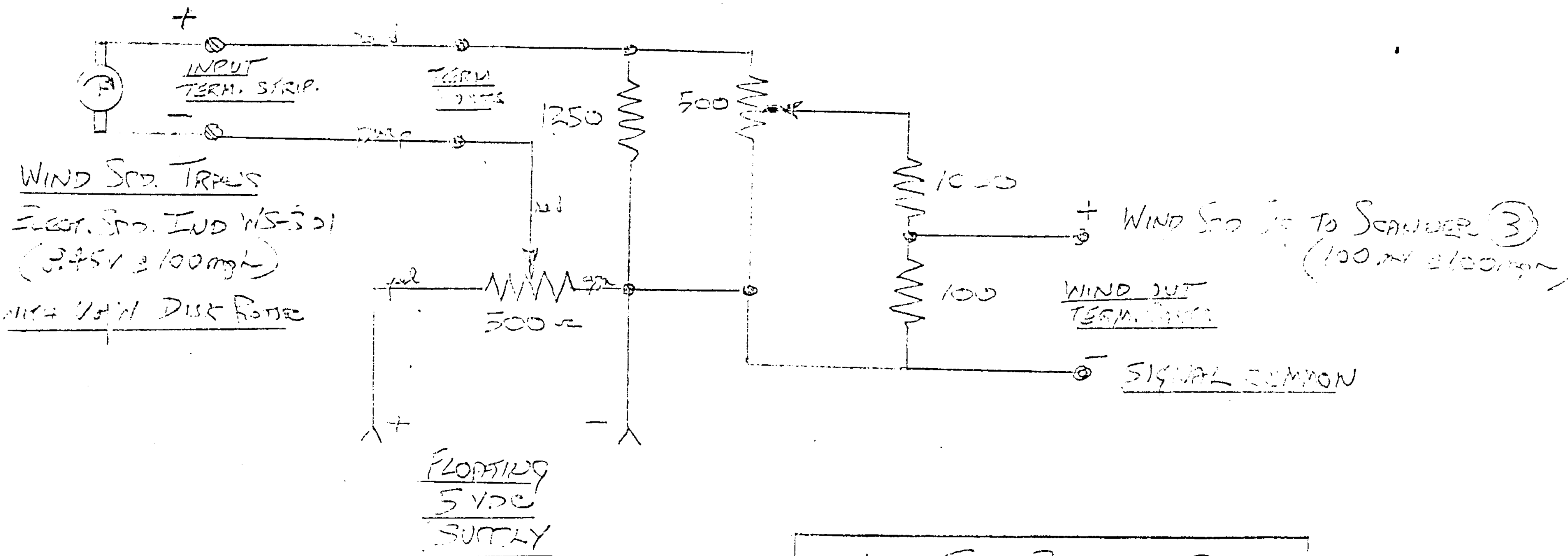
°F.	Reading in °F. or °C. to be converted	°C.
-216.4	-138	-94.44
-212.8	-136	-93.33
-209.2	-134	-92.22
-205.6	-132	-91.11
-202.0	-130	-90.00
-198.4	-128	-88.89
-194.8	-126	-87.78
-191.2	-124	-86.67
-187.6	-122	-85.56
-184.0	-120	-84.44
-180.4	-118	-83.33
-176.8	-116	-82.22
-173.2	-114	-81.11
-169.6	-112	-80.00
-166.0	-110	-78.89
-162.4	-108	-77.78
-158.8	-106	-76.67
-155.2	-104	-75.56
-151.6	-102	-74.44
-148.0	-100	-73.33
-144.4	-98	-72.22
-140.8	-96	-71.11
-137.2	-94	-70.00
-133.6	-92	-68.89
-130.0	-90	-67.78
-126.4	-88	-66.67
-122.8	-86	-65.56
-119.2	-84	-64.44
-115.6	-82	-63.33
-112.0	-80	-62.22
-108.4	-78	-61.11
-104.8	-76	-60.00
-101.2	-74	-58.89
-97.6	-72	-57.78
-94.0	-70	-56.67
-90.4	-68	-55.56
-86.8	-66	-54.44
-83.2	-64	-53.33
-79.6	-62	-52.22
-76.0	-60	-51.11
-72.4	-58	-50.00
-68.8	-56	-48.89
-65.2	-54	-47.78
-61.6	-52	-46.67
-58.0	-50	-45.56
-54.4	-48	-44.44
-50.8	-46	-43.33
-47.2	-44	-42.22
-43.6	-42	-41.11
-40.0	-40	-40.00
-36.4	-38	-38.89
-32.8	-36	-37.78
-29.2	-34	-36.67
-25.6	-32	-35.56
-22.0	-30	-34.44
-18.4	-28	-33.33
-14.8	-26	-32.22
-11.2	-24	-31.11
-7.6	-22	-30.00
-4.0	-20	-28.89

°F	Reading in °F. or °C. to be converted	°C.
-0.4	-18	-27.78
+3.2	-16	-26.67
+6.8	-14	-25.56
+10.4	-12	-24.44
+14.0	-10	-23.33
+17.6	-8	-22.22
+19.4	-7	-21.67
+21.2	-6	-21.11
+23.0	-5	-20.56
+24.8	-4	-20.00
+26.6	-3	-19.44
+28.4	-2	-18.89
+30.2	-1	-18.33
+32.0	±0	-17.78
+33.8	+1	-17.22
+35.6	+2	-16.67
+37.4	+3	-16.11
+39.2	+4	-15.56
+41.0	+5	-15.00
+42.8	+6	-14.44
+44.6	+7	-13.89
+46.4	+8	-13.33
+48.2	+9	-12.78
+50.0	+10	-12.22
+51.8	+11	-11.67
+53.6	+12	-11.11
+55.4	+13	-10.56
+57.2	+14	-10.00
+59.0	+15	-9.44
+60.8	+16	-8.89
+62.6	+17	-8.33
+64.4	+18	-7.78
+66.2	+19	-7.22
+68.0	+20	-6.67
+69.8	+21	-6.11
+71.6	+22	-5.56
+73.4	+23	-5.00
+75.2	+24	-4.44
+77.0	+25	-3.89
+78.8	+26	-3.33
+80.6	+27	-2.78
+82.4	+28	-2.22
+84.2	+29	-1.67
+86.0	+30	-1.11
+87.8	+31	-0.56
+89.6	+32	±0.00
+91.4	+33	+0.56
+93.2	+34	+1.11
+95.0	+35	+1.67
+96.8	+36	+2.22
+98.6	+37	+2.78
+100.4	+38	+3.33
+102.2	+39	+3.89
+104.0	+40	+4.44
+105.8	+41	+5.00
+107.6	+42	+5.56
+109.4	+43	+6.11
+111.2	+44	+6.67
+113.0	+45	+7.22
+114.8	+46	+7.78

°F.	Reading in °F. or °C. to be converted	°C.
+116.6	+47	+8.33
+118.4	+48	+8.89
+120.2	+49	+9.44
+122.0	+50	+10.00
+123.8	+51	+10.56
+125.6	+52	+11.11
+127.4	+53	+11.67
+129.2	+54	+12.22
+131.0	+55	+12.78
+132.8	+56	+13.33
+134.6	+57	+13.89
+136.4	+58	+14.44
+138.2	+59	+15.00
+140.0	+60	+15.56
+141.8	+61	+16.11
+143.6	+62	+16.67
+145.4	+63	+17.22
+147.2	+64	+17.78
+149.0	+65	+18.33
+150.8	+66	+18.89
+152.6	+67	+19.44
+154.4	+68	+20.00
+156.2	+69	+20.56
+158.0	+70	+21.11
+159.8	+71	+21.67
+161.6	+72	+22.22
+163.4	+73	+22.78
+165.2	+74	+23.33
+167.0	+75	+23.89
+168.8	+76	+24.44
+170.6	+77	+25.00
+172.4	+78	+25.56
+174.2	+79	+26.11
+176.0	+80	+26.67
+177.8	+81	+27.22
+179.6	+82	+27.78
+181.4	+83	+28.33
+183.2	+84	+28.89
+185.0	+85	+29.44
+186.8	+86	+30.00
+188.6	+87	+30.56
+190.4	+88	+31.11
+192.2	+89	+31.67
+194.0	+90	+32.22
+195.8	+91	+32.78
+197.6	+92	+33.33
+199.4	+93	+33.89
+201.2	+94	+34.44
+203.0	+95	+35.00
+204.8	+96	+35.56
+206.6	+97	+36.11
+208.4	+98	+36.67
+210.2	+99	+37.22
+212.0	+100	+37.78
+213.8	+101	+38.33
+215.6	+102	+38.89
+217.4	+103	+39.44
+219.2	+104	+40.00
+221.0	+105	+40.56
+222.8	+106	+41.11

°F.	Reading in °F. or °C. to be converted	°C.
+224.6	+107	+41.67
+226.4	+108	+42.22
+228.2	+109	+42.78
+230.0	+110	+43.33
+231.8	+111	+43.89
+233.6	+112	+44.44
+235.4	+113	+45.00
+237.2	+114	+45.56
+239.0	+115	+46.11
+240.8	+116	+46.67
+242.6	+117	+47.22
+244.4	+118	+47.78
+246.2	+119	+48.33
+248.0	+120	+48.89
+249.8	+121	+49.44
+251.6	+122	+50.00
+253.4	+123	+50.56
+255.2	+124	+51.11
+257.0	+125	+51.67
+258.8	+126	+52.22
+260.6	+127	+52.78
+262.4	+128	+53.33
+264.2	+129	+53.89
+266.0	+130	+54.44
+267.8	+131	+55.00
+269.6	+132	+55.56
+271.4	+133	+56.11
+273.2	+134	+56.67
+275.0	+135	+57.22
+276.8	+136	+57.78
+278.6	+137	+58.33
+280.4	+138	+58.89
+282.2	+139	+59.44
+284.0	+140	+60.00
+285.8	+141	+60.56
+287.6	+142	+61.11
+289.4	+143	+61.67
+291.2	+144	+62.22
+293.0	+145	+62.78
+294.8	+146	+63.33
+296.6	+147	+63.89
+298.4	+148	+64.44
+300.2	+149	+65.00
+302.0	+150	+65.56
+303.8	+151	+66.11
+305.6	+152	+66.67
+307.4	+153	+67.22
+309.2	+154	+67.78
+311.0	+155	+68.33
+312.8	+156	+68.89
+314.6	+157	+69.44
+316.4	+158	+70.00
+318.2	+159	+70.56
+320.0	+160	+71.11
+321.8	+161	+71.67
+323.6	+162	+72.22
+325.4	+163	+72.78
+327.2	+164	+73.33
+329.0	+165	+73.89
+330.8	+166	+74.44

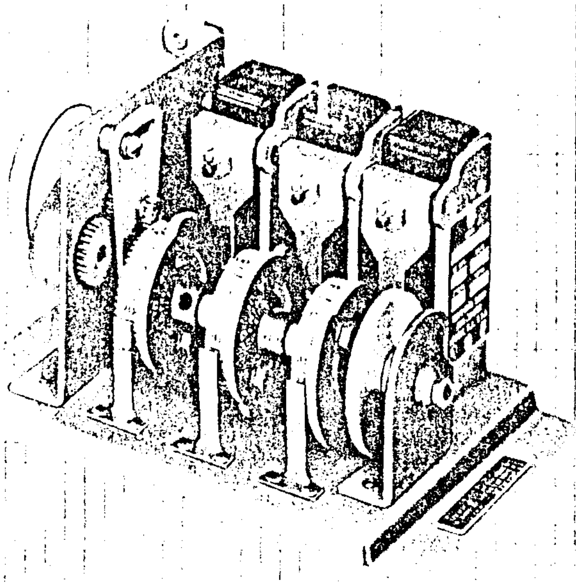
°F	Reading in °F. or °C. to be converted	°C.
+332.6	+167	+75.00
+334.4	+168	+75.56
+336.2	+169	+76.11
+338.0	+170	+76.67
+339.8	+171	+77.22
+341.6	+172	+77.78
+343.4	+173	+78.33
+345.2	+174	+78.89
+347.0	+175	+79.44
+348.8	+176	+80.00
+350.6	+177	+80.56
+352.4	+178	+81.11
+354.2	+179	+81.67
+356.0	+180	+82.22
+357.8	+181	+82.78
+359.6	+182	+83.33
+361.4	+183	+83.89
+363.2	+184	+84.44
+365.0	+185	+85.00
+366.8	+186	+85.56
+368.6	+187	+86.11
+370.4	+188	+86.67
+372.2	+189	+87.22
+374.0	+190	+87.78
+375.8	+191	+88.33
+377.6	+192	+88.89
+379.4	+193	+89.44
+381.2	+194	+90.00
+383.0	+195	+90.56
+384.8	+196	+91.11
+386.6	+197	+91.67
+388.4	+198	+92.22
+390.2	+199	+92.78
+392.0	+200	+93.33
+393.8	+201	+93.89
+395.6	+202	+94.44
+397.4	+203	+95.00
+399.2	+204	+95.56
+401.0	+205	+96.11
+402.8	+206	+96.67
+404.6	+207	+97.22
+406.4	+208	+97.78
+408.2	+209	+98.33
+410.0	+210	+98.89
+411.8	+211	+99.44
+413.6	+212	+100.00
+415.4	+213	+100.56
+417.2	+214	+101.11
+419.0	+215	+101.67
+420.8	+216	+102.22
+422.6	+217	+102.78
+424.4	+218	+103.33
+426.2	+219	+103.89
+428.0	+220	+104.44
+431.6	+222	+105.56
+435.2	+224	+106.67
+438.8	+226	+107.78
+442.4	+228	+108.89
+446.0	+230	+110.00
+449.6	+232	+111.11



WIND SPD SENSOR CKT.

SAME AT STEVENS PASS TELEMETRY

220



OPERATING INSTRUCTIONS

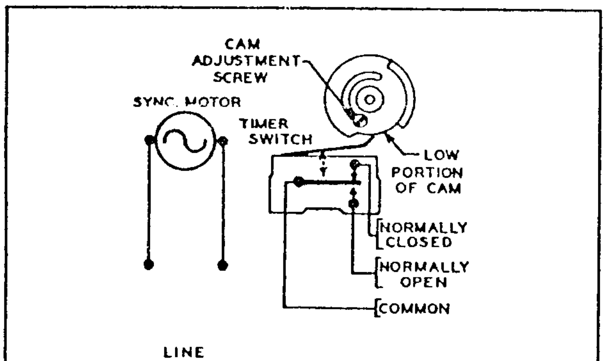
Series CM, MC, RA & RC

PROGRAMMING CAM TIMERS

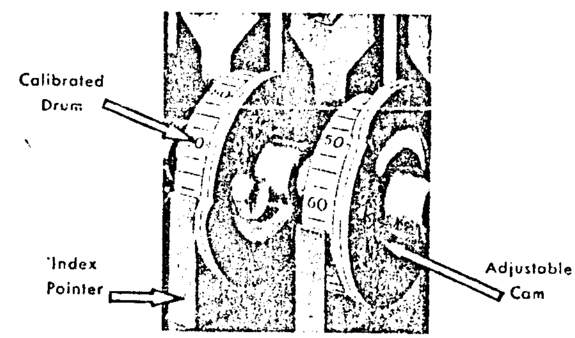
for

Catalog Bulletin #206

The switches used on the Cam Timer Series are Snap Action, Single Pole Double Throw totally enclosed micro switches, each switch is marked Normally Open (N.O.), Normally Closed (N.C.) and Common (C). These markings designate the condition of the switch in relation to the low or detent portion of the cam. A circuit is completed between the Common and the Normally Closed contact of the switch when actuator arm is in detent. Therefore, by setting the cam opening at 10%, the contacts will be closed for 10% and opened for 90% of the total time cycle. By wiring the switch to either N.O. or N.C. the load "on time" can be adjusted for a total of 2% to 98% of the total overall time cycle.



WIRING DIAGRAM ONE OR MORE CAMS



The cam opening may be adjusted by loosening the cam screw and turning the movable cam to the required degree of opening and then re-tightening the screw.

Refer to Catalog Bulletin #206 for gear rack chart and dimensions.

INDUSTRIAL TIMER
A UNIT OF ESTERLINE CORPORATION

INDUSTRIAL TIMER CORPORATION U.S. HIGHWAY 287 PARSIPPANY, N. J. 07054

TIMING SEQUENCE...MC & RC
(Multi-cam Types)

Each cam is individually mounted on the main shaft by means of a heavy duty friction which allows for easy finger adjustment of the timing sequence. The cams also incorporate a drum calibrated from 0% to 100%. Facing each calibrated drum is an index pointer for the cam sequencing.

1. Set first cam at zero on drum using index pointer as a guide.

2. Calculate the percentage of time difference when cam #2, 3, etc. should be operated. For example, if the overall time cycle is 60 seconds, the first cam is set at zero; if the next operation is to be started 15 seconds later, or 25% of the total overall time cycle, the second drum is set at 25%, against its index pointer. If the third operation is 15 seconds later, the third cam will be set at 50%, etc., additional cams are set in a like manner.

The knurled disc at the end of the camshaft should be held to prevent movement of the shaft while setting the sequence of individual cams. It may also be used to rotate the entire shaft for checking out program set-up, prior to timer operation.

CHANGING TIME CYCLE

1. Gear racks are interchanged by removing the gear rack screw. To prevent binding of gears when installing another gear rack, be certain there is a good amount of gear play. NOTE: the number and letter are stamped on the gear rack and should always face the cam shaft.

2. Additional gear rack assemblies for changing overall time cycles are listed in catalog gear rack chart.

ELECTRICAL CHARACTERISTICS

1. Cam Timers rated for 115 volt operation will operate within a range of 100 to 130 volts A.C.

2. 220 volt units will operate within a range of 205 to 240 volts A.C.

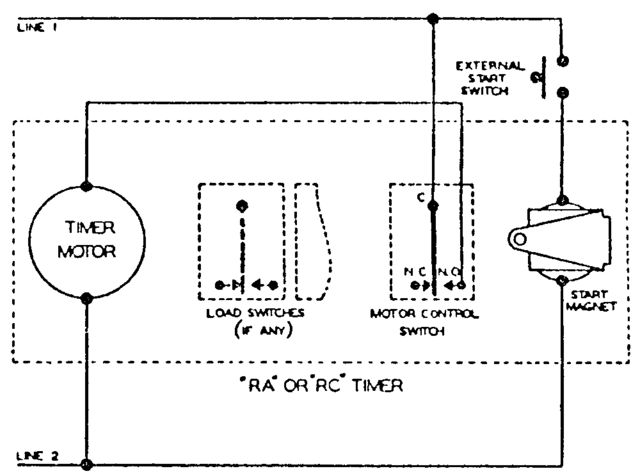
3. Switch rating 10 amps.

RA AND RC INSTRUCTIONS
For motor control switch and start magnet

Wire motor control switch as shown at right. Start timer by energizing the start magnet which, in turn, mechanically operates the switch.

For single cycle operation, energize the start magnet for a period which is less than the time required for the timer to complete a full cycle.

For continuous recycling the start magnet may be energized for any period of time. When released, the timer will run to the "O" position and stop.



Refer to Catalog Bulletin #206 for gear rack chart and dimensions.

programming cam timers concluded

☐ gear rack chart

MODEL	RA 0	RA 1	RA 2	RA 3	RA 4	RA 5	RA 6	RA 7	RA 8	RA 9	RA 10	RA 11	RA 12
MODEL	CM 0	CM 1	CM 2	CM 3	CM 4	CM 5	CM 6	CM 7	CM 8	CM 9	CM 10	CM 11	CM 12
MODEL	MC 0	MC 1	MC 2	MC 3	MC 4	MC 5	MC 6	MC 7	MC 8	MC 9	MC 10	MC 11	MC 12
MODEL	RC 0	RC 1	RC 2	RC 3	RC 4	RC 5	RC 6	RC 7	RC 8	RC 9	RC 10	RC 11	RC 12
GEAR RACKS	SEE NOTE 2*												
E-12	40c	4 sec	10 sec	20s	40s	2m	3m20s	10m	20m	40m	2h	3h20m	8h
E-14	46.7c	4.67s	11.67s	23.33s	46.67s	2m20s	3m53s	11m40s	23m20s	46m40s	2h20s	3h53m	9h20m
D-12	48c	4.8s	12s	24s	48s	2m24s	4m	12m	24m	48m	2h24m	4h	9h36m
E-15	50c	5 sec	12.5s	25s	50s	2m30s	4m10s	12m30s	25m	50m	2h30m	4h10m	10h
E-16	53.3c	5.33s	13.33s	26.67s	53.3s	2m40s	4m27s	13m20s	26m40s	53m20s	2h40m	4h27m	10h40m
D-14	56c	5.6s	14s	28s	56s	2m48s	4m40s	14m	28m	56m	2h48m	4h40m	11h12m
C-12	1 sec	6 sec	15s	30s	60s	3m	5m	15m	30m	60m	3h	5h	12h
D-16	64c	6.4s	16s	32s	64s	3m12s	5m20s	16m	32m	64m	3h12m	5h20m	12h48m
E-20	66.7c	6.67s	16.67s	33.33s	66.67s	3m20s	5m33s	16m40s	33m20s	66m40s	3h20m	5h33m	13h20m
C-14	70c	7s	17.5s	35s	70s	3m30s	5m50s	17m30s	35m	70m	3h30m	5h50m	14h
D-18	72c	7.2s	18s	36s	72s	3m36s	6m	18m	36m	72m	3h36m	6h	14h24m
E-22	73.3c	7.33s	18.33s	36.67s	73.33s	3m40s	6m7s	18m20s	36m40s	73m20s	3h40m	6h7m	14h40m
C-15	75c	7.5s	18.75s	37.5s	75s	3m45s	6m15s	18m45s	37m30s	75m	3h45m	6h15m	15h
B-12	80c	8 sec	20s	40s	80s	4m	6m40s	20m	40m	80m	4h	6h40m	16h
E-26	86.7c	8.67s	21.67s	43.33s	86.67s	4m20s	7m13s	21m40s	43m20s	86m40s	4h20m	7h13m	17h20m
D-22	88c	8.8s	22s	44s	88s	4m24s	7m20s	22m	44m	88m	4h24m	7h20m	17h36m
C-18	90c	9 sec	22.5s	45s	90s	4m30s	7m30s	22m30s	45m	90m	4h30m	7h30m	18h
B-14	93.3c	9.33s	23.33s	46.67s	93.33s	4m40s	7m47s	23m20s	46m40s	93m20s	4h40m	7h47m	18h40m
D-24	96c	9.6s	24s	48s	96s	4m48s	8m	24m	48m	96m	4h48m	8h	19h12m
B-15	100c	10 sec	25s	50s	100s	5m	8m20s	25m	50m	100m	5h	8h20m	20h
D-26	104c	10.4s	26s	52s	104s	5m12s	8m40s	26m	52m	104m	5h12m	8h40m	20h48m
B-16	106.7c	10.67s	26.67s	53.33s	106.7s	5m20s	8m54s	26m40s	53m20s	106m40s	5h20m	8h54m	21h20m
C-22	110c	11 sec	27.5s	55s	100s	5m30s	9m10s	27m30s	55m	110m	5h30m	9h10m	22h
D-28	112c	11.2s	28s	56s	112s	5m36s	9m20s	28m	56m	112m	5h36m	9h20m	22h24m
E-34	113.3c	11.33s	28.33s	56.67s	113.3s	5m40s	9m27s	28m20s	56m40s	113m20s	5h40m	9h27m	22h40m
A-12	2 sec	12 sec	30s	60s	2m	6m	10m	30m	60m	2h	6h	10h	24h
D-32	2s8c	12.78s	32s	64s	128s	6m24s	10m40s	32m	64m	2h8m	6h24m	10h40m	25h36m
C-26	2s10c	13 sec	32.5s	65s	130s	6m30s	10m50s	32m30s	65m	2h10m	6h30m	10h50m	26h
B-20	2s12c	13.2s	33.33s	66.67s	133.3s	6m40s	11m7s	33m20s	66m40s	2h13m	6h40m	11h7m	26h40m
D-34	2s16c	13.56s	34s	68s	136s	6m48s	11m20s	34m	68m	2h16m	6h48m	11h20m	27h12m
A-14	2s20c	14 sec	35s	70s	140s	7m	11m40s	35m	70m	2h20m	7h	11h40m	28h
D-36	2s24c	14.4s	36s	72s	144s	7m12s	12m	36m	72m	2h24m	7h12m	12h	28h48m
B-22	2s27c	14.7s	36.67s	73.33s	146.7s	7m20s	12m13s	36m40s	73m20s	2h27m	7h20m	12h13m	29h20m
A-15	2s30c	15 sec	37.5s	75s	150s	7m30s	12m30s	37m30s	75m	2h30m	7h30m	12h30m	30h
A-16	2s40c	16 sec	40s	80s	160s	8m	13m20s	40m	80m	2h40m	8h	13h20m	32h
C-34	2s50c	17 sec	42.5s	85s	170s	8m30s	14m10s	42m30s	85m	2h50m	8h30m	14h10m	34h
B-26	2s52c	17.2s	43.33s	86.67s	173.3s	8m40s	14m27s	43m20s	86m40s	2h53m	8h40m	14h27m	34h40m
A-18	3 sec	18 sec	45s	90s	3m	9m	15m	45m	90m	3h	9h	15h	36h
B-28	3s7c	18.7s	46.67s	93.33s	186.7s	9m20s	15m33s	46m40s	93m20s	3h7m	9h20m	15h33m	37h20m
A-20	3s20c	20 sec	50s	100s	200s	10m	16m40s	50m	100m	3h20m	10h	16h40m	40h
B-32	3s33c	21.3s	53.33s	106.7s	213.4s	10m40s	17m47s	53m20s	106m40s	3h33m	10h40m	17h47m	42h40m
A-22	3s40c	22 sec	55s	110s	220s	11m	18m20s	55m	110m	3h40m	11h	18h20m	44h
B-34	3s47c	22.7s	56.67s	113.3s	226.7s	11m20s	18m53s	56m40s	113m20s	3h47m	11h20m	18h54m	45h20m
A-24	4 sec	24 sec	60s	2m	4m	12m	20m	60m	2h	4h	12h	20h	48h
A-26	4s20c	26 sec	65s	130s	260s	13m	21m40s	65m	2h10m	4h20m	13h	21h40m	52h
A-28	4s40c	28 sec	70s	140s	280s	14m	23m20s	70m	2h20m	4h40m	14h	23h20m	56h
A-30	5 sec	30 sec	75s	150s	5m	15m	25m	75m	2h30m	5h	15h	25h	60h
A-32	5s20c	32 sec	80s	160s	320s	16m	26m40s	80m	2h40m	5h20m	16h	26h40m	64h
A-34	5s40c	34 sec	85s	170s	340s	17m	28m20s	85m	2h50m	5h40m	17h	28h20m	68h
A-36	6 sec	36 sec	90s	3m	6m	18m	30m	90m	3h	6h	18h	30h	72h

c-cycles s-seconds m-minutes h-hours

1. ORDERING INFORMATION--Model number selected from top of gear rack chart, gear rack, number of load switches, voltage and frequency.

ALTERNATE ORDERING INFORMATION—Required time cycle (one complete rotation of cam shaft), number of load switches, voltage and frequency. Since some time cycles are available in 3 model numbers, the use of the ALTERNATIVE ordering information may expedite delivery by allowing us to ship model in stock with required time cycle.

Multi-switch cam timers requiring time cycles in shaded area may require high torque timing motor. This is due to increased torque encountered in rapid time cycles. To determine need of larger motor; multiply required time cycle in seconds by 2/3, the answer will be the maximum number of switches that can be operated with a standard timing motor. EXAMPLE: Time cycle 15 seconds. 2/3 x 15s = 10. 10 switches can be operated at 15 seconds with a standard timing motor, more than 10 load switches requires the use of a high torque timing motor.

Price added for Hi-Torque motors:

Series	Motor Speed	120/60 Hz
MC-0 RC-0	1 RPS	$45.00
MC-1 RC-1	1/6 RPS	45.00

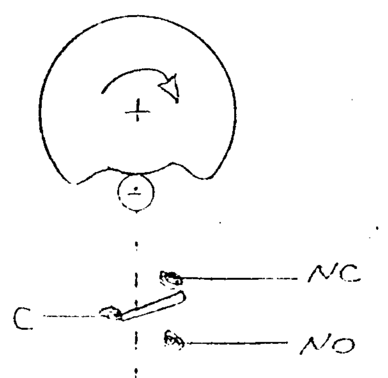
NOTES ON SEQUENCE CAMS

(REFER TO INDUSTRIAL TIMER OPERATING INSTRUCTIONS FOR PROGRAMMING TYPE RC CAM TIMERS)

- CYCLE TIME DEPENDS ON GEAR RACK

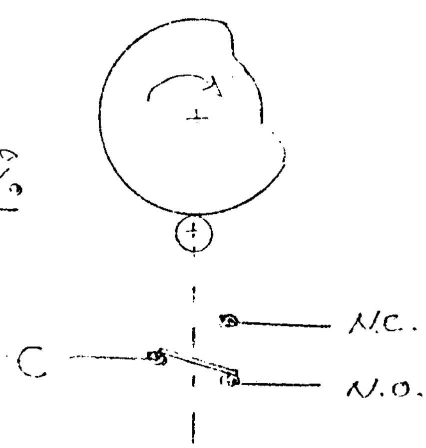
- IF AN ON TIME OF LESS THAN 50% OF THE CYCLE TIME IS DESIRED, USE THE N.O. CONTACT:

ON < 50%



- IF AN ON TIME OF MORE THAN 50% IS DESIRED, USE THE N.O. CONTACT:

ON > 50%



SEE INSTRUCTION SHEET FOR SETTING AND INDEXING CAMS

Bp: Al Smith Co.

CARITRONICS INC.

Oct 97

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Encapsulated Power Supplies

FEATURES:

- LOW COST
- RUGGED ENCAPSULATION
- SHORT CIRCUIT PROTECTION

SPECIFICATIONS:

INPUT VOLTAGE: 115 ± 10 vac.

OUTPUT VOLTAGE: See ratings chart.

OUTPUT CURRENT: See ratings chart.

OUTPUT SET: ±2%.

OPERATING TEMPERATURE: −25°C to 71°C

FREQUENCY: 50 to 400 Hz.

TEMPERATURE COEFFICIENT: 0.02%/°C.

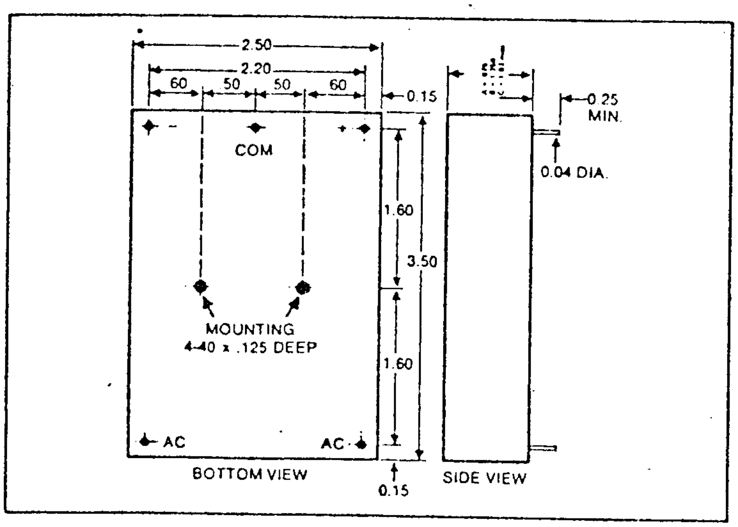
INPUT ISOLATION: 50 Megohms.

OUTPUT IMPEDANCE @ 10 KHz: 200 Milliohms.

STORAGE TEMPERATURE: −25°C to 85°C.

RIPPLE: 1.0mV RMS

MODEL SINGLES	OUTPUT VOLTAGE Vdc	OUTPUT CURRENT mA	REGULATION LINE	REGULATION LOAD	CASE SIZE	1-9
S-5-250	5	250	0.05%	0.1%	A	37.00
S-5-500	5	500	0.05%	0.1%	A	43.00
S-5-1000	5	1000	0.05%	0.1%	B	53.00
S-5-2000	5	2000	0.05%	0.1%	C	73.00
DUALS						
D-12-100	±12	±100	0.05%	0.05%	A	43.00
D-15-100	±15	±100	0.05%	0.05%	A	43.00
D-12-200	±12	±200	0.05%	0.05%	B	53.00
D-15-200	±15	±200	0.05%	0.05%	B	53.00
D-12-300	±12	±300	0.05%	0.05%	C	73.00
D-15-300	±15	±300	0.05%	0.05%	C	73.00



CARITRONICS INC. 13 CAMBRAY ROAD MONTVILLE NEW JERSEY 07045 (201) 575-8916

STANDARD POWER SUPPLIES

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INSTRUCTION SHEET
SPS/CPS SERIES

FEATURES

- Voltage adjustment potentiometer
- Foldback current limiting
- 115/230 Vac, 47-440 Hz input
- 0.1% line/load regulation
- Temperature compensated circuitry
- 0.1% ripple
- Optional overvoltage protection
- Optional square current limiting
- Optional logic inhibit

DESCRIPTION

The SPS and CPS Series are series regulated, solid state power supplies designed to provide closely regulated DC voltages in all popular voltage and current levels. The output is floating, hence any voltage may be plus or minus or referenced to another voltage.

OPERATING PROCEDURE

For 115 Vac, 47-440Hz connect input leads to terminals 1 and 4 of transformer or input terminal block, terminals 1 & 3 and 2 & 4 will be jumpered. (Factory connection)

For 230 Vac input, remove jumpers between 1 & 3 and 2 & 4. Then jumper terminals 2 and 3 together and connect 230 Vac to terminals 1 and 4. Suggest twisted AC input wires if electrical noise reduction is prime concern.

Output terminals identified in figures on back of this sheet are marked + and -. Load should be connected to these terminals with due care to proper wire size and solid electrical connection for best results. Output voltages may be adjusted with the potentiometers identified in the figures located on the back of this sheet

SUGGESTED TEST PROCEDURE

Connect AC input power as outlined in operating procedure. Place a variac between Vac source and input to transformer. Place an AC voltmeter across transformer input terminals 1 and 4. Set input voltage for nominal 115 Vac with variac.

Place resistive load across output, check Vdc output specifications. DC voltmeter should be connected directly across output terminals. Greatest test errors are made at this point.

LINE REGULATION

With output adjusted to rated voltage, reduce input Vac to 104 volts and record or note output voltage. Then increase input Vac. to 126 Vac and note output voltage. Total output voltage change should not exceed .2% or ± .1%.

LOAD REGULATION

Set AC input voltage to 115 Vac. Place DC voltmeter across output terminals and record or note output voltage. A load resistor, equal to the rated load of the supply at selected DC voltage setting, is then applied to output terminals. The voltage change should be noted. This differential change should not exceed .2% or ± .1% of DC output voltage.

Output current adjust is accomplished by placing a load resistor of the desired value across output terminal; adjust current limit potentiometer identified in figures on back of this sheet until voltage starts to drop. This is the fold back point of current limiting, this control is factory set to 120% of rated output and sealed.

RIPPLE

With voltage set at 115 volts and full load across DC output terminals, the measurable AC voltage on output should not exceed 0.1% RMS.

OVERVOLTAGE PROTECTION

Optional overvoltage protection is available on most models. Consult the catalog selection guide or the listing on the next page for appropriate models or contact the factory for application note.

Loads generating high back EMF voltages should be checked with parallel diode, zener, or series diode to reduce detrimental effects on pass elements. It is recommended that the AC input circuit be fused. A suggested fuse rating is listed on the reverse side of this sheet.

SUGGESTED PRACTICES

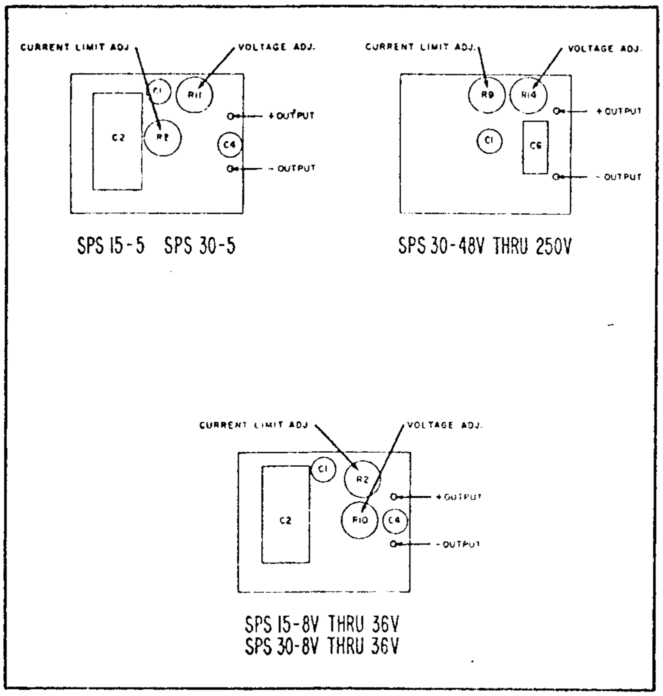
Moving air is desireable when mounting in a confined area. Chassis may be attached to other heat dissipating surfaces to improve cooling characteristic at maximum ratings.

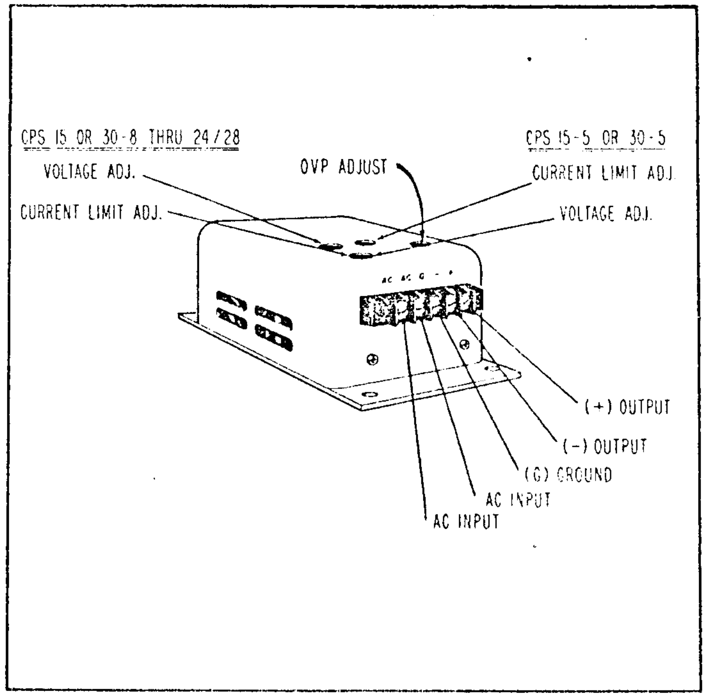
STANDARD POWER, INCORPORATED ■ 1400 South Village Way ■ Santa Ana, Calif. 92705 ■ phone (714) 558-8512

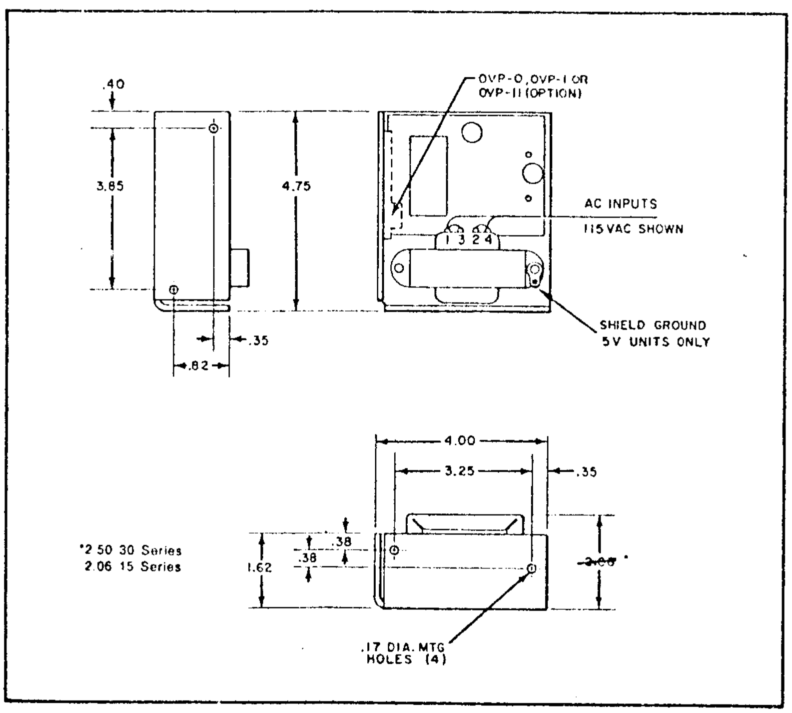
SPS / CPS 15 SERIES
SPS / CPS 30 SERIES

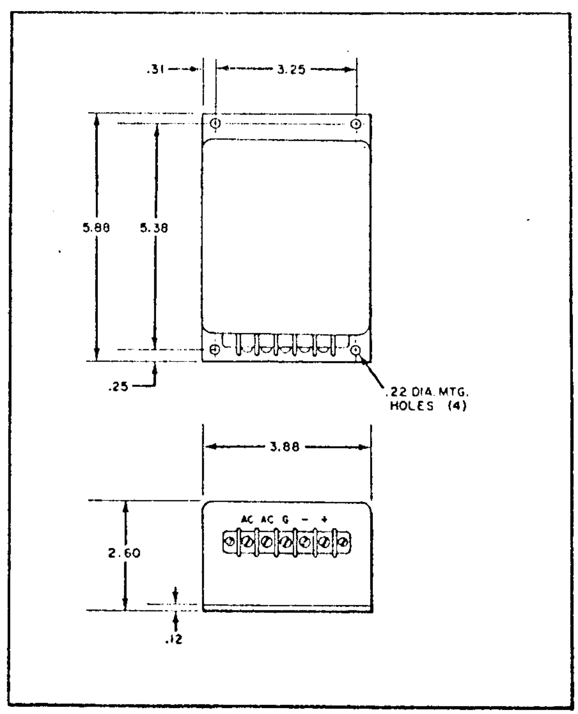
NOTES:

1. Recommended input fuse 1A, Type 3 AG.
2. OVP-1 is compatible with 5V through 28V models.
3. OVP-0 or OVP-11 may be used on 5V models.
4. If problems are encountered in series operation of two power supplies due to a common load connected across the two supplies, contact the factory for application note, AN 101.









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For AA-1 Auto-Answer Specs see Weather Service Bldg. Readout Section

For Wind Speed Sensor, Deriming Heaters, and 723 Voltage Reg. Specs.

see Stevens Pass Telemetry Section