

TM 11-426

WAR DEPARTMENT TECHNICAL MANUAL

THERMOGRAPHS ML-77 AND ML-277

WAR DEPARTMENT • 17 JULY 1944

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TM 11-426, Thermographs ML-77 and ML-277, is published for the information and guidance of all concerned.

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For explanation of symbols, see FM 21-6.

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DESTRUCTION NOTICE

WHY—To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW—**SMASH**—Use sledges, axes, handaxes, pickaxes, hammers, crow-bars, heavy tools.

CUT—Use axes, handaxes, machetes.

BURN—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

EXPLOSIVES—Use firearms, grenades, TNT.

DISPOSAL—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT—**SMASH**—Clock ML-79-A, carrying case, linkage system, temperature elements, ink and oil bottles, gears.

CUT—Temperature charts, Bourdon tube.

BURN—Temperature charts.

BEND—Pen, linkage system, Bourdon tube, spring clip.

BURY or SCATTER—Any or all of the above after destroying their usefulness.

DESTROY EVERYTHING

SECTION I

DESCRIPTION

1. PURPOSE. Thermographs ML-77 (fig. 1) and ML-277 (fig. 2) are self-recording thermometers, each producing a continuous record of temperature over a period of time. Thermograph ML-277 is used in Arctic climates. Thermographs ML-77 and ML-277 each produce either a weekly or a daily record.

2. COMPONENT PARTS. **a. Thermograph ML-77.** (1) The component parts of Thermograph ML-77 are:

One temperature measuring-and-recording mechanism, mounted in case.

One clock ML-79-A.

One pen.

(2) The items listed below must be procured separately. They are used with Thermograph ML-77, but are not supplied as part of the equipment.

<i>Item</i>	<i>Signal Corps stock No.</i>
Ink, special register, green	7A1100
Ink, special register, purple	7A1101
Ink, special register, red	7A1102
Oil, watch, grade No. 1	6G1339.1
Form SC-120-A	6D120A
Temperature charts, range -50° F. to $+80^{\circ}$ F.	7A1797/C2

b. Thermograph ML-277. (1) The component parts of Thermograph ML-277 are:

One temperature measuring-and-recording mechanism, mounted in case.

One Clock ML-279.

One pen.

(2) The items listed below must be procured separately. They are used with Thermograph ML-277, but are not supplied as part of the equipment.

<i>Item</i>	<i>Signal Corps stock No.</i>
Ink, low-temperature	7A1099
Oil, low-temperature	7A1977/01
Temperature charts, range -50° F. to $+80^{\circ}$ F.	7A1797/C2
Temperature charts, range -80° F. to $+50^{\circ}$ F.	7A1797/C1

3. DIMENSIONS AND WEIGHT. The over-all dimensions of Thermographs ML-77 and ML-277 are identical. The dimensions are: length, $13\frac{7}{8}$ inches; width, $5\frac{3}{8}$ inches; height, $8\frac{3}{8}$ inches. Each thermograph

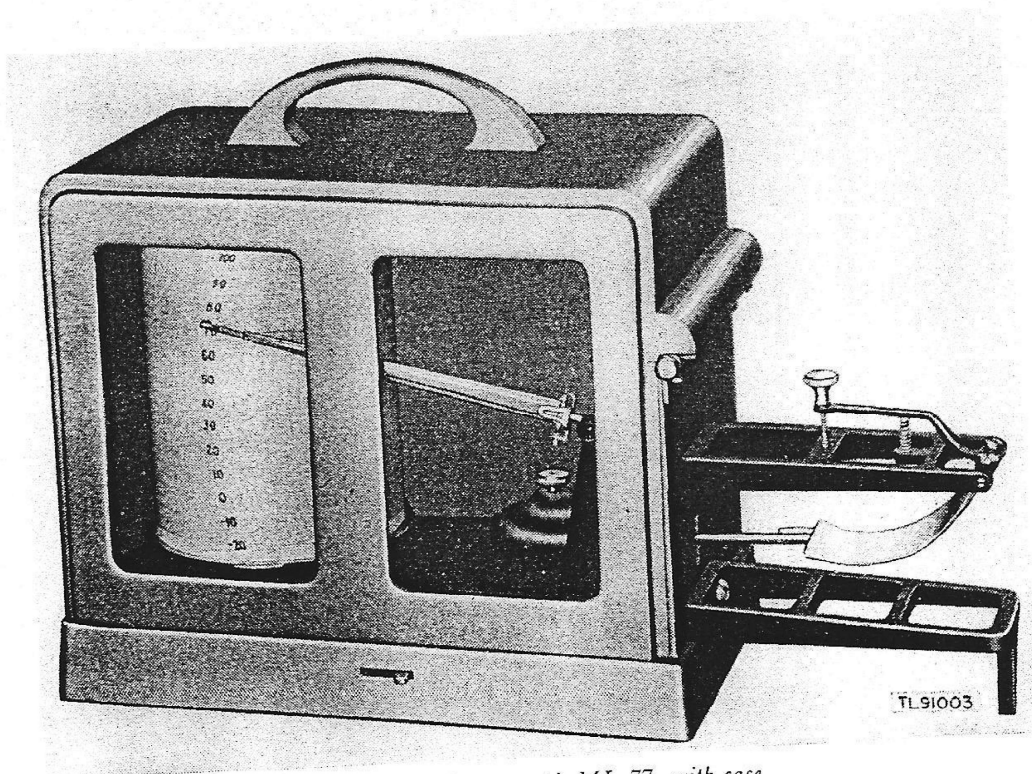


Figure 1. Thermograph ML-77, with case.

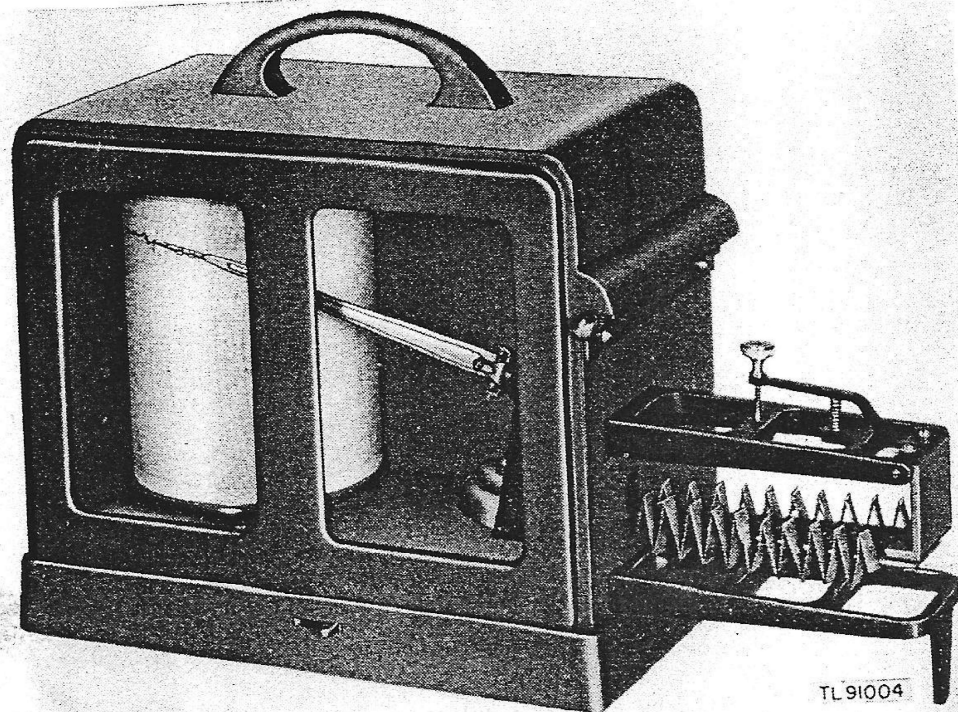


Figure 2. Thermograph ML-277, with case.

case, including Clock ML-79-A, weighs about 10 pounds when unpacked and about 15 pounds when packed.

4. COMPARISON OF THERMOGRAPHS ML-77 AND ML-277.

Primarily, Thermograph ML-277 differs from Thermograph ML-77 in three respects: the temperature element, the vertical link and accessories (par. 15), and the temperature charts. In all other details the thermographs are identical.

a. **Clock ML-79-A (fig. 3).** Clock ML-79-A is a jeweled clock which is contained within a brass cylinder. The clock operates 8 days on one winding and makes one revolution weekly or daily, depending upon the particular set of gears in use. There is an opening for the main clock shaft through the center of the clock unit. The shafts for the weekly and

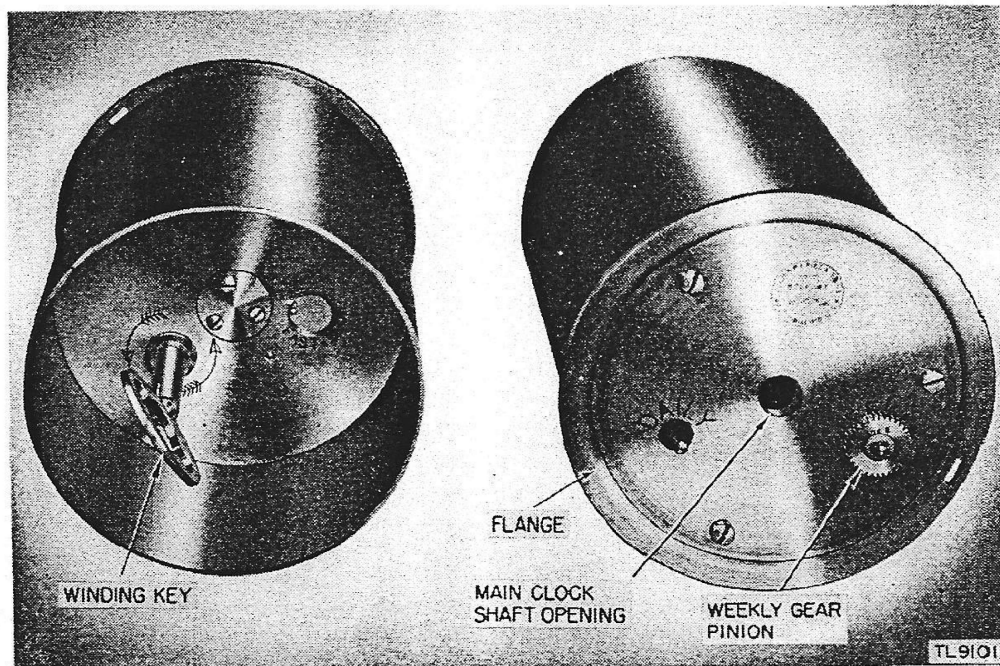


Figure 3. Clock ML-79-A, top and bottom views.

daily gear pinions are on the under side of the clock, to the left and right of the main clock-shaft opening. The winding key and the FAST-SLOW adjustment window are located inside the top of the clock.

NOTE: Clock ML-279, which is used with Thermograph ML-277, is identical with Clock ML-79-A, except that it has been previously lubricated with a special lubricating oil.

(1) *Gears.* Two sets of gears, a weekly set and a daily set, are provided. The weekly set is marked 176E, and completely rotates the cylinder once in 176 hours. The large weekly stationary gear is mounted on the main clock shaft (fig. 4). The small weekly drive gear is fastened on the clock shaft labeled WEEKLY (fig. 3). The set of daily gears is kept under the clock change-gear cover. This set is marked 29E, and completely rotates the cylinder once in 29 hours. The daily gears are not normally used.

(2) *Cylinder.* The brass cylinder which contains the clock movement is $3\frac{5}{8}$ inches in diameter at the center, $3\frac{1}{6}$ inches in diameter at the bottom

flange, and $5\frac{1}{8}$ inches high ($5\frac{1}{4}$ inches high with the flange). The spring chart clip, which fits through a slot in the cylinder flange and fastens over a notch in the top rim, holds the temperature chart firmly in place.

b. Temperature element. (1) *Thermograph ML-77* (fig. 5). The temperature element of Thermograph ML-77 is a liquid-in-metal thermometer

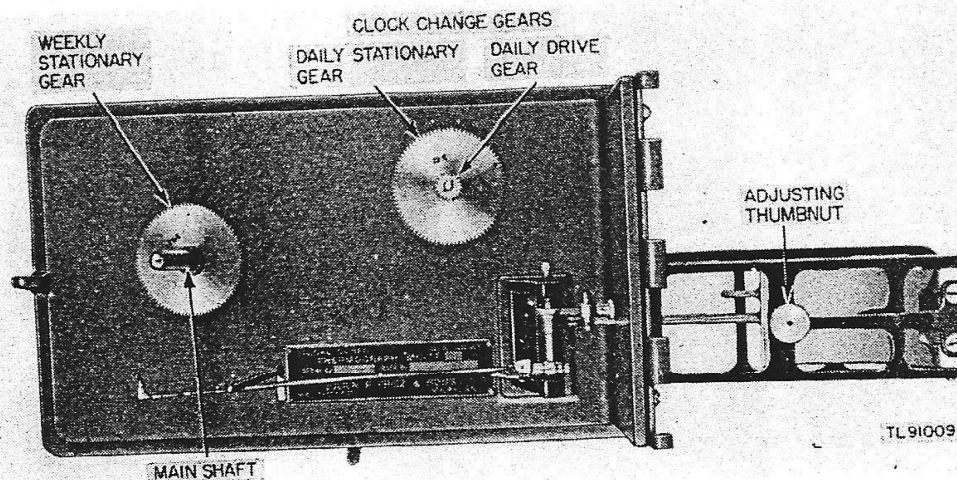


Figure 4. Thermograph ML-77—top interior view, showing clock spindle and indicating mechanism

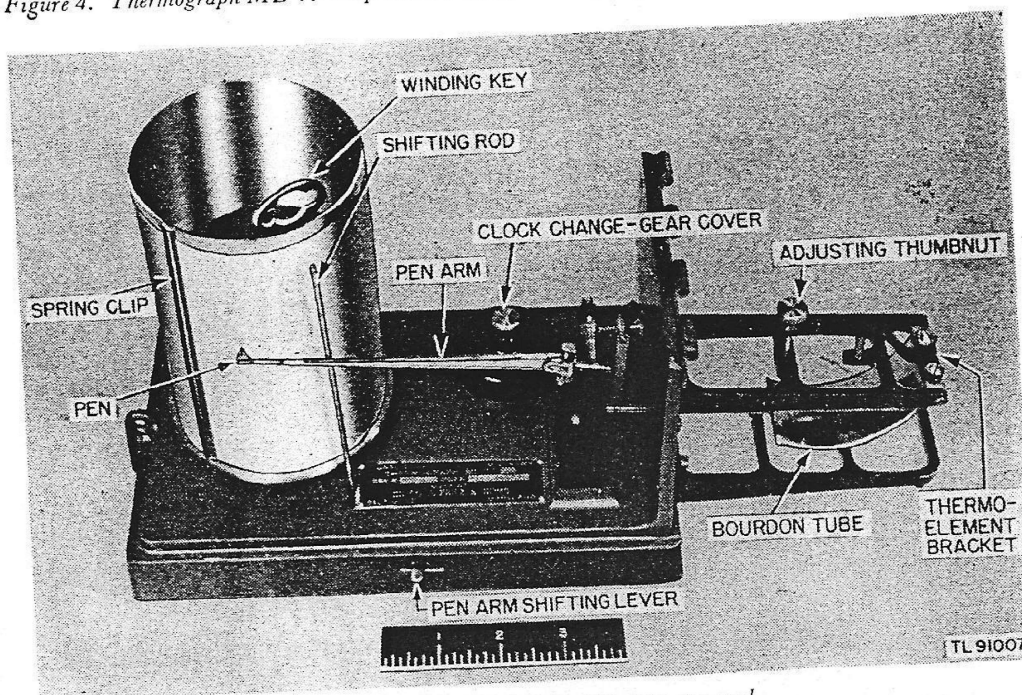


Figure 5. Thermograph ML-77, case removed.

called a Bourdon tube. The liquid used is alcohol. One end of the Bourdon tube is fixed to a rigid thermo-element bracket, while the other end is connected through a system of linkages to the pen arm. The tube is made of thin phosphor bronze and has a gold-plated external surface to minimize the effects of radiations. The tube is oval in cross-section and is sealed at both ends. It is mounted outside the case on a bracket support to provide for maximum ventilation and best exposure.

(2) *Thermograph ML-277* (fig. 6). The temperature element of Thermograph ML-277 is a tapered bimetallic strip composed of invar and brass welded together. One end of the temperature element is fixed to the rigid thermo-element bracket, while the other end is connected through a system of linkages to the pen arm. A radiation fin is attached to each side of the temperature element. The bimetallic strip is mounted outside the case on a bracket support to provide for maximum ventilation and best exposure.

c. Temperature charts. (1) *Thermograph ML-77*. Form SC-120-A (fig. 7) is the weekly chart. On the vertical scale, each division represents 1° F. Temperature divisions are labeled in steps of 10° . The chart covers a temperature range of -20° F. to $+110^{\circ}$ F. Time is read on the horizontal scale. Each division on the horizontal scale represents a time interval of 2 hours. For temperatures below -20° F., readjust the thermograph

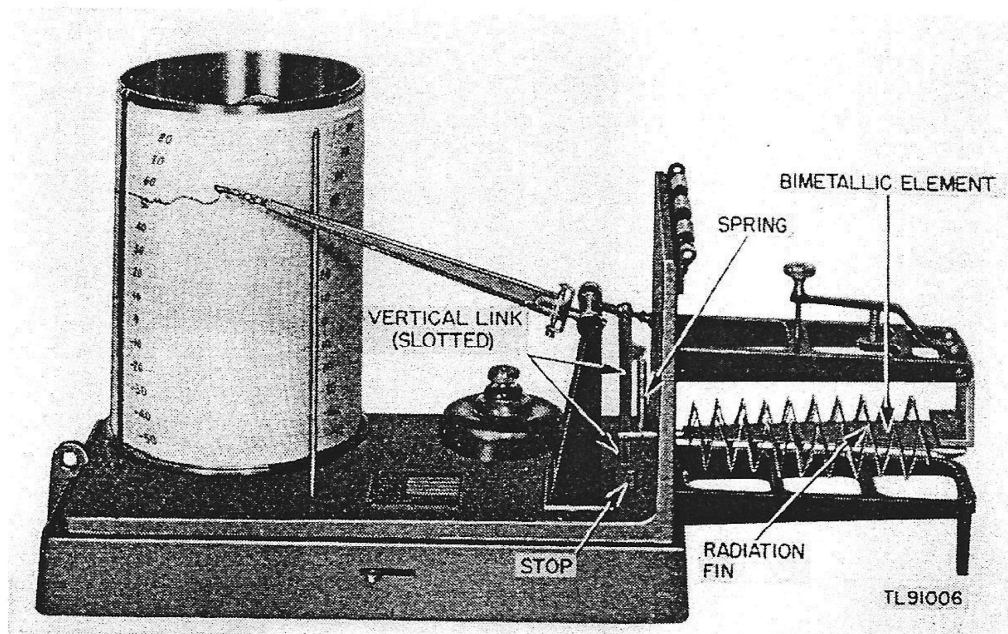


Figure 6. *Thermograph ML-277*, case removed.

(par. 11b.) and use a temperature chart, range -50° F. to $+80^{\circ}$ F. (See (2) below.)

(2) *Thermograph ML-277*. Thermograph ML-277 uses two kinds of charts. One chart is graduated in labeled intervals of 10° from -80° F. to $+50^{\circ}$ F. The other chart ranges from -50° to $+80^{\circ}$ F. Each chart extends over a range of 130° F., but by use of both charts a total range of 160° F. may be accommodated. Two charts are necessary, since arctic temperatures may rise above $+50^{\circ}$ F. and fall below -50° F. at the same station. Time is read on these charts in the same way as on Form SC-120-A (see (1) above).

d. Pen. The recording pen is made of nickel-silver. The point of the pen is formed by two triangular nibs which fit closely together. The barrel is a round reservoir which holds a week's supply of ink. The pen is held firmly on the pen arm by a set of front and rear clamps on the top of the pen.

e. Special register ink. The ink readily absorbs and retains moisture. It is available in three colors: green, purple, and red. The ink contains alcohol and glycerine to maintain a liquid state at low temperatures.

f. **Pen arm.** The pen arm is a pointed, horizontal rod which is located in front of the shifting rod (see g. below), and is attached to the horizontal shaft. The length of the pen arm from the tip of the spiked end to the center of the horizontal axis is 14 centimeters or 5.51 inches. The pen arm is free to swing inward about an inclined vertical axis (fig. 8). The pen arm carriage is fitted to the horizontal axis so that the pen arm is tilted a few degrees inward at the top.

g. **Shifting rod.** The shifting rod, controlled by the pen-arm shifting lever on the frame base of the instrument (fig. 5), is a vertical rod which passes through the platform of the instrument and stands beside the cylinder.

h. **Carrying case.** The recording mechanism is covered by a glass-paneled, sheet-metal case which is hinged with a removable pin on the upper right-hand side. When the cover is raised, stops on the hinge prevent the cover from resting on the temperature-adjusting thumbnut. A hook on the left-hand side of the case fits into a ring at the base of the instrument and keeps the case closed (figs. 1 and 2). The handle on the case permits the case to be carried from place to place.

SECTION II

INSTALLATION AND OPERATION

Caution: Thermographs ML-77 and ML-277 are delicate precision instruments. Handle them carefully at all times.

5. UNPACKING THERMOGRAPH ML-77 OR ML-277. Unpack the thermograph carefully. The carrying case and the cylinder containing the clock mechanism are packed separately. Be careful not to jolt or drop the package containing the clock.

6. LOCATING THERMOGRAPH ML-77 OR ML-277. a. Place the thermograph in a position where the sun will not shine on it and where the temperature element is exposed to freely circulating air. Be sure that the thermograph is protected against vibration and temperature radiation effects. Normal location of the thermograph is in Shelter ML-41 on the back, left-hand side of the shelter floor where it will not interfere with other instruments.

b. Locate a standard thermometer near Thermograph ML-77 or ML-277 for comparison with, and for correction of, the thermograph.

7. INSTALLING CHART. a. Cut the bottom edge of the chart carefully along the trimming line.

b. Fit the chart on the cylinder so that the margin is in line with the notch and flange slot on the cylinder (fig. 7 (1)).

c. Wrap the chart around the cylinder until the left-hand end can be lapped over the right-hand margin. The ends of the chart must meet so that the temperature lines are in correct alignment (fig. 7 (1) and (2)). Make sure that the chart fits snugly against the bottom flange of the cylinder.

NOTE: Keep the fingers off the face of the chart as much as possible. Fingerprints cause the ink to spread and make a ragged trace.

d. Fasten the spring clip which holds the chart in place. Push the clip as far down as possible to keep the chart from slipping (fig. 7 (3)).

e. If a daily chart is required and is not available, convert a weekly chart to a daily record by letting three divisions represent 1 hour. This will not provide an absolutely accurate time record, but it will be accurate enough for most purposes.

8. WINDING CLOCKS ML-79-A AND ML-279. Wind the clock before replacing the cylinder on the shaft. Use the winding key located inside the top of the cylinder (fig. 3).

a. Make 12 half-turns of the key if the clock is wound once a week.

b. Make a 14 half-turns of the key if the clock is wound when the move-



Figure 7. Replacing chart.

ment is completely run down, Clocks ML-79-A and ML-279 run down completely in 9 days.

Caution: Never wind Clocks ML-79-A and ML-279 too much.

9. INSTALLING CYLINDER. a. Push the pen-arm shifting lever to the extreme right. This adjusts the shifting rod so that the pen arm is in a nonrecording position and is out of the way.

b. Lower the cylinder onto the clock shaft. Be careful to eliminate the possibility of a time-lag error (see (1), (2), and (3) below). The major adjustment for time is made as the cylinder is lowered onto the clock shaft, before the clock gear is engaged.

(1) Use the shifting rod to move the pen close to the chart.

(2) Turn the cylinder on its axis until the pen falls a trifle to the right of the correct time as shown on the chart. Lower the clock until the gears mesh.

(3) Turn the clock unit *counterclockwise* until the pen indicates the proper time. Setting must be made by turning the cylinder counterclockwise to take up backlash in the clock gear train. If the pen does not rest on the correct time, the operation should be repeated until an exact adjustment is made.

Caution: Be certain that the pen does not catch on the edge of the chart or on the spring clip. This will bend the pen arm. Keep the pen arm in front of the shifting rod at all times.

10. INKING PEN. a. Be sure that the tip of the pen arm rests under the front and rear clamps of the pen. Make sure that the pen is seated against the shoulder of the pen arm. If necessary, adjust the position of the pen so that the over-all length of the pen arm is proper (14 centimeters or 5.51 inches).

b. In the space between the nibs of the point place a drop of special recording ink (the amount that ordinarily clings to the end of a small wire or to the applicator in the ink bottle). Fill the round reservoir of the pen about half-full of recording ink.

c. If necessary, start ink flowing by carefully drawing a piece of cellophane or lint-free paper, such as chart paper, between the nibs. Be careful not to bend or damage the points. Make sure that no particles are caught between points.

d. Remove all ink on the outer surface of the pen or pen arm. Ink on these points collects dirt and dust and produces too broad a record line.

11. ADJUSTING PEN TO TEMPERATURE. a. Hold Thermometer ML-7 or any standard thermometer as near as possible to the temperature element of the thermograph.

b. Turn the temperature adjusting thumbnut (fig. 5) until the reading of Thermograph ML-77 or of Thermograph ML-277 is adjusted to the reading of the standard thermometer (par. 17). Turning the adjusting thumbnut clockwise raises the pen; turning the adjusting thumbnut counterclockwise lowers the pen. Make this adjustment in a location where there is a good circulation of air around the temperature element and standard thermometer. *Never* use the link and lever assembly to adjust the pen to correct temperature; such procedure changes the calibration of the thermograph. Adjust the reading of the thermograph to the reading of the thermometer whenever charts are changed and when the thermograph develops a temperature error of 5° or more.

12. CHANGING CYLINDER SPEED. To control the speed of rotation of the cylinder and to change from a weekly to a daily record, perform the following operations:

- a. Move the pen away from the chart (par. 9a).
- b. Remove the cylinder from the shaft.
- c. Release the shaft by unscrewing the wingnut on the under side of the frame base.
- d. Remove the weekly gear from the shaft.
- e. Replace this gear with the larger of the two daily gears from under the gear change cover.
- f. Replace the shaft and tighten the wingnut securely.
- g. Remove the pin which holds the small gear on the clock shaft marked WEEKLY, and then pull the gear from the shaft (fig. 3). Install the smaller of the spare change gears on the clock shaft labeled DAILY. *Be sure to replace the pin and washer.*

NOTE: Weekly gears are marked 176E. Daily gears are marked 29E.

- h. Make sure that the gear fits tightly on the clock shaft, since the driving force of Clock ML-79-A or ML-279 depends on this condition. To correct a loose fit, carefully squeeze the slotted sleeve of the gear with a pair of pliers before pressing the gear onto the shaft.

13. READING TEMPERATURE. Read the temperature directly from the chart to the nearest degree.

SECTION III

FUNCTIONING OF PARTS

14. TEMPERATURE ELEMENT. a. Thermograph ML-77. As the temperature rises, the liquid in the Bourdon tube expands and causes the tube to straighten. When the tube straightens, its free end moves downward and causes the pen arm to move upward. In response to a decrease in temperature, the liquid in the Bourdon tube contracts and increases the curvature of the tube. The free end of the tube rises, causing the pen arm to fall and to record the lower temperature.

b. Thermograph ML-277. (1) The bimetallic temperature strip changes its shape with temperature variations because the two metals expand and contract at unequal rates. When the temperature rises, the temperature element moves downward and forces the pen arm up. When the temperature falls, the free end of the temperature element moves up, causing the pen arm to move down and to record the low temperature.

(2) The radiation fins provide a quick transference of heat to the bimetallic strip. As a result, the temperature element reacts faster to the temperature of the moving air.

15. VERTICAL LINK AND CALIBRATING MECHANISM. a. Thermograph ML-77. (1) *Vertical link.* The vertical link, connecting the free end

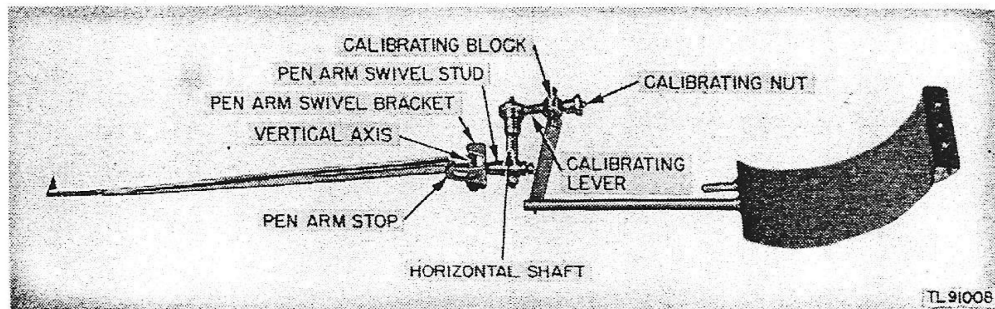


Figure 8. Thermograph ML-77, Bourdon tube, linkage system, and pen.

of the Bourdon tube to the calibrating lever and pen-arm swivel stud on the horizontal shaft, transfers the motion of the Bourdon tube (par. 14a) to the pen arm (fig. 8).

(2) *Calibrating mechanism.* The calibrating mechanism (fig. 8) regulates the sweep of the pen arm.

(a) A movable calibrating block attaches the vertical link to the calibrating lever and provides a means of adjusting the effective length of the calibrating lever.

(b) The calibrating nut, acting against a coil spring, moves the calibrating block lengthwise on the calibrating lever.

(c) A setscrew secures the calibrating block to the calibrating lever.

b. Thermograph ML-277. (1) *Vertical link.* The vertical link, connecting the free end of the bimetallic strip to the calibrating lever and pen-arm swivel stud on the horizontal shaft, transfers the motion of the bimetallic temperature element to the pen arm. The slot in the link allows the temperature element to move down against a spring when Thermograph ML-277 is exposed to temperatures above 80° F.

(a) *Spring.* The spring keeps the pin, which engages the vertical link, in contact with the upper end of the slot in the vertical link over the entire range of the temperature chart in use.

(b) *Stop.* The stop (fig. 6) prevents undue strain on the link and lever system when the temperature element, at any adjustment within its range (par. 4c (2)), is exposed to temperatures of 140° F. or less. Since the stop limits the extent of the downward motion of the vertical link, the pen never leaves the cylinder.

(2) *Calibrating mechanism.* The calibrating mechanism of the Thermograph ML-277 is identical with that of Thermograph ML-77 (see a (2) above).

NOTE: Except for the temperature elements and vertical link arrangements, the functioning of parts for Thermographs ML-77 and ML-277 is identical.

16. PEN AND PEN ARM. The pen and pen arm make a visible record of temperature changes on the chart. Capillarity controls the flow of ink from the barrel.

a. Pen arm swivel bracket (fig. 8). The pen-arm swivel bracket holds the vertical axis. This bracket is mounted on the pen-arm swivel stud which is attached by a setscrew to the front end of the horizontal shaft. The swivel bracket is turned so that the vertical axis tilts inward a few degrees to provide constant pressure of the pen point against the chart.

b. Pen-arm stop (fig. 8). The pen-arm stop prevents the pen arm from swinging out too far and provides a safe limit to the outward motion of the pen arm when the point is lifted from the chart.

17. ADJUSTING THUMBNUIT. The adjusting thumbnut sets the pen on the chart to correspond to the air temperature. This thumbnut acts against a coil spring and moves the bracket attached to the temperature element. When the bracket is moved, the tube rotates about the fixed end and changes the position of the pen on the record chart (figs. 5 and 6).

SECTION IV

MAINTENANCE

NOTE: Unsatisfactory performance of Thermograph ML-77 or ML-277 will be reported immediately on W. D., A. G. O. Form No. 468. If form is not available, see TM 38-250.

18. GENERAL. **a.** Keep Thermographs ML-77 and ML-277 clean and free from dust and dirt. Dust the temperature element with a soft cloth about once a week. Handle the Bourdon tube carefully; slight bending will damage it.

b. Keep the cover closed except when adjustments are being made. When adjustments are required, dust the thermograph with a soft brush.

NOTE: Under normal conditions, if Thermographs ML-77 and ML-277 are given the care necessary for preserving such precision instruments, no further servicing will be required.

19. OILING THERMOGRAPH ML-77 OR THERMOGRAPH ML-277. **a. Oiling pivots.** After continued long use, or after a period when the air has been unusually dusty, wipe the pivots of the pen arm and of the horizontal shaft clean with a soft cloth, and then apply a small drop of grade No. 1 watch oil to Thermograph ML-77 or low-temperature oil to Thermograph ML-277. Apply to each pivot only the amount of oil that will cling to the end of a fine wire. Too much oil tends to collect dirt and dust. Resulting excess friction hinders the performance and accuracy of the thermograph.

b. Oiling clock movement. The clock movements of Thermograph ML-277 and Thermograph ML-77 should be oiled only at the instrument repair depot.

(1) *Exposures above 0° F.* Oil, Lubricating, Special, Specification AXS-777, should be used. If it is not available, grade No. 1 watch oil may be used for exposures above 0° F.

(2) *Exposures below 0° F.* (a) Use Oil, Lubricating, Special, Specification AXS-777, for the entire lubrication during subzero weather. This special lubricating oil remains in liquid form to -90° F.

(b) Cover the upright shaft with a light film of vaseline, but take care that no grease gets on the pinion or gear. Grease, Lubricating, Special, Specification AXS-637, may be substituted for vaseline.

20. MAINTAINING PEN AND PEN ARM. **a.** To adjust a pen which fails to make a fine, clear line, remove the pen from the pen arm and clean the pen after removing it from the pen arm.

(1) Hold the pen arm with one hand, and gently pull off the pen with the other.

(2) Wash the pen with soap and water. Scrape off dried ink which does not dissolve in soap and water, and then wash the pen again.

NOTE: Wash and scrape ink from the pen carefully. Scratches on the sides of the nibs near the point will change the usual capillary action of the pen. The nibs must fit closely together.

(3) If the pen fails to give a satisfactory record line after washing, replace it with a new pen.

b. If the pen has a point which is too blunt to draw a fine line, replace it with a new pen. If a new pen is not available, sharpen the rounded point on an oilstone.

c. Be sure the pen-arm swivel stud is next to the bevel at the end of the horizontal shaft (fig. 8).

d. Check the angle at which the vertical axis is tilted. If the vertical axis is tilted inward too much, it will cause excessive pressure. If the vertical axis is not tilted inward enough, the trace will be too light and may not be continuous.

e. If the pen arm rides on the shifting rod, either the shifting rod is bent, or the pen arm is set in too far on the horizontal shaft. The pen arm must be at the front edge of the shoulder of the shaft. To adjust the position of the pen arm, loosen the setscrew in the pen-arm swivel stud (fig. 8), and move the pen arm to the correct position.

21. INKING. Fill the barrel of the pen only half-full of ink. In foggy weather or during periods of prolonged mist and rain, the ink will absorb moisture and the barrel will overflow if it has been filled to capacity. If the pen barrel overflows because of the presence of excess moisture in the air, proceed as follows:

a. Empty the barrel with a small piece of blotting paper. Otherwise, the ink left in the barrel is diluted and makes an illegible record.

b. Fill the barrel with *new* ink.

NOTE: Thermograph ML-277 uses a special low-temperature ink. If this ink runs at higher temperature ranges, substitute the ink used in Thermograph ML-77.

22. REPLACING CHART. Move the pen away from the chart, and then lift the cylinder from the shaft. Remove the chart by sliding the clip upward and out of the lower slot. If the chart contains a record, handle the chart carefully to avoid smearing the trace. (See par. 7 and fig. 7 for detailed instructions for installing new chart.)

NOTE: After replacing the chart, always check the temperature indicated by the pen against a standard mercurial thermometer and readjust the adjusting thumbnut if necessary (par. 11 b).

23. CLOCK UNIT.

Caution: Never remove the clock from the cylinder in which it is mounted.

a. **Winding clock.** Wind Clocks ML-79-A and ML-279 once a week, preferably at the time the charts are changed (par. 8):

b. **Correcting time.** Open the sliding window marked FAST-SLOW in the top of the clock case, and adjust the regulator (fig. 3). Each graduation on the regulator represents 42 seconds in 24 hours.

(1) To increase the speed of rotation, move the regulator one graduation toward the FAST end. The speed of rotation increases 42 seconds per day or almost 5 minutes per week.

(2) Move the regulator one graduation toward the SLOW and to decrease the speed of rotation. The speed of rotation decreases 42 seconds per day or almost 5 minutes per week.

NOTE: Since the graduations on the chart do not permit a setting as close as 5 minutes, adjustment of the regulator within one graduation of correct time will be satisfactory.

c. Correcting binding gears. (1) Friction between the clock drive gear and the daily or weekly pinion causes the clock to stop. To correct this condition, proceed as follows:

- (a) Remove the cylinder from the shaft.
- (b) Loosen slightly the three screws at the base of the cylinder (fig. 3).
- (c) Note that the pinion shaft can now be shifted somewhat. Move the shaft to a position where no friction occurs at any point throughout an entire revolution.

NOTE: When the small gear has been moved correctly, backlash will occur when the cylinder is in any position.

- (d) Tighten the three screws at the proper setting.
- (2) Stiffening of lubricating oil in the bearings may cause the clock to stop in extremely cold weather.
 - (a) Take the instrument indoors, temporarily, to a temperature above freezing.
 - (b) When the clock is warm, try to start it by rotating it carefully on its axis.

d. In tropics. At least once every 3 months, send the clock unit with its shaft and gears to an instrument repair depot for cleaning and oiling.

e. Repairing poorly functioning clock. *Do not attempt to repair or adjust the clock mechanism of a poorly functioning clock.* Remove the cylinder, the shaft, and the large external gear. Pack them, and send them to an authorized repair depot. Be sure to include the shaft and gears, since they are necessary to test the clock.

f. Precautions. (1) Do not drop or subject the clock to mechanical shocks.

(2) Do not leave the clock movement exposed to excessive moisture. Excessive moisture causes rust and rust causes friction which stops the clock.

(3) When transporting the thermograph from one location to another or when returning it to a depot for repairs, pack the clock separately. Use enough packing material to protect the clock from shocks and vibration.

24. CALIBRATING THERMOGRAPH ML-77 OR ML-277 IN FIELD.

If Thermograph ML-77 or Thermograph ML-277 is set at one temperature or registers one temperature accurately, but, unless adjusted, does not register accurately a second temperature within a range of 5° of the first, recalibration is necessary. Accurate calibration is possible only at repair depots where the necessary equipment is available (par. 25). In the field, however, it is possible to recalibrate in the following manner:

a. Increasing sweep of pen arm. If the thermograph reading is too low for temperatures at the top of the chart and too high for temperatures at the bottom of the chart, the pen arm is swinging over too short an arc. To correct this condition, proceed as follows (fig. 8):

- (1) Loosen the setscrew in the calibrating block.
- (2) Turn the calibrating nut clockwise to move the vertical link nearer the horizontal shaft. This increases the sweep of the pen arm. Two or three turns of the calibrating nut may be necessary to take care of a 2- or 3-degree variation in temperature range.
- (3) Tighten the setscrew after the adjustment is made.
- (4) Reset the temperature adjusting thumbnut to the existing temperature.
- (5) Observe temperatures recorded by the thermograph long enough to get a maximum and a minimum reading. If the range is still incorrect, repeat the procedure until the required accuracy is obtained.

b. **Decreasing sweep of pen arm.** If the thermograph reading is too high for temperatures at the top of the chart and too low for temperatures at the bottom of the chart, the pen arm is swinging over too large an arc. To correct this condition, proceed as in *a* above, with the exception that the calibrating nut must be turned to move the vertical link *away* from the horizontal shaft. This shortens the sweep of the pen arm.

25. CALIBRATION AT DEPOT. a. **Thermograph ML-77.**(1) Suspend the thermograph over a water bath maintained at 32° F.

(2) Tilt the thermograph slightly so that the temperature element and part of the base are immersed in the water. Make sure that the clock and shaft do not get wet.

(3) Allow enough time for the unit to react, and then set the pen at 32° F. with the adjusting thumbnut.

(4) Remove the thermograph and place it in a water bath maintained at 100° F.

(5) Wait for the temperature element to react to temperature, and then read the chart.

(6) If the reading is not 100° F., shift the calibrating block to expand or contract the range as necessary.

(a) To increase the range, loosen the setscrew in the adjustment clamp and turn the calibrating nut *clockwise*.

(b) To decrease the range, turn the calibrating nut *counterclockwise*.

NOTE: Two or three turns of the calibrating nut may be necessary to compensate for a 2° or 3° variation from 100° F.

(c) Turn the calibrating nut until the pen moves halfway between the highest recorded temperature of the instrument and the 100° F. mark.

(7) Reset the pen to 100° F. with the temperature-adjusting thumbnut.

(8) Insert the thermograph in the bath and observe results.

(9) Additional adjustments may be necessary before the instrument is accurately calibrated. When calibration is completed, tighten the setscrew in the adjustable clamp.

b. **Thermograph ML-277.** The calibration of Thermograph ML-277 is identical to the calibration of Thermograph ML-77, with the exception that the baths for Thermograph ML-277 are maintained at temperatures of 32° F. and 75° F.

26. MOISTUREPROOFING AND FUNGIPROOFING. Moistureproofing and fungiproofing are not required for Thermographs ML-77 and ML-277.

SECTION V

SUPPLEMENTARY DATA

27. MAINTENANCE PARTS LIST FOR THERMOGRAPH ML-77.

NOTE: Order all maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Signal Corps stock No.	Name of part and description	†Station stock	Quantity per unit
7A1777.....	Thermograph ML-77: recording F. thermometer; includes Clock ML-79-A and case.		1
7A1777/1.....	Arm: pen.....		1
7A579A/C1...	Clip: chart; brass; $\frac{3}{16}$ " wide x $4\frac{1}{2}$ " (approx.) long; bends at both ends; Friez part No. ST-379-2; used with Clock ML-79-A and ML-279 (for thermograph record chart).	*	1
7A579A.....	Clock ML-79-A: 8-day; cylinder, 93-mm diam. x 130-mm long, w/clock movement inclosed; has spindle gears and attaching nut; makes one revolution in 7 days or one revolution in 1 day; weighs 3.5 lbs; p/o Thermograph ML-77.	*	1
6D120A.....	Form SC No. 120-A: range, -20° F. to $+110^{\circ}$ F.	*	1
7A1777/G1...	Glass: $3\frac{1}{16}$ " x $5\frac{3}{8}$ ", approximately 0.090" thick.		2
7A1102.....	Ink: special register; red; $\frac{1}{4}$ -oz. bottle...	*	1
7A1100.....	Ink: special register; green; $\frac{1}{4}$ -oz. bottle...	*	1
7A1101.....	Ink: special register; purple; $\frac{1}{4}$ -oz. bottle...	*	1
7A1777/N1...	Nut: arm; Friez part No. HT-15 (used with Thermographs ML-77 and ML-277).		1
6G1339.1....	Oil: watch; grade No. 1; nongum; 1-oz. bottle.	*	1
7A1208.....	Pen: nib type; front and rear clamps...	*	1
7A1777/P1...	Pin: arm; Friez part No. HT-19 (used with Thermographs ML-77 and ML-277).		1
7A1777/S2...	Screw: arm; Friez part No. HT-14 (used with Thermographs ML-77 and ML-277).		

See footnotes at end of table.

27. MAINTENANCE PARTS LIST FOR THERMOGRAPH ML-77— Continued.

Signal Corps stock No.	Name of part and description	†Station stock	Quantity per unit
7A1777/S3...	Spring: arm; Friez part No. HT-16 (used with Thermographs ML-77 and ML-277).		1

†Parts not stocked in station stock are carried in region or depot stock. (Consult ASF catalog Sig 10-900).

*Indicates stock available.

28. MAINTENANCE PARTS LIST FOR THERMOGRAPH ML-277.

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Signal Corps stock No.	Name of part and description	†Station stock	Quantity per unit
7A1797.....	Thermograph ML-277: recording F. thermometer; temperature range —80° F. to +80° F.; includes Clock ML-279 and case; similar to Thermo- graph ML-77 w/special bimetal temperature element for a standard Bourdon tube; requires special low- temperature ink and clock oil; for use in Arctic region.		1
7A1777/1....	Arm: pen.....	*	1
7A1797/C2...	Chart: thermograph record sheet; range +80° F. to —50° F.; weekly (used with Thermograph ML-277).	*	1
7A1797/C1...	Chart: thermograph record sheet; range +50° F. to —80° F.; weekly (used with Thermograph ML-277).	*	1
7A579A/C1..	Clip: chart; brass; $\frac{3}{16}$ " wide x $4\frac{1}{2}$ " (approx.) long; bends at both ends; Friez part No. ST-379-2; used with Clock ML-79-A and ML-279 (for thermograph record chart).	*	1
7A591-279...	Clock ML-279: Spec. 174-1; cylinder, 93-mm diam. x 130-mm long, w/clock movement inclosed; has spindle gears and attaching nut; ad- justable to make one revolution in 7 days or one revolution in 1 day; similar to Clock ML-79-A, except modified and tested for operation at —80° F.; weighs 3.5 lbs.; p/o Thermo- graph ML-277.	*	1

See footnotes at end of table.

28. MAINTENANCE PARTS LIST FOR THERMOGRAPH ML-277— Continued.

Signal Corps stock No.	Name of part and description	†Station stock	Quantity per unit
7A1777/G1...	Glass: 3 $\frac{1}{16}$ " x 5 $\frac{3}{8}$ " x (approx.) 0.090"		2
7A1099.....	Ink: special-register; used for low-tem- perature operation; 1-oz. bottle; Friez model No. 50 (used with Thermo- graph ML-277).	*	1
7A1797/L1...	Link: vertical; Friez part No. 43127 (used with Thermograph ML-277).		1
7A1777/N1...	Nut: arm; Friez part No. HT-15 (used with Thermographs ML-77 and ML- 277).		1
7A1797/O1 ..	Oil: low-temperature; 1-oz. bottle; Friez part No. 501199 (used with Thermo- graphs ML-77 and ML-277).	*	1
7A1208.....	Pen: nib type; front and rear clamps. ...	*	1
7A1777/P1...	Pin: arm; Friez part No. HT-19 (used with Thermographs ML-77 and ML- 277).		1
7A1777/S2...	Screw: arm; Friez part No. HT-14 (used with Thermographs ML-77 and ML- 277).		1
7A1777/S3...	Spring: arm; Friez part No. HT-16 (used with Thermographs ML-77 and ML-277).		1
7A1797/S1...	Spring: for vertical link; Friez part No. AF-193.		1
7A1797/E1...	Element: temperature; bimetal; with corrugated radiation vanes; Friez part No. 43126.		1

† Parts not stocked in station stock are carried in region or depot stock. (Consult ASF catalog Sig 10-900).

* Indicates stock available.



TECHNICAL MANUAL

THERMOGRAPHS ML-77, ML-77-A, AND ML-277

CHANGES }
No. 1 }WAR DEPARTMENT
WASHINGTON 25, D. C., 14 November 1945

TM 11-426, 17 July 1944, is changed as follows:

The title of this manual is changed to read: THERMOGRAPHS ML-77, ~~ML-77-A~~, AND ML-277.

1. PURPOSE (Superseded). Thermographs ML-77 and ML-77-A (fig. 1), and ML-277 (fig. 2) are self-contained instruments for producing a continuous permanent record of temperature on a paper chart. The record normally covers a period of 1 week, but provision is made for a daily record for special circumstances. Thermographs ML-77 and ML-77-A are identical and are used in all atmospheric temperatures above -50° F.; all references to Thermograph ML-77 in this manual also apply to Thermograph ML-77-A. Thermograph ML-277 is usable for temperatures as low as -80° F. and therefore is intended only for Arctic regions.

2. COMPONENT PARTS. a. Thermograph ML-77.

* * * * *

(2) (Superseded.) The items listed below must be procured separately. They are used with Thermograph ML-77 but are not supplied as part of the equipment.

Item	Signal Corps stock No.
Ink, special register, purple.....	7A1101
* Thermograph Chart ML-234 (range -50° to $+80^{\circ}$ F.).....	7A5291-234
* Thermograph Chart ML-235 (range -20° to $+110^{\circ}$ F.).....	7A5291-235

b. Thermograph ML-277.

* * * * *

(2) (Superseded.) The items listed below must be procured separately. They are used with Thermograph ML-277 but are not supplied as part of the equipment.

* The temperature range of Thermograph ML-77 is 160° (-50° to $+110^{\circ}$ F.), but the *recording range* at any setting of the adjusting thumbnut is only 130° . Note that each of the charts for Thermograph ML-77 covers 130° , one chart beginning at the lower end (-50°) of the temperature range, and the other chart ending at the highest end ($+110^{\circ}$), so that between the two charts the entire temperature range of the thermograph can be utilized.

Item	Signal Corps stock No.
Ink, low-temperature	7A1099
† Thermograph Chart ML-233 (range -80° to $+50^{\circ}$ F.)	7A5291-233
† Thermograph Chart ML-234 (range -50° to $+80^{\circ}$ F.)	7A5291-234

Figure 2.—Thermograph ML-277, development model (the temperature element of the production model does not have radiation fins (see fig. 6)).

Figure 4.—Thermograph ML-77—top interior view, showing clock spindle, clock change gears with cover removed, and indicating mechanism.

4. COMPARISON OF THERMOGRAPHS ML-77 AND ML-277. Primarily, Thermograph ML-277 differs from Thermograph ML-77 in three respects: the temperature element, the vertical link and accessories (ink, clock, and charts), and the range of operation. In all other * * * thermographs are identical.

* * * * *

Note. (Superseded.) Clock ML-279, which is used with Thermograph ML-277, is similar to Clock ML-79-A, the only difference being that Clock ML-279 is more loosely assembled for ability to perform at low temperatures and is lubricated with a low temperature oil.

* * * * *

b. Temperature element.

* * * * *

(2) Thermograph ML-277 (fig. 6). The temperature element * * * the pen arm. The bimetallic strip * * * and best exposure.

c. Temperature charts. (Superseded.) (1) Thermograph Charts ML-233, ML-234, and ML-235, each cover a temperature range of 130° on their vertical scales, with each graduation representing 1° F. and with each 10° F. interval labeled. Time is read on the horizontal scale of each chart, with each division representing an interval of 2 hours.

(2) Thermograph Charts ML-233, ML-234, and ML-235 are identical in all respects except for the labeling of the temperature graduations. Thus, any of the charts will fit on Thermograph ML-77 or ML-277, but because the ranges of labeled graduations vary with the charts, the chart to be installed each week must be selected with a view to the anticipated range of temperatures over which the thermograph is to operate, and with a view to the range limitations of the thermograph itself. (See par. 1.) The pen of the thermograph must be set to read in agreement with the graduations on the chart selected. (See par. 11b.)

* * * * *

† The temperature range of Thermograph ML-277 is 160° (-80° to $+80^{\circ}$ F.), but the recording range at any setting of the adjusting thumbnut is only 130° . Note that each of the charts for Thermograph ML-277 covers 130° , one chart beginning at the lower end (-80°) of the temperature range, and the other chart ending at the highest end ($+80^{\circ}$), so that between the two charts the entire temperature range of the thermograph can be utilized.

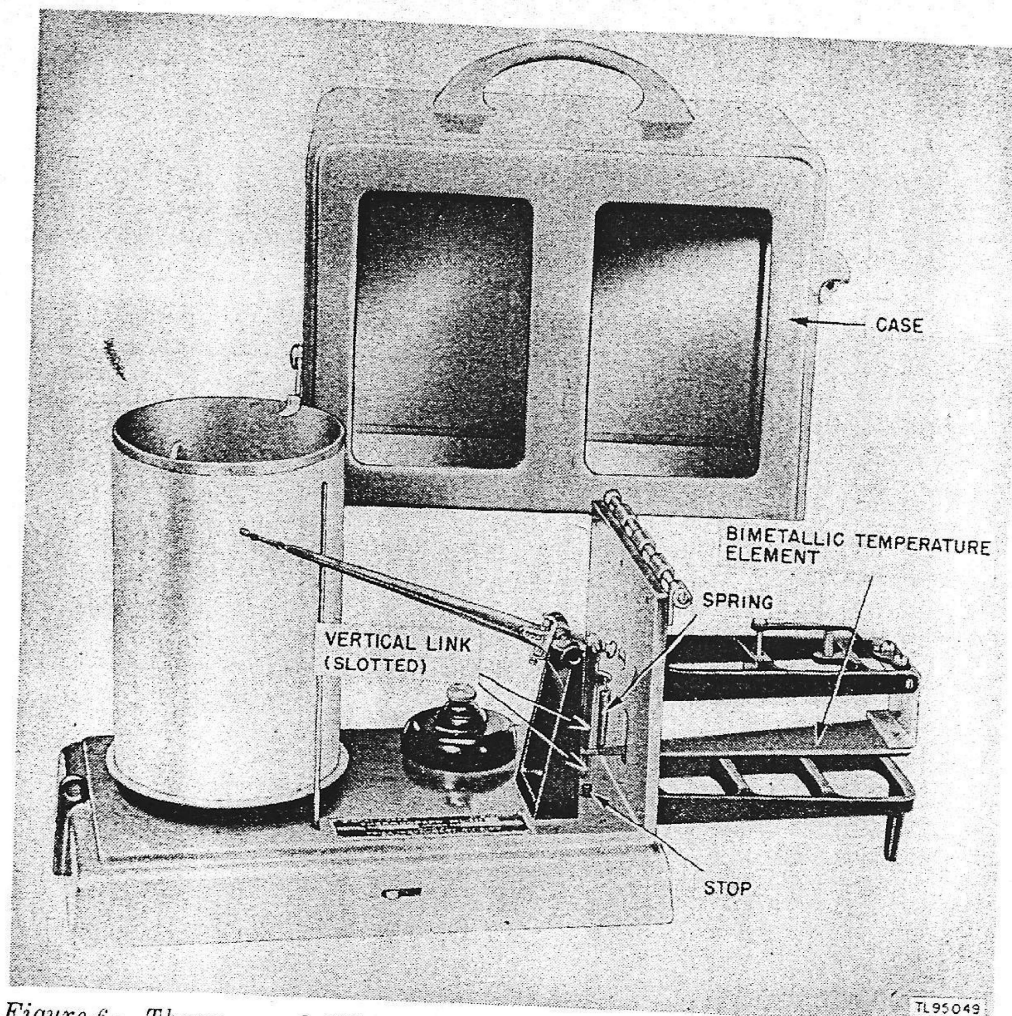


Figure 6.—Thermograph ML-277, production model, shown with case removed. (The development model (fig. 2) had radiation fins along the sides of the temperature element.)

11. ADJUSTING PEN TO TEMPERATURE. a. (Superseded.) Use Thermometer ML-7 or the dry bulb thermometer of Psychrometer ML-24 as a standard for comparison of the thermograph reading. If the thermograph is not located in an instrument shelter, hold the thermometer as near as possible to the temperature element of the thermograph. If the instruments are in an instrument shelter, leave the thermograph and the thermometer in their normal positions in the shelter. Allow sufficient time for both the thermograph and the thermometer to reach temperature equilibrium with the surrounding air. In making comparative readings, particularly when the temperature of the air is low, take care to prevent body heat from heating the instruments.

b. Turn the temperature * * * lowers the pen. If the instruments are not installed in an instrument shelter, be sure to perform this adjustment in a location where there is good

circulation of air around the temperature element and standard thermometer. *Never* use the * * * of the thermograph. Adjust the reading of the thermograph to the reading of the thermometer whenever charts are changed.

14. TEMPERATURE ELEMENT.

- * * * * *
- b. Thermograph ML-277.
- * * * * *
- (2) Rescinded.

15. VERTICAL LINK AND CALIBRATING MECHANISM.

- * * * * *
- b. Thermograph ML-277. (1) *Vertical link*. The vertical link, * * * above 80° F.
- (a) *Spring*. The spring (fig. 6) keeps the pin, which engages the vertical link, in contact with the upper end of the slot in the vertical link over the entire range of the temperature chart in use.
- * * * * *

SECTION IV

MAINTENANCE

Note (Superseded): Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on WD AGO Form 468 (Unsatisfactory Equipment Report); by Army Air Forces on AAF Form 54 (Unsatisfactory Report). If either form is not available, prepare letter containing the data elicited by the appropriate one of the sample forms shown in figures 9 and 10 without reproducing copies of the forms.

17.1. MEANING OF PREVENTIVE MAINTENANCE (Added). Preventive maintenance is a systematic series of operations performed periodically on equipment in order to maintain top efficiency in performance, to minimize unwanted interruptions in service, and to eliminate major break-downs. To appreciate the meaning of the term *preventive maintenance*, it is necessary to distinguish preventive maintenance from trouble shooting and repair. The primary function of preventive maintenance is to prevent major break-downs and the consequent necessity of repair. The primary function of trouble shooting and repair is to locate and correct existing defects. The importance of preventive maintenance cannot be overemphasized. The usefulness of Thermograph ML-77 or ML-277 depends upon its continuous operation at highest possible accuracy. Consequently, users and repairmen of thermograph equipment must maintain equipment properly.

Note. The operations in paragraphs 18, 20, 21, 22, 23, and 24 are first and second echelon (organization operators and repairmen) maintenance. The operations in paragraphs 19 and 25 are higher echelon maintenance.

17.2. DESCRIPTION OF PREVENTIVE MAINTENANCE TECHNIQUES

(Added). a. General. Most of the parts of any piece of equipment require routine preventive maintenance. Those requiring maintenance differ in the amount and kind required. Because maintenance techniques cannot be applied indiscriminately, definite and specific instructions are needed. The remainder of this paragraph contains information which will serve as a guide for personnel assigned to perform the six basic maintenance operations, namely: Feel, Inspect, Tighten, Clean, Adjust, and Lubricate. The standard lettering system for the six operations is as follows:

F—Feel *
I—Inspect
T—Tighten
C—Clean
A—Adjust
L—Lubricate *

The first two operations establish the need for the other four. The selection of operations is based on a general knowledge of field needs. For example, in dusty localities dust will filter into the equipment no matter how much care is taken to prevent it. Rapid changes in weather (such as heavy rain followed by blistering heat), excessive dampness, snow, and ice tend to cause corrosion of exposed surfaces and parts. Without frequent inspections and the necessary tightening, cleaning, and lubricating operations, equipment becomes undependable and subject to break-down when it is most needed.

b. Inspect. Inspection is the most important operation in the preventive maintenance program. A careless observer will overlook the evidences of minor trouble. Although these defects may not interfere with the performance of the equipment, valuable time and effort can be saved if they are corrected before they lead to major break-downs. Make every effort to become thoroughly familiar with the indications of normal functioning, in order to be able to recognize the signs of a defection. Inspection consists of carefully observing all parts of the equipment, noticing their color, placement, state of cleanliness, etc.

c. Tighten, clean, and adjust. These operations are self-explanatory. Specific procedures to be followed in performing them are given where necessary throughout the succeeding paragraphs in this section.

Caution: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

19. (Superseded.) OILING CLOCK MOVEMENT OF THERMOGRAPH ML-77 OR ML-277. The clock movement of Thermograph ML-77 or ML-277 is to be oiled *only* at an instrument repair depot.

* The Feel and Lubricate operations are not applicable to Thermograph ML-77 or ML-277.

a. Exposures above 0° F. Use Oil, Clock and Watch (OCW) for exposures above 0° F.

b. Exposures below 0° F. Use Oil, Lubricating Preservative, Special (PS), for subzero exposures.

c. Clock shaft. Cover the upright shaft with a light film of Grease, Lubricating, Special (GL), but take care that no grease gets on the pinion or gear.

24. (Superseded.) RESETTING RANGE OF THERMOGRAPH ML-77 OR ML-277 IN THE FIELD. If the daily range of temperatures as indicated by the thermograph differs persistently from the daily range as indicated by the maximum and minimum thermometers by as much as 2°, in a range of 20° or less, the instrument is out of calibration. Accurate recalibration can be made *only* at a repair depot. Field personnel, however, sometimes can bring the instrument back into calibration by resetting the range adjustment. If the range as indicated by the thermograph is *less* than the range indicated by the thermometers, the pen arm is swinging over too short an arc and the sweep of the pen arm should be increased. If the range as indicated by the thermograph is *greater* than that indicated by the thermometers, the pen arm is swinging over too long an arc, and the sweep should be decreased.

a. Increasing sweep of pen arm. If the pen arm is swinging over too short an arc, proceed as follows (fig. 8) :

(1) Loosen the setscrew in the calibrating block.

(2) Turn the calibrating nut clockwise to move the vertical link nearer the horizontal shaft. This increases the sweep of the pen arm. Two or three turns of the calibrating nut may be necessary to take care of a 2° or 3° variation in the temperature range.

(3) Tighten the setscrew after the adjustment is made.

(4) Reset the temperature adjusting thumbnut to the existing temperature.

(5) Observe the temperatures recorded by the thermograph long enough to get a maximum and a minimum reading. If the range still is incorrect, repeat the procedure until the required accuracy is obtained.

b. Decreasing sweep of pen arm. If the pen arm is swinging over too long an arc, proceed as instructed in a (1) through (5) above, except turn the calibrating nut to move the vertical link *away* from the horizontal shaft. This shortens the sweep of the pen arm.

26.1. UNSATISFACTORY EQUIPMENT REPORT (Added). a. AGF or ASF equipment. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel feel is normal, War Department Unsatisfactory Equipment Report (WD AGO Form 468) should be filled out and forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D. C. If the form is not available, prepare letter containing the data elicited by the sample form shown in figure 9 without reproducing copies of the form.

b. AAF equipment. When trouble in equipment used by Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form 54 should be filled out and forwarded as directed on the form. If the form is not available, prepare letter containing the data elicited by the sample shown in figure 10 without reproducing copies of the form.

WAR DEPARTMENT UNSATISFACTORY EQUIPMENT REPORT									
FOR	TECHNICAL SERVICE Signal Corps	MATERIEL	DATE 25 Jun 44						
FROM	ORGANIZATION 00th Field Artillery Observation Battalion	STATION APO 000, New York, N.Y.							
TO	NEXT SUPERIOR HEADQUARTERS Commanding General, X Corps	STATION APO 00, New York, N.Y.	TECHNICAL SERVICE Signal Corps						
COMPLETE MAJOR ITEM									
NOMENCLATURE Wind Transmitter ML-0-Z		TYPE	MODEL						
MANUFACTURER A.B.C. Company		U. S. A. REG. NO.	SERIAL NO. 0000						
EQUIPMENT WITH WHICH USED (If applicable)		DATE RECEIVED 10 Jun 44							
Wind Equipment SCM-00									
DEFECTIVE COMPONENT—DESCRIPTION AND CAUSE OF TROUBLE									
PART NO. 7A000.1	TYPE Anemometer head	MANUFACTURER X.Y.Z. Corporation	DATE INSTALLED 10 Jun 44						
DESCRIPTION OF FAILURE AND PROBABLE CAUSE (If additional space is required, use back of form)									
Field coils failed (probably because of humid conditions)									
DATE OF INITIAL TROUBLE 15 Jun 44	TOTAL TIME INSTALLED		TOTAL PERIOD OF OPERATION BEFORE FAILURE						
	YEARS --	MONTHS --	DAYS 5						
	YEARS --	MONTHS --	DAYS --						
		HOURS 106	MILES --						
		ROUNDS --							
BRIEF DESCRIPTION OF UNUSUAL SERVICE CONDITIONS AND ANY REMEDIAL ACTION TAKEN									
Operation in tropics. Unit oven-dried 8 Feb 44.									
TRAINING OR SKILL OF USING PERSONNEL		RECOMMENDATIONS (If additional space is required, use back of form)							
POOR	FAIR	GOOD							
		X	Redesign generator shaft.						
TYPED NAME, GRADE, AND ORGANIZATION John A. Doe, Capt., FA, Asst S-3 00th FA Observation Battalion			SIGNATURE <i>John A. Doe</i>						
FIRST ENDORSEMENT									
TO CHIEF	TECHNICAL SERVICE	OFFICE							
NAME, GRADE, AND STATION		STATION	DATE						
Instructions									
1. It is imperative that the chief of technical service concerned be advised at the earliest practical moment of any constructional, design, or operational defect in materiel. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data. 2. This form will be used for reporting manufacturing, design, or operational defects in materiel, petroleum fuels, lubricants, and preserving materials with a view to improving and correcting such defects, and for use in recommending modifications of materiel. 3. This form will not be used for reporting failures, isolated material defects or malfunctions of materiel resulting from fat-over-and-tear or accidental damage nor for the replacement, repair or the issue of parts and equipment. It does not replace currently authorized operational or performance records. 4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 740-10 (change No. 1). 5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches, or other illustrative material are highly desirable. 6. When cases arise where it is necessary to communicate with a chief of service in order to secure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means. 7. This form will be made out in triplicate by using or service organization. Two copies will be forwarded direct to the technical service; one copy will be forwarded through command channels. 8. Necessity for using this form will be determined by the using or service troops.									
W. D., A. G. O. Form No. 468 20 August 1944		This form supersedes W. D., A. G. O. Form No. 468, 1 December 1943, which may be used until existing stocks are exhausted. TL 97890A							

Figure 9.—Sample filled-out Unsatisfactory Equipment Report (AGO Form 468).

WAR DEPARTMENT AAF Form No. 54 (Rev. 2-15-43)		WAR DEPARTMENT ARMY AIR FORCES		LEAVE BLANK	
TO BE FILLED IN BY STATION		UNSATISFACTORY REPORT		A. S. C. SERIAL No. REFER TO CLASS	
STATION SERIAL No.	DATE SUBMITTED	(See AAF Reg. 15-54 for Information on Proper Use of this Form)			
14 PAD 44	5 Jan 44				
STATION Panama Air Depot		ORGANIZATION 909th Signal Co Depot Avn			
SUBJECT OF REPORT Radio Set SCR-588-B, U.S. Ser. #50		Manufacturer R.E.L.		AAF Order or Shipment No.	
AIRCRAFT—Model & AAF Serial No.		ENGINE—Model & AAF Serial No.		UNIT OR ACCESSORY—Type, Model and Serial No. Antenna Control KC-388-B	
AIRCRAFT REPORTS ONLY LAST O. L. R.—Report		Date		Flying Time Since Total Flying Time	
ENGINE REPORTS ONLY LAST OVERRUN—Report		Hours Since		Reports and Hours At Each Previous Overhaul	
Name Plate Transformer, R.E.L. #14033		Part Drawing, Serial and Specification No. Item T1, Fig 21, Power Turning Gear Bk			
Time in Use 1,500 hours		Quantity on Hand 3		Quantity Known Defective 1	
Indicate by "X" Disposition of Exhibit		No. Previous Failures 2		Manufacturer Hammond	
☐ Photographed and Prints Enclosed ☒ Held for Instructions ☐ Sent Under Separate Cover ☐ Sent in Attached Package ☐ Required and Returned to Service ☐ Disposed of (Explain Below) ☐ To Overhaul Facility (INITIALS)		Inspector's No. or Identification X31752			
GIVE COMPLETE DETAILS, PROBABLE CAUSES AND RECOMMENDATIONS BELOW: (Use Only Applicable Spaces Above—Avoid Unnecessary Repetition)					
EXPEDITE					
1. This organization has experienced three (3) plate transformer failures in the Thyratron control of an Early Warning Ground Radar Set, SCR-588-B, located in the vicinity of Panama. This set has been in operation for approximately nine (9) months, twenty-four (24) hours a day, except when shut down for brief periods during which time the set was given a complete preventive maintenance check-up. This set has had an inspection by an engineer from the PAD monthly and no abnormal operating conditions were observed. 2. While the Thyratron is not equipped with the Thyratron Fan Modification Kit, No. 5888-A2, the operating temperature was not abnormal due to air conditioning of the room and also to the removing of the Thyratron side panels. The operating room was maintained at 72° and humidity at 50%. 3. After being in service for about two months, the transformer became very hot, smoke poured out, and antenna became inoperative. Upon investigation, one secondary of the transformer was found to have had shorted turns. The circuit and all relative parts and components were thoroughly checked afterward and proved in proper working condition. This transformer had been impregnated against moisture. This part had been manufactured by the Hammond Company. The two previous defective parts had been manufactured by the Canadian Transformer Company. 4. It is the opinion of this organization that the fault lies in improper design of the transformer. As a substitute, four small receiver type transformers were installed externally, which proved operationally satisfactory.					
ROUTING		SEND ORIGINAL AND TWO COPIES DIRECT TO COMMANDING GENERAL, HQ, AIR SERVICE COMMAND, PATTERSON FIELD, FAIRFIELD, OHIO. U. S. GOVERNMENT PRINTING OFFICE: 1942 34-2440C-1			

Figure 10.—Sample filled-out Unsatisfactory Report (Army Air Forces Form 54).

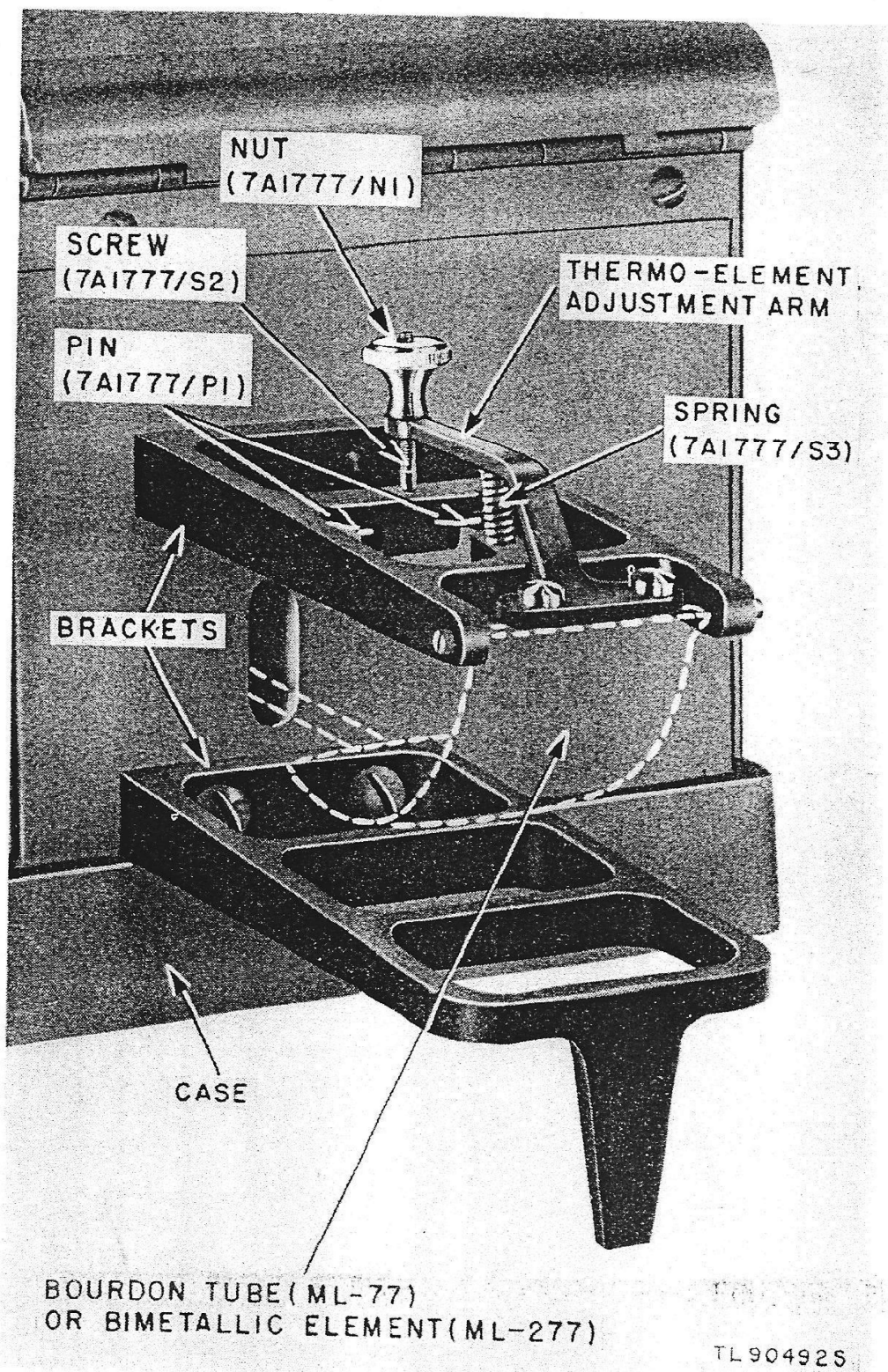


Figure 11.—Thermograph ML-77 or ML-277, thermo-element adjusting arm and bracket.

29. MAINTENANCE PARTS FOR THERMOGRAPHS ML-77 AND ML-277 (Added). The following information was compiled on 16 June 1945. The appropriate pamphlets of the ASF Signal Supply Catalog for Thermographs ML-77 and ML-277 are:

Organizational Spare Parts:

SIG 7-ML-77

SIG 7-ML-277

Higher Echelon Spare Parts:

SIG 8-ML-77

SIG 8-ML-277

Fixed Plant Maintenance List:

SIG 10-900, Meteorological Equipment

For an index of available catalog pamphlets, see the latest issue of ASF Signal Supply Catalog SIG 2.

[AG 300.7 (23 Jul 45)]

BY ORDER OF THE SECRETARY OF WAR:

OFFICIAL:

EDWARD F. WITSELL

Major General

Acting The Adjutant General

G. C. MARSHALL

Chief of Staff

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Refer to FM 21-6 for explanation of distribution formula.