

NOVALYNX CORPORATION

**MODEL 240-3010-A
MECHANICAL PYRANOGRAPH**

INSTRUCTION MANUAL



REVISION DATE: October 1998

Receiving and Unpacking

Carefully unpack all components and compare to the packing list. Notify NovaLynx Corporation immediately concerning any discrepancy. Inspect equipment to detect any damage that may have occurred during shipment. In the event of damage, any claim for loss must be filed immediately with the carrier by the consignee. Damages to equipment sent via Parcel Post or UPS require the consignee to contact NovaLynx Corporation for instructions.

Returns

If equipment is to be returned to the factory for any reason, call NovaLynx between 8:00 a.m. and 4:00 p.m. Pacific Time to request a Return Authorization Number (RA#). Include with the returned equipment a description of the problem and the name, address, and daytime phone number of the sender. Carefully pack the equipment to prevent damage or additional damage during the return shipment. Call NovaLynx for packing instructions in the case of delicate or sensitive items. If packing facilities are not available take the equipment to the nearest Post Office, UPS, or freight service and obtain assistance with the packaging. Please write the RA# on the outside of the box.

Warranty

NovaLynx Corporation warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from the date of shipment from the factory. NovaLynx Corporation's obligations under this warranty are limited to, at NovaLynx's option: (i) replacing; or (ii) repairing; any product determined to be defective. In no case shall NovaLynx Corporation's liability exceed product's original purchase price. This warranty does not apply to any equipment that has been repaired or altered, except by NovaLynx Corporation, or that has been subjected to misuse, negligence, or accident. It is expressly agreed that this warranty will be in lieu of all warranties of fitness and in lieu of the warranty of merchantability.

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NovaLynx Corporation
Model 240-3010-A Pyranograph

1.0 INTRODUCTION

Mechanical Pyranographs are survey type instruments designed for continuous recording of the intensity of direct and scattered solar radiation. Daily totals can be calculated from the collected data. The Pyranographs work on the principle of the difference in the temperature of four parallel rectangular bimetallic strips 2 white and 2 black. The temperature difference is proportional to the intensity of solar radiation.

Previously, NovaLynx had several model numbers covering different clocks, spring wound and electric with weekly or monthly rotations. The Model 240-3010-A Pyranograph features and uses a battery powered, quartz crystal clock with 1 day or 7 day rotation.

The electronic clock includes a selector switch for switching drum rotation from one day (26 hours), to seven days (176 hours). Additional time is provided in the clock rotation and on the chart paper to overlap the data whenever the chart is not replaced within the normal time period. The two different settings on the clock require that the chart paper matches the time setting. A list of available chart paper by model numbers is provided on page 2 of this manual. (Note: The clock has a 31 day position but 31 day charts are not available at this time.)

The chart paper used on the drum recorder has a single calibrated sections for recording radiation. The zero or low-scale is at the bottom edge of the calibrated section and the full-scale or high-scale is at the upper edge. The chart paper wraps around the clock drum and is marked by a cartridge ink pen. The ranges of the chart paper and the time base are selected at the time of purchase. One pack of charts is supplied with each instrument. Additional chart paper of the same type or chart paper with different spans or different time bases may be ordered at any time from NovaLynx. Some customers find that charts with a different range or a different time base need to be used during different times of the year depending upon the use of the recorded information. More than one Pyranograph recording site may be required in some instances. The chart paper has space in the margin for station identification and the date.

A properly maintained Pyranograph will provide many years of useful service. Refer to the maintenance section of this manual for information regarding the care of the instrument. Contact NovaLynx for additional assistance and for repairs and replacement parts.

2.0

SPECIFICATIONS

| | |
|-----------------|--|
| Sensing element | Black and White |
| | bimetallic strips |
| Calibration | gm Cal/cm ² -min, W/m ² |
| Scale divisions | Approximately 0.05 gm cal/cm ² -min |
| Range | Approximately 2.5 gm Cal/cm ² -min |
| Spectrum | 0.36 to 2.0 micron |
| Lag coefficient | Approximately 5 minutes |
| Drum rotation | One day or seven day |
| Clock drive | 1.5 VDC battery |
| Pen type | Cartridge |
| Chart size | 3.5" H x 11.5" L |
| | (89 x 292 mm) |
| Size | 13" L x 8.25" W x 8.75" H |
| | (330 x 210 x 220 mm) |
| Weight/Shipping | 14 lbs/25 lbs |
| | (6.4 kg/11.3 kg) |

2.1 CHARTS

Pyranograph charts for Models 240-3010A

| Chart Catalog Number | Chart Range | Drum Rotation | Charts/Package |
|----------------------|-------------------------|---------------|----------------|
| 240-30101 | 0-2.5 Ly/min | 176 hour | 55 |
| 240-30103 | 0-1500 W/m ² | 176 hour | 55 |
| 240-30104 | 0-1500 W/m ² | 26 hour | 400 |

3.0

INSTALLATION

- 3.1 This instrument is thoroughly tested and fully calibrated at the factory and is ready for installation. Please refer to the return authorization card included in the packing box if damage has occurred. Also, notify NovaLynx Corp.
- 3.2 The Mechanical Pyranograph is shipped in a dual fiberboard container. The inner

container is packed with styrofoam panels to protect the instrument from damage during shipment. The outside container is also filled with foam chips for further protection.

- 3.3 The clock is shipped wrapped inside a plastic bag. Remove the clock from the bag. A Nickel plated chart clip should be on one side of the drum. If the clip is not on the clock search the carton. The clip may become loose during shipping. If the clip is on the clock, slide it upward and remove it from the drum.
- 3.4 Open the clock drum by grasping the bottom of the clock with one hand and the brass drum with the other hand. Look closely at the bottom edge of the clock drum. There should be three small pins that hold the drum onto the bottom plate. Notice the position of each slot around the pins. Rotate the two clock pieces in opposite directions to separate them. Typically, the clock drum will be rotated in a counter-clockwise direction while the bottom plate rotates clockwise.
- 3.5 With the brass drum removed, the battery holder will be exposed. Insert the two, AA batteries into the battery holders. Batteries are not normally supplied with the instrument. Notice the polarity markings on the plastic battery holders. Check to be sure that the batteries face correctly as they are being inserted.
- 3.6 Upon completion of the battery installation, look at the top of the clock assembly. One of the three LEDs should be flashing to indicate the clock is operating. If an LED is not flashing check the batteries to make certain that they have power and that they are facing correctly in the holders. If the clock does not appear to be working contact NovaLynx for assistance or for a replacement clock.
- 3.7 If the LED is flashing and the clock appears to be working properly, replace the clock drum onto the bottom plate. Notice that the chart clip notch in the drum must be in line with the slot in the bottom plate when the clock is put back together. Rotate the two pieces together until the pins are against the front edges of the slots.
- 3.8 Remove the packing material from around the desiccant glass and empty the desiccant into the glass. If the desiccant is blue in color, it is ready to use. If it is pink, it must be dried. Place the desiccant in an oven at 180°F for two to four hours or until it turns blue. The glass container is pyrex and can be used in the oven for drying.
- 3.9 Locate the instrument outdoors so that it is not obstructed from the path of the sun. The Model 190-3012 mast is an ideal mount for this instrument. When installing this instrument, take care not to locate it where shadows will appear. Level the instrument using the three feet and the bull's-eye level on the base. The

window on the front of the instrument should be oriented toward north in the northern hemisphere to guard against solar radiation entering the case.

- 3.10 Close the lid of the instrument, being sure that the internal mechanism is sealed from the outside environment. The base gasket and wing nut latch provide this protection.

CHART PAPER INSTALLATION

The chart paper is installed easiest with the clock removed from the Pyranograph. To install the chart paper, first remove the chart clip from the clock drum. Select the chart paper that the black lines for the station ID number and the start date of the chart have been filled in as required. After the chart information has been written onto the end of the chart, fold down the end margin exactly along the end line of the calibrated portion of the chart. The fold will place the station ID and the date under the chart.

Slide the chart clip between the folds of the chart. The edge of the clip must sit in the crease of the fold. Hold this end of the chart in one hand. With the other hand, take the left hand edge of the chart paper and wrap it around the clock drum. The paper should be positioned so that the end of the chart will line up with and slightly overlap the chart clip slot located on the bottom plate of the clock.

Holding the end of the chart paper against the drum, slide the chart clip into the slot on the bottom plate and insert the top of the clip into the notch on the upper edge of the drum. Notice that when inserting the chart clip, the edge of the chart with the clip will overlap the end of the chart being held against the drum. Press firmly on the free end of the chart to prevent it from slipping out as the chart clip is put into place. Several attempts at loading the chart paper may be necessary until familiarity with the procedure is attained.

A properly loaded chart paper will be tightly wrapped around the drum of the clock. The folded edge of the paper will be seated against the chart clip. The free end of the paper will be underneath the chart clip and aligned with the overlapping portion of the chart paper. If the chart paper slips or moves during the insertion of the chart clip, it may be necessary to start over in order to properly align the edges of the chart. The bottom edge of the chart paper, the zero side of the humidity chart, must be touching the bottom plate of the clock. With the chart paper properly installed, the ink pens will be able to write on all of the chart and will travel easily over the chart on top of the chart clip.

CLOCK INSTALLATION

The clock is placed over the shaft located on the base of the Pyranograph. First, the brass nut at the top of the shaft must be removed. There is a spacer located between the shaft and the case. The spacer must be in place and the shaft must be securely fastened to the case in order for the clock to properly operate. If the spacer appears to be missing notify NovaLynx for a replacement. Check the shaft to make certain that it does not rotate or move. If it appears to be loose, tighten the nuts located underneath the instrument case. If everything appears to be correctly placed, slide the clock over the shaft and secure it to the shaft on the top side using the brass thumb nut. Do not over-tighten the brass nut. Finger-tight should provide plenty of force to keep the clock on the shaft. The clock should rotate freely around the shaft.

Check at this point to ensure that the pens lifted away from the chart paper surface. To begin recording data, rotate the clock in a clockwise direction until the correct time line appears beneath the ink pens. For weekly charts check to ensure that the day of the week has been correctly selected.

Before placing the ink pens onto the chart notice that each pen has a white plastic protective cap covering the pen tip. Remove the caps to expose the fiber tips of the pens. Save the caps and recover the pens whenever they are not being used to extend pen life.

Lower the pens onto the chart paper by rotating the pen lifter bar. Move the pens gently by hand, up and down a small distance to make marks on the chart paper. Look at the marks to see whether they have been written on top of the correct timing mark. If necessary move the clock to correct the position until the pens are at the timing mark. Rotate the clock only in a clockwise direction. Due to back lash in the clock gear mechanism, there will be some loss of time if the clock is moved in a counter-clockwise direction. The clock will not move until the back lash slack is recovered.

For initial set-up of the Pyranograph, let the instrument operate for some time to ensure that the clock is operating properly and to see that the ink pens are writing properly. For weekly charts, the clock will rotate very slowly and it will take at least one or two days to check the clock operation. Try to do the clock operation test before permanently installing the Pyranograph and before trying to collect critical data.

Final installation of the Pyranograph involves placing the instrument into an outdoor instrument shelter or onto an indoor shelf or table. The instrument should be as level as possible. Water should never splash onto the humidity and temperature sensing elements. Avoid placing the instrument in locations where there may be direct sunlight exposure the direct sunlight temperature is being measured.

4.0 THEORY OF OPERATION

Solar radiation passing through the glass hemisphere falls on four bimetallic strips. The hemisphere will transmit 90% of the radiation in the range of 0.36 to 2.0 micron. Two of the bimetallic strips are painted white and reflect the incoming radiation. These strips only respond to ambient temperature conditions. The other two bimetallic strips are painted black. They absorb the incoming radiation, as well as the ambient radiation. One black and one white strip are connected so that the ambient conditions cancel each other, with the remaining bimetallic curvature representing the incoming radiation.

One end of each white strip is attached to the instrument frame. The other end of each white strip is attached to one end of a black strip. The opposite end of the black strips are tied together and connect to the pen arm linkage. A baseline adjustment screw is provided for the full scale range. The plate under the bimetallic strips is used to reflect radiation not falling on the strips so that internal parts will not exhibit temperature changes.

The case is painted white to insure that the internal components will stay at ambient temperatures. A window is provided in the case for viewing the chart readings. The desiccant and gasket seals keep the inside of the case dry. Without them, condensation would form on the inside of the glass hemisphere, causing large errors in data collection.

5.0 CALIBRATION

Calibration of this instrument is a very delicate operation. Only a qualified instrument technician with precision instruments should attempt this procedure.

Place the instrument in a completely dark room and after leveling the instrument, set the baseline or zero point by adjusting the pinion head screw on the sensor mounting rod located under and toward the back of the white reflective plate. An alternate method would be to make this adjustment at night during the dark hours.

The full scale value is derived from a calibration constant. Generally, the full scale is not adjusted but instead the calibration constant is changed.

$$\text{Solar Radiation} = K \times \text{chart reading}$$

From the above formula, solar radiation in g cal/cm²-min can be determined by multiplying the chart reading by the calibration constant. For this instrument the calibration constant is approximately 0.470. The actual value is: (on the serial tag)

$$K = \underline{\hspace{10em}}$$

Locate this instrument next to an instrument of a known calibration. Take several readings at different radiation exposures and determine a new calibration constant. NOTE: This instrument has a lag time of approximately five minutes so it should not be calibrated during partially cloudy conditions.

The procedure outline in the following steps is for reading the charts of the Pyranograph. A sample chart is used to obtain the values indicated.

To obtain the value for a single point on the chart, locate the arc passing through the point of interest. Refer to point A on the sample chart.

For the example shown, point "A" is at division number 3.6. The reading at point "A" is $3.6 \times .470 = 1.69$ with units of gram calories per centimeter squared minute ($\text{g cal/cm}^2\text{-min}$).

To obtain the equivalent value in Watts per square meter (Wm^{-2}), multiply 1.69 by 698.

The hourly summary box is the total of the 4 readings during the hour. For hour number 10 there are 4 readings at 15 minute intervals. In the example these 4 readings are indicated as "B", "C", "D", and "E". The individual results are 1.669, 1.636, 1.575, 1.542. The hourly summary total is 6.422.

The daily total value is the total of the hourly summaries, representing the total amount of solar energy measured during the time period.

A more accurate method for obtaining the daily total is to integrate the area under the curve of the trace. The area under the curve may be measured directly with a planimeter or indirectly by dividing the area under the trace into small trapezoidal figures and computing the area of each trapezoid. The area of a trapezoid is determined by the equation:

$$A = \frac{(h_L + h_R) \times (t_R - t_L)}{2}$$

Where: h_L is the left side
 h_R is the right side
 t_R is the time at h_R
 t_L is the time at h_L

For the sample chart shown, the results of the area calculation for the trapezoid shown is:

$$A = \frac{(2.3 + 2.9) \times (4 - 2.75)}{2} = 3.25$$

The sum of all the trapezoidal shaped areas equals the daily total solar energy.

6.0 MAINTENANCE

The instrument should be routinely maintained preventing dust and dirt build-up. Whenever a chart change is required, simply brush the dust and dirt from the instrument. This type of preventive maintenance will provide long reliable recorder operation. At routine intervals, three to six months, clean all pivot points with solvent and with a small brush apply a light coat of instrument oil.

The outside surface of this instrument should be maintained in a highly polished state to reflect direct solar radiation. Paint the surfaces of the case with a high gloss white enamel when required. The bimetallic strips are painted with a special paint and should not be painted except by the factory.

When the desiccant turns a pink color, immediately replace it with a new container or dry it as described in Section 3.16.

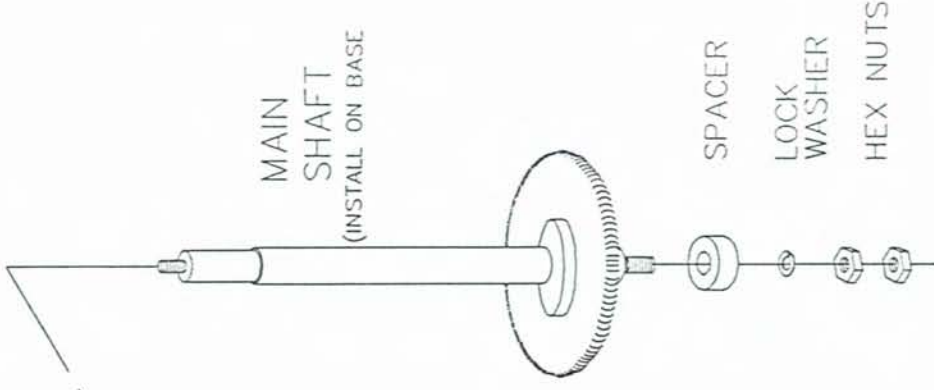
Alkaline batteries should be used for battery operated clocks. Change batteries every six months.

The clock mechanism should be cleaned and adjusted by a time piece repairman.

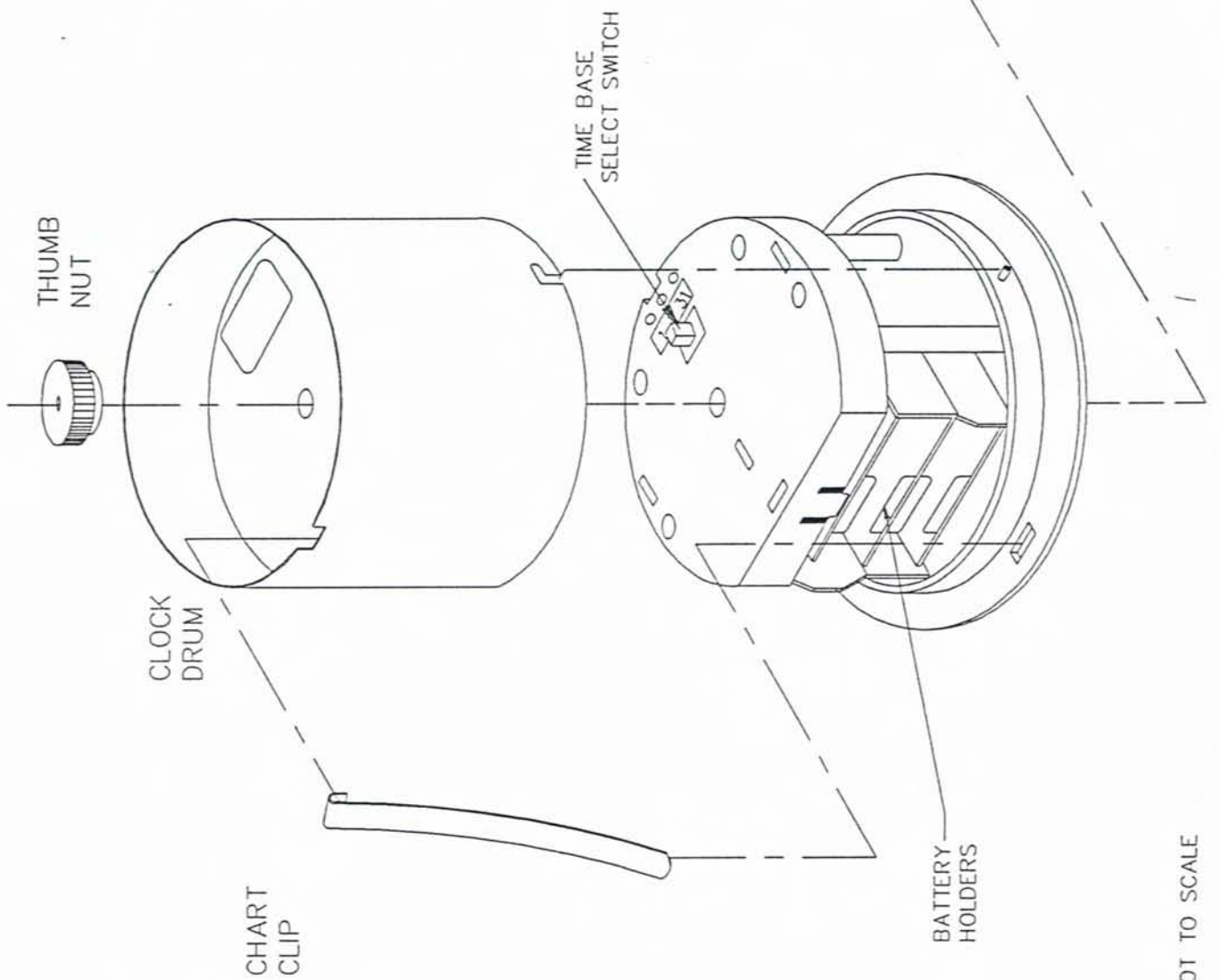
7.0

SCHEMATIC & PARTS LIST

The following pages include schematics, assembly drawings, and parts list for this instrument. Please note that the parts lists are arranged in assembly/subassembly form. Each subassembly is on its own page. Subassemblies and parts are listed in the smallest economical size available.

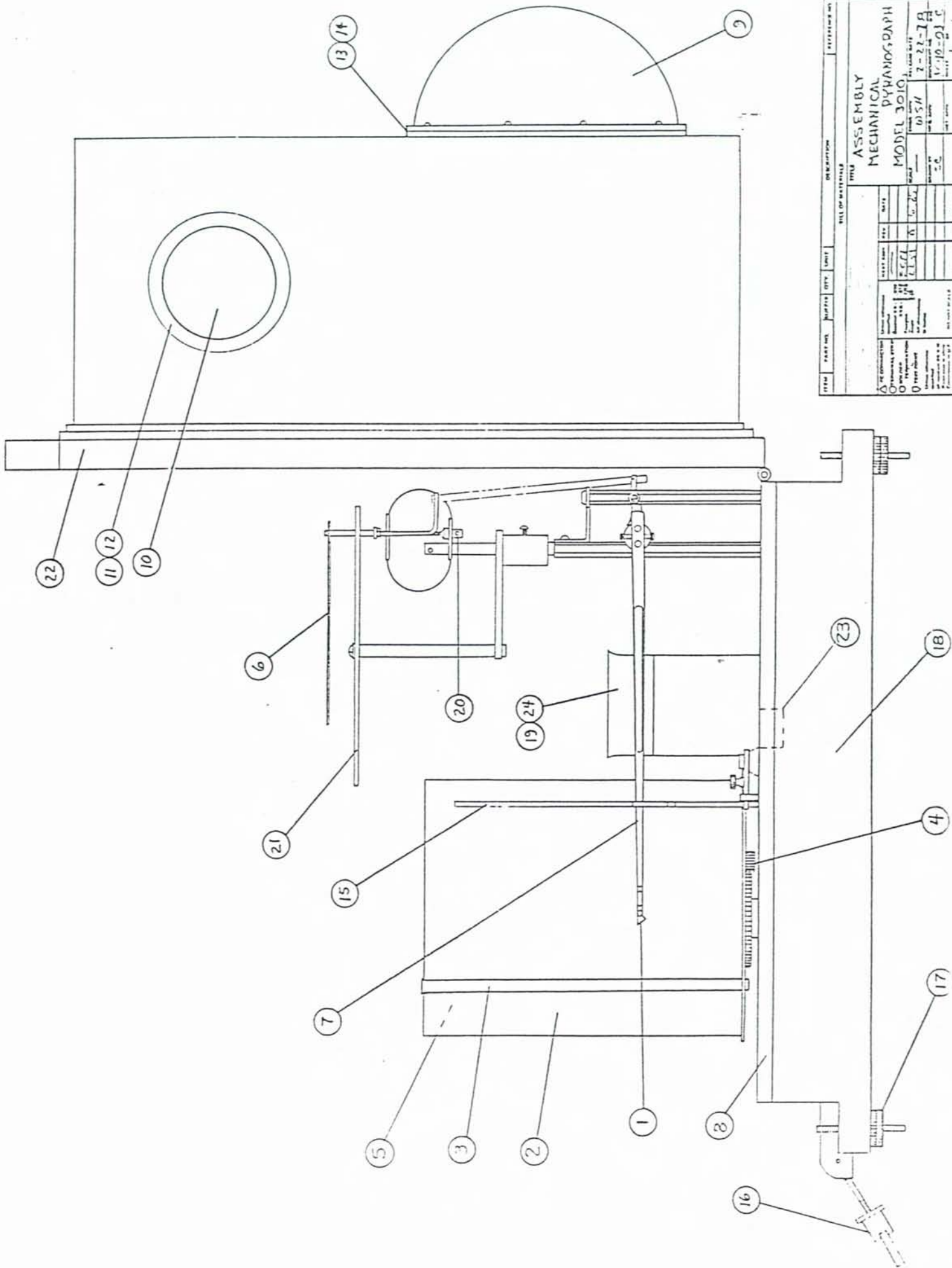


SPACER IS INSTALLED BETWEEN MAIN SHAFT & INSTRUMENT CASE.

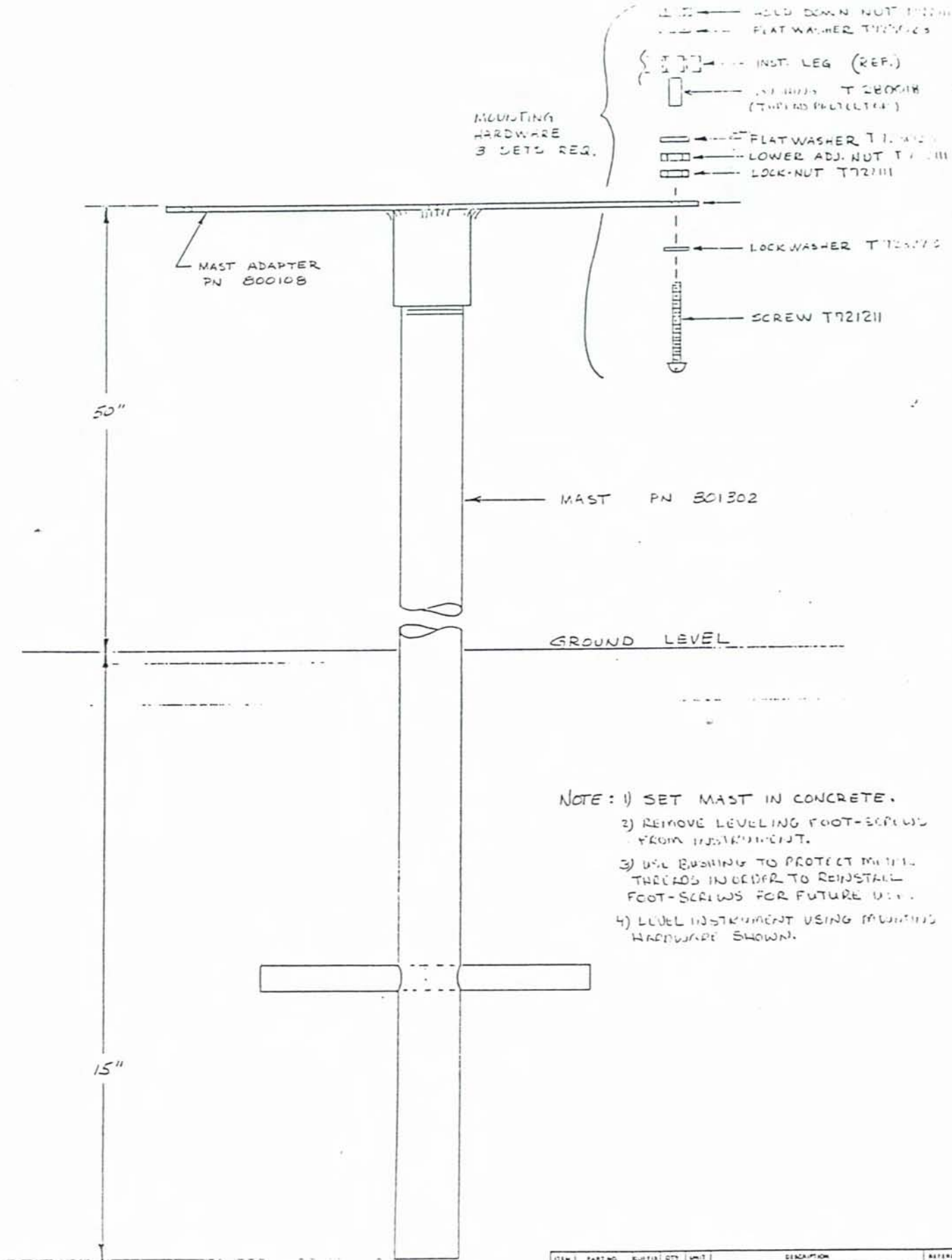


| | | |
|-------------------------------------|----------|--------------|
| | | C |
| TITLE ASSEMBLY, ELECTRONIC CLOCK | | |
| MODEL | SCALE | SHEET 1 OF 1 |
| BY | DATE | DWG. NO. |
| RCN | 10-27-94 | 941039 |
| | | NONE |

DRAWING NOT TO SCALE



| ITEM | PART NO. | QUANTITY | UNIT | DESCRIPTION | REVISION NO. |
|-------------------|----------|----------|------|-------------|--------------|
| BILL OF MATERIALS | | | | | |
| TITLE | | | | | |
| ASSEMBLY | | | | | |
| MECHANICAL | | | | | |
| MODEL 3010 | | | | | |
| DRAWN BY | | | | | |
| CHECKED BY | | | | | |
| DATE | | | | | |
| SCALE | | | | | |
| SHEET NO. | | | | | |
| TOTAL SHEETS | | | | | |
| APPROVED BY | | | | | |
| DATE | | | | | |
| PROJECT NO. | | | | | |
| DRAWING NO. | | | | | |
| REV. NO. | | | | | |
| REV. DATE | | | | | |
| REV. DESCRIPTION | | | | | |
| REV. 1 | | | | | |
| REV. 2 | | | | | |
| REV. 3 | | | | | |
| REV. 4 | | | | | |
| REV. 5 | | | | | |
| REV. 6 | | | | | |
| REV. 7 | | | | | |
| REV. 8 | | | | | |
| REV. 9 | | | | | |
| REV. 10 | | | | | |
| REV. 11 | | | | | |
| REV. 12 | | | | | |
| REV. 13 | | | | | |
| REV. 14 | | | | | |
| REV. 15 | | | | | |
| REV. 16 | | | | | |
| REV. 17 | | | | | |
| REV. 18 | | | | | |
| REV. 19 | | | | | |
| REV. 20 | | | | | |
| REV. 21 | | | | | |
| REV. 22 | | | | | |
| REV. 23 | | | | | |
| REV. 24 | | | | | |



- NOTE: 1) SET MAST IN CONCRETE.
 2) REMOVE LEVELING FOOT-SCREWS FROM INSTRUMENT.
 3) USE BUSHING TO PROTECT METAL THREADS IN ORDER TO REINSTALL FOOT-SCREWS FOR FUTURE USE.
 4) LEVEL INSTRUMENT USING MOUNTING HARDWARE SHOWN.

| ITEM | PART NO. | QUANTITY | UNIT | DESCRIPTION | REFERENCE |
|------------------------|----------|----------|------|-------------|-----------|
| BILL OF MATERIALS | | | | | |
| TITLE | | | | | |
| ASSEMBLY DRAWING | | | | | |
| MAST, PYRANOGRAPH | | | | | |
| PART NO. 3012 | | | | | |
| SCALE - 24 5-18-78 | | | | | |
| DRAWN BY - 24 301203 | | | | | |
| CHECKED BY - 24 301203 | | | | | |
| DATE - 5-18-78 | | | | | |