T. O. 33D2-3-5-1

HANDBOOK

OPERATION AND SERVICE INSTRUCTIONS

TESTER, FUEL QUANTITY GAGE

TYPE MD-1

(GENERAL RADIO CO.)

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE
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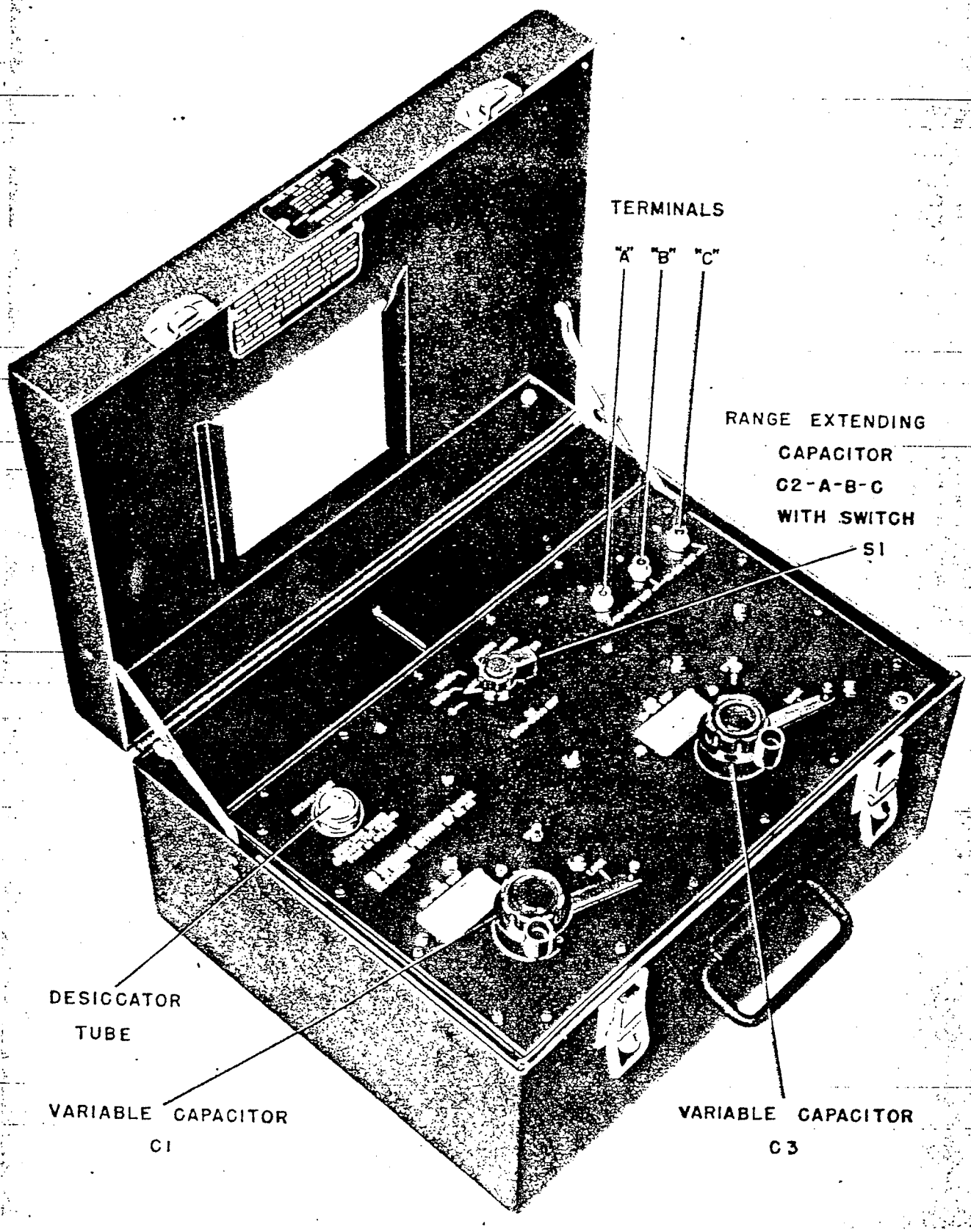

Figure 1-1. Fuel Quantity Gage Tester, Type MD-1.

SECTION I

INTRODUCTION AND DESCRIPTION

1-1. INTRODUCTION.

1-2. This handbook contains a description of the Fuel Quantity Gage Tester, Type MD-1, together with operating instructions, periodic inspection, maintenance, trouble shooting, and calibration procedure.

1-3. The tester is manufactured by the General Radio Company, 275 Massachusetts Ave., Cambridge, Mass. under their Type No. P-579 in conformance with MIL-T-8579 specifications. It has Air Force Stock Number 7CAC-806250 and A.S.O. Stock No. R88-T-0941-005-000.

1-4. PURPOSE AND USE.

1-5. The tester is intended for use in calibrating and adjusting capacitance-type fuel quantity indicating systems as used in modern aircraft, and as manufactured by several different firms. Fuels used in modern jet-engine aircraft vary widely in composition, and as a result exhibit relatively broad variations in dielectric constant and density. Compensation of the dielectric-constant type is employed primarily in the basic capacitor-type fuel gage for purposes of minimizing the errors in indication caused by the variations in the fuels. The composition of fuels used in reciprocating-engine aircraft does not vary appreciably and as a result compensation is not required for fuel gages installed in this group of aircraft.

1-6. DESCRIPTION OF TESTER.

1-7. The tester (see figure 1-1) consists essentially of two calibrator units (C1 and C2 comprising one unit, and C3 the other) mounted on an aluminum panel which in turn is mounted on an aluminum instrument case. A Correction Chart is supplied with the tester (refer to paragraph 1-17). Nine connector cables and three tee adaptors are also furnished (refer to paragraph 1-19).

1-8. The aluminum panel and instrument case combination unit containing the two calibrator units is mounted in the front compartment of an aluminum transit case. The rear compartment of the transit case provides a place in which to store the connector cables and tee adaptors. The aluminum panel and instrument case combination is attached to the transit case through Lord bonded-rubber mountings, and washers are provided for snubbing. Foam rubber strips are cemented to three sides of the transit case and to the partition near the level of the panel of the calibrator units. These rubber strips serve to snub shock or vibratory motion of the calibrator units in a fore-and-aft or sidewise direction. The transit case has a black wrinkle finish, and is provided with a hinged cover, toggle-type hasps, rubber feet on two faces, and a carrying handle.

1-9. The variable capacitor C1 of the first calibrat unit has a direct-calibrated range alone of 50 to 11 uuf. Higher capacitances, up to a maximum of 61 uuf direct-reading, can be secured by adding in (switching) the proper step of the fixed range-extendi capacitor C2, which has five steps of successive mult ples of 1000 uuf. The variable capacitor C1 and t three fixed capacitors making up C2 have been design to simulate precisely the action of the tank units r quired for uncompensated as well as compensated fu gages.

1-10. The variable capacitor C3, comprising the s cond calibrator unit, has a direct-calibrated range 10 to 210 uuf. This variable capacitor has been d signed to simulate precisely the action of the con pensator sensing unit required for compensated fu gages.

1-11. The three capacitors, C1, C2 and C3, as stat above are attached to an aluminum panel which mounted on the sealed aluminum instrument case (s figure 1-2). These three capacitors are of the thre wire variety, that is, they have both electrodes electr cally disconnected from shield or ground, and have metallic shield for grounding purposes.

1-12. The shaft and frame of each of the variable c pacitors C1 and C3, are attached mechanically a electrically to the aluminum panel and instrument ca combination, which serves as the grounded shie mentioned above in paragraph 1-11. The rotor a stator plates of the variable capacitors are insulat respectively from the shaft and from the frame. Ea of the variable capacitors has a spinner knob and dia locking arm located immediately in front of the gla window on the front panel through which its main di and vernier dial are visible (see figure 1-1).

1-13. Each of the three fixed capacitors making up C is of silvered-mica construction. Each capacitor completely enclosed in a sealed copper case which pr vides both shielding and further protection from moi ture for the hygroscopic mica. These three fixed c pacitors are interconnected by a switch, located in t upper center of the front panel, to provide five equ steps of successive multiples of 1000 uuf (refer paragraph 1-9).

1-14. The internal wiring of the tester terminates three mutually different receptacles, located in the u per right-hand corner of the panel (see figure 1-1 These terminals are marked "A", "B" and "C" and t connections made are indicated in the schematic dia gram of the tester (see figure 4-1). The shells of a three receptacles are directly connected to the pane

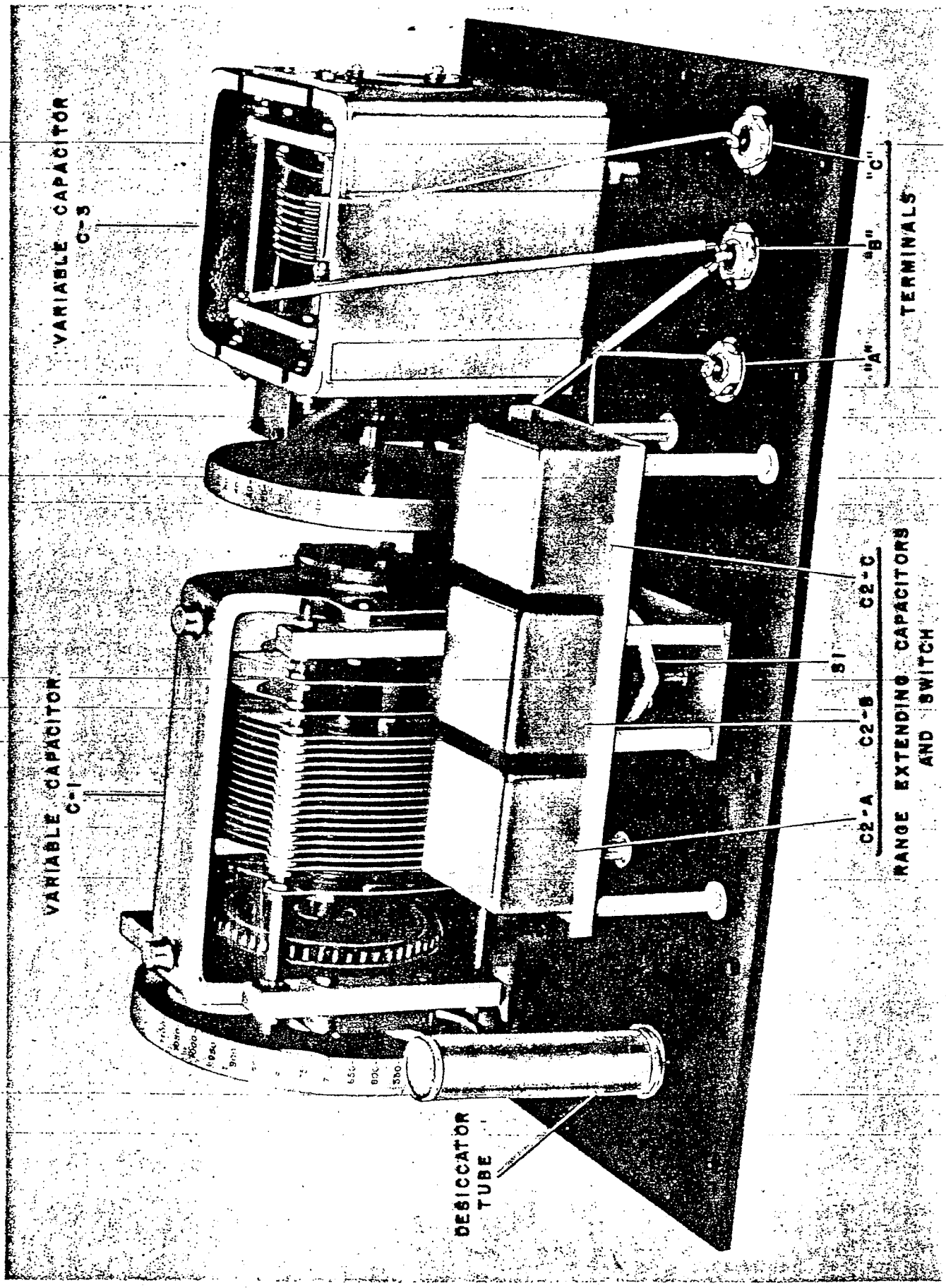

Figure 1-2. Front Panel of Tester, Rear View

1-15. DESCRIPTION OF REMOVABLE DESICCATOR TUBE.

1-16. A removable indicating-type desiccator tube is mounted in the upper left-hand corner of the panel (see figure 1-2). This desiccator tube is a plastic tube filled with 20 grams of silica gel desiccant granules. The granules contain a coloring material to indicate the state of their moisture-absorbing ability. When they are dry, the color is a definite blue. As they take up moisture the color changes to pink, and then to tan, at which time the desiccant will no longer fulfill its function and a new desiccant tube must be installed. The desiccator tube is designated as Protek Plug No. 23274 and is manufactured by Chandler-Evans Division, Niles-Bemont-Pond Company, 1 Charter Oak Blvd., West Hartford, Conn.

1-17. DESCRIPTION OF CORRECTION CHART.

1-18. In a card holder, integral with the inside of the cover of the transit case, will be found an individual Correction Chart for capacitors C1, C2 and C3. This chart gives actual capacitance corrections. While capacitors are adjusted closely, they can be measu with greater precision, and corrections reflecting s measurements on a particular tester are entered this individual Correction Chart. The chart is t laminated between two transparent plastic sheets give it mechanical and environmental protection. plying the corrections set forth on this chart will sult in obtaining the highest degree of accuracy fr the tester. The Correction Chart applies only to tester to which it is keyed by a written-in Serial

1-19. DESCRIPTION OF CONNECTOR CABLES A TEE ADAPTORS.

1-20. In the rear compartment of the transit case a stowed nine connector cables and three tee adapto The cables are listed and identified in Table I. tee adaptors (and the receptacles mounted on the pan of the tester) are listed and identified in Table II. manufacturers code used in both tables is given in ble III. The connector cables and tee adaptors are shown in figure 1-3.

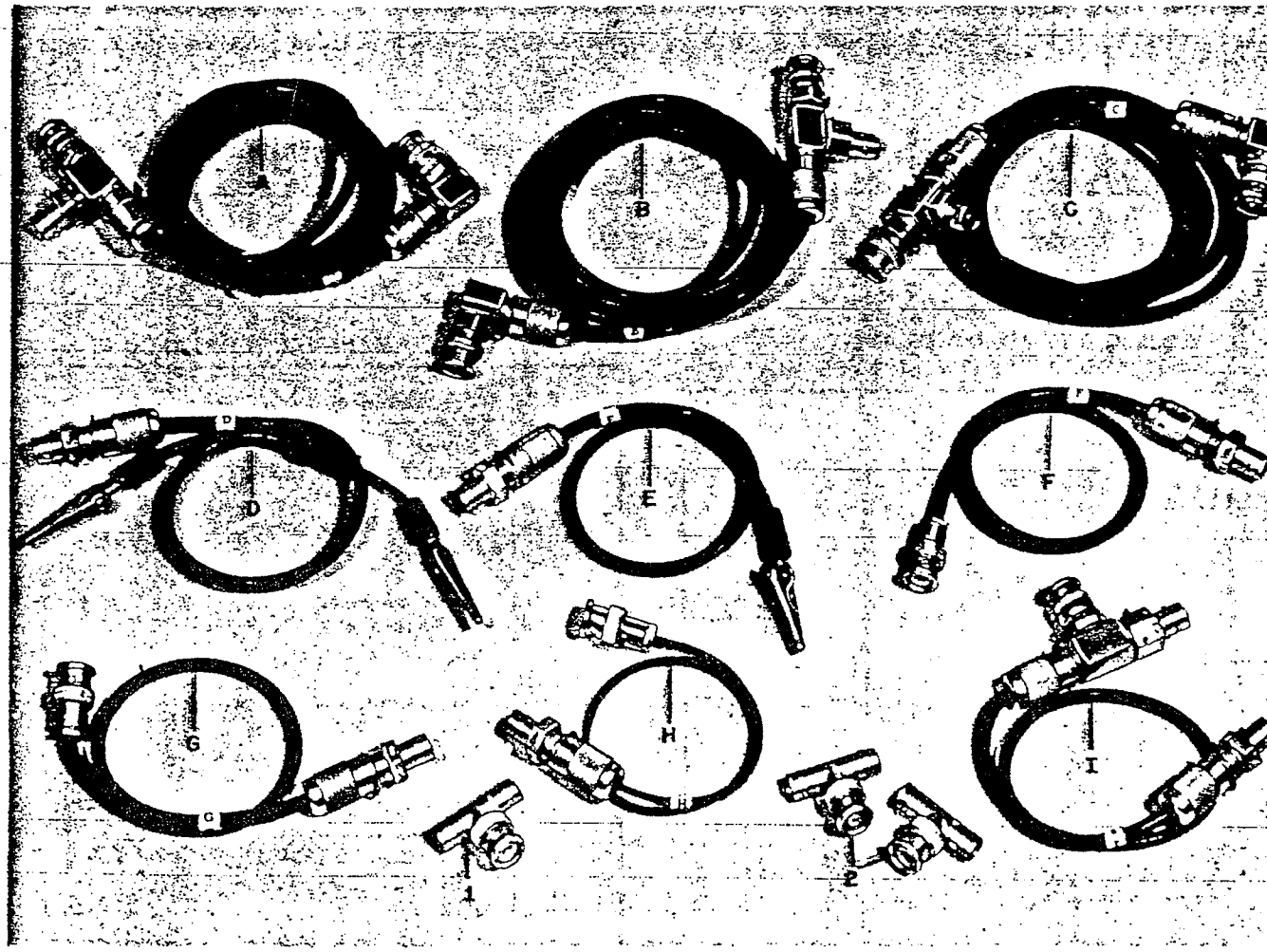

Figure 1-3. Connector Cables and Tee Adaptors supplied with Fuel Quantity Gage Tester, Type MD-1.

TABLE I. CONNECTOR CABLES FOR TESTER TYPE MD-1

Tag End Connector				Other End Connector			Wire			
Tag	Type	Mfr Code	Part No.	Type	Mfr Code	Part No.	Length (ft)	Type	Mfr Code	Part No.
A	Angle	MH	412266H	Tee	MH	412267T	6	Unshielded	GAVM	No.18 ga., No.31, B*
B	Angle	MH	412266R	Tee	MH	412267L	6	Coaxial	-	RG-58C/U
C	Angle	MH	412266M	Tee	MH	412267EK	6	Unshielded	GAVM	No.18 ga., No.31, B*
D	Straight	MH	412269F	Test Clip	MUE	60S, 1 Red, 1 Black	1	Coaxial	-	RG-58C/U
E	Straight	MH	412269B	Test Clip	MUE	60S, Red	1	Unshielded	GAVM	No.18 ga., No.31, B*
F	Straight	MH	412269F	Straight	-	UG-88/U	1	Coaxial	-	RG-58C/U
G	Straight	MH	412269B	Straight	KE	LC-53-03**	1	Unshielded	GAVM	No.18 ga., No.31, B*
H	Straight	MH	412269J	Straight	IPC	13925 (UG-88/U Modified)	1	Unshielded	GAVM	No.18 ga., No.31, B*
I	Straight	MH	412269J	Tee	MH	412267BM	1	Unshielded	GAVM	No.18 ga., No.31, B*

*B indicates Black
**Or LC (Liquidometer Corp.) EA5202R-2A, or IPC (Industrial Products Co.) 14350

TABLE II. TEE ADAPTORS AND PANEL RECEPTACLES FOR TESTER TYPE MD-1

No.	Mfr Code	Part No.
Adaptors		
1	KE	LC-93-03*
2	-	UG-274A/U
Receptacles**		
"A"	MH	415607B
"B"	MH	415607A
"C"	MH	415607C

*Or LC (Liquidometer Corp) EA5203R
**Mounted on panel of Tester

TABLE III. MANUFACTURER'S CODE

Code	Name and Address
GAVM	Gavitt Manufacturing Company Brookfield, Mass.
IPC	Industrial Products Company Danbury, Conn.
KE	Kings Electronics Co., Inc. 46 Marbledale Road Tuckahoe, N.Y.
LI	Liquidometer Corporation 36th & Skillman Ave. Long Island City, N.Y.
MH	Minneapolis-Honeywell Regulator Co. Aeronautical Division 2600 Ridgeway Road Minneapolis 13, Minn.
MUE	Mueller Electric Co. 1597 East 31 St. Cleveland, Ohio

SECTION II

SPECIAL SERVICE TOOLS

2-1. No special tools or fixtures are required for the operation or maintenance of the tester.

SECTION III

PREPARATION FOR USE, STORAGE, OR SHIPMENT

3-1. PREPARATION FOR USE.

3-2. There are no special instructions needed for preparing the tester for use other than to check the condition of the desiccator tube on the panel. When the tester has been removed from the container in which it was shipped, the removable desiccator tube on the panel should be checked for moisture presence and replaced if necessary (refer to paragraphs 1-15 and 5-3). The tester is then ready for use.

3-3. STORAGE.

3-4. When stored for any length of time, a new desiccator tube should be installed in the panel (refer to paragraphs 1-15 and 5-3) and the tester then sealed in a moisture-proof container. This container should th be packed in a sturdy cardboard box cushioned wi packing material. If storage conditions are apt to l damp, it would be well to place a desiccant inside t cardboard box. Before storage, mark the box "Fu Quantity Gage Tester, Type MD-1" for identificatio

3-5. SHIPMENT.

3-6. When the tester is to be shipped, it should fir be packed as instructed above in paragraph 3-3. the tester is to be shipped to a hot or humid area, mal certain the moisture-proof container is secure sealed. Labels indicating that the shipment is "Fr gile" should be placed on the exterior of the shippin box.

SECTION IV

OPERATION INSTRUCTIONS

4-1. PRE-OPERATION CONNECTIONS.

4-2. The tester should be connected to the equipment to be tested by means of the connector cables and tee adaptors (see Tables I, II and III and figure 1-3) supplied with the tester (refer to paragraph 1-19) selected as needed to test a particular fuel quantity gage. The connector cables "A", "B" and "C" are provided with tee-connections which along with the three tee adaptors permit the Tester to be simultaneously connected with the respective fuel gage electronic units (amplifiers or power units) and the respective tank unit circuits. The most commonly encountered connections to be made are indicated in the paragraphs which follow.

4-3. Connector cables identified by tags "A", "B" and "C", have been designed to form the main connecting link between the tester and the fuel gage equipment under calibration or testing, or both, for the majority of the fuel gage power units manufactured by Minneapolis-Honeywell.

4-4. When connecting the tester to Fuel Gage Pow Calibrator Units, Parts No. G1099B and No. G1099 manufactured by Minneapolis-Honeywell, it is nece sary to employ connector cables "D" and "E" respe tively with connector cables "B" and "A".

4-5. When connecting the tester to the BNC-type co nectors provided on fuel quantity gage equipment of t capacitor type, manufactured by Simmonds Aeroce sories, Inc., the Liquidometer Corporation, or Avie Kinckerbocker, Inc., it is necessary to employ co nector cables "F", "G" and "H", along with two UC 274A/U tee adaptors and one Kings Electronic (K type LC-93-03 tee adaptor, for connecting the cab connectors "A", "B" and "C" to the fuel gage amp fiers and power units manufactured by the abov named three firms.

4-6. When connecting the tester to the compensator r ceptacle provided for Power Unit, Part No. RG7021 manufactured by Minneapolis-Honeywell, it is nece

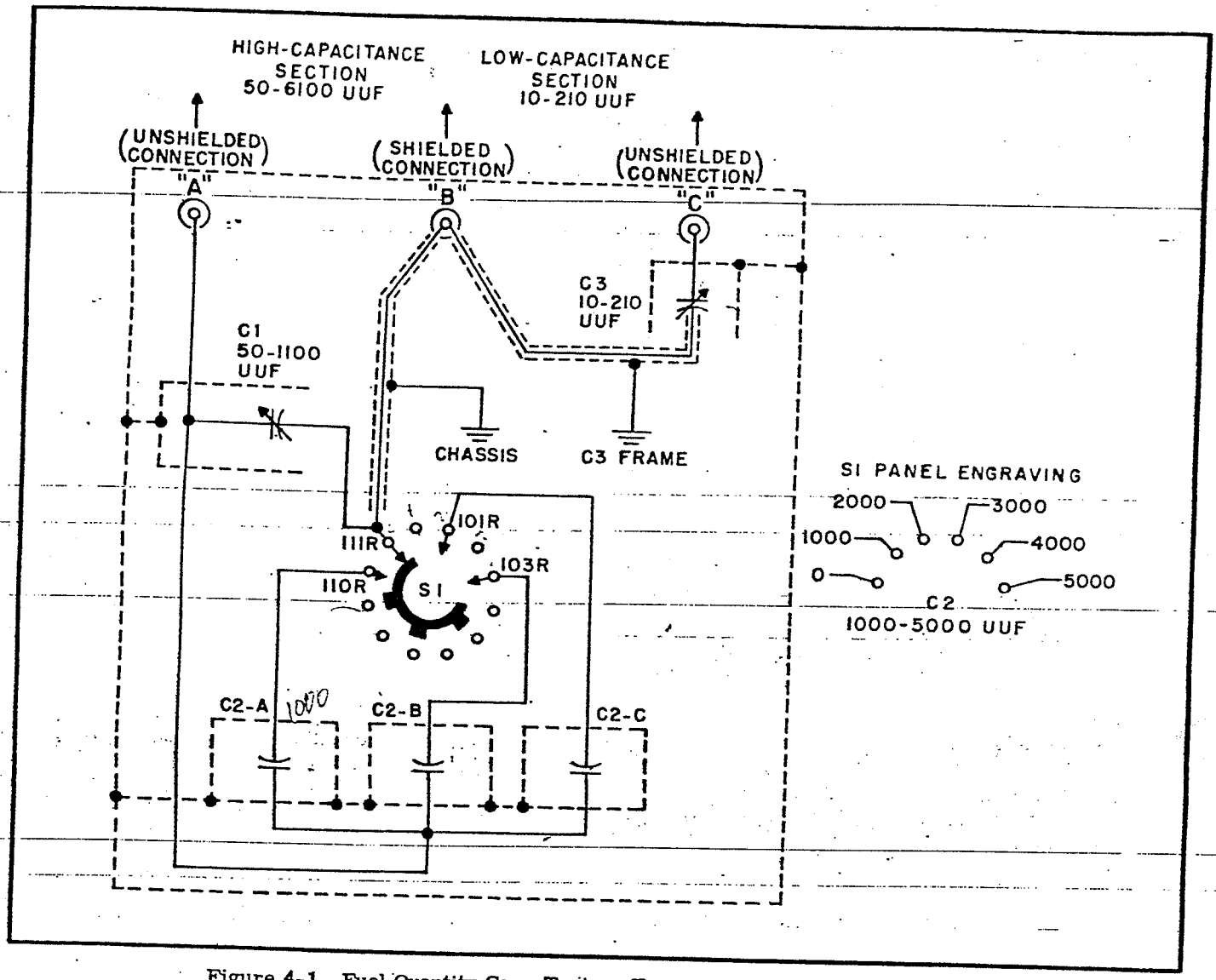

Figure 4-1. Fuel Quantity Gage Tester, Type MD-1, Schematic Diagram

sary to employ connector cable "T" with connector cable "C".

4-7. USE OF CAPACITORS C1 AND C2.

4-8. A schematic diagram of the tester is shown by figure 4-1. Where capacitances greater than the initial range of the variable capacitor C1 are required, the range-extending capacitor C2, set to the proper value, must be used. The capacitances required may be selected by rotating the knobs on the panel of the tester and observing the readings on the main and vernier dials of C1. The vernier dial of C1 is graduated in increments of 0.2 uuf.

4-9. If the range-extending capacitor C2 is used, the reading of C1 plus the setting of C2 will give the capacitance actually in use. For example, if 1558 uuf is the desired capacitance, the 1000 uuf setting for C2 must be used and the selector knob of C1 turned until 578 uuf is indicated on the dials of C1, corrected if desired by the data on the Correction Chart (refer to paragraphs 1-17 and 4-13). After the desired capacitance has been obtained the dial-locking arm should be moved to the locked position.

4-10. USE OF CAPACITOR C3.

4-11. Variable capacitor C3 has both a main and a vernier dial. The vernier dial is graduated in increments of 0.05 uuf. This capacitor is normally used when calibrating and adjusting compensated fuel gages of the capacitor type. When capacitor C3 is needed for a particular adjustment, a cable should be connected to its receptacle (marked "C" on the panel), the dials of C3 set to the desired capacitance, and then locked with the dial-locking arm.

4-12. If the compensating capacitor C3 is not required no cable should be attached to the receptacle marked "C" and the "WARNING" notice on the etched plate mounted on the inside of the hinged cover of the transit case should be carefully read and heeded. This plate is shown by figure 4-2.

4-13. USE OF CORRECTION CHART.

4-14. To obtain the highest degree of accuracy from the tester the Correction Chart should be used (refer to paragraph 1-17). When corrections are to be applied

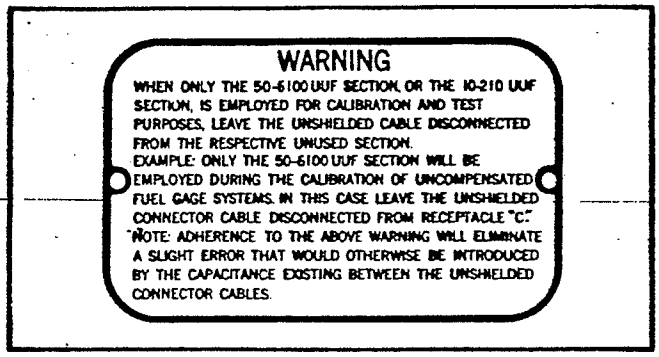

Figure 4-2. Warning Plate of Tester

they should be made as follows:

a. If the correction is listed on the chart in the "Add" column, it should be added to the dial reading to obtain the true capacitance. Conversely, to obtain a particular desired capacitance, the dial must be set to a reading less than the capacitance value by the amount of the "Add" correction.

b. If the correction is listed on the chart in the "Subtract" column it should be subtracted from the dial reading to obtain the true capacitance. Conversely, to obtain a desired capacitance the dial must be set to a reading greater than the capacitance value by the amount of the "Subtract" correction.

c. For example: suppose the correction at 650 uuf is "Add 0.6 uuf". If the dial is set to 650 the actual capacitance is 650.6 uuf. Conversely, to obtain an actual capacitance of 650 uuf, the dial must be set at 649.4 uuf.

4-15. USE OF TECHNICAL ORDERS.

4-16. For detailed operating instructions relative to the use of the tester with any particular airplane application refer to the applicable -2 Technical Order provided for that airplane.

SECTION V

PERIODIC INSPECTION, MAINTENANCE, AND LUBRICATION

5-1. PERIODIC INSPECTION.

5-2. The tester, connector cables, and tee adaptors should be regularly inspected in accordance with the schedule given in Table IV. Particular attention should be given the removable desiccator tube (refer to paragraph 1-15) and if the tube indicates the presence of internal moisture in the tester a new desiccator tube should be installed as directed in paragraph 5-3.

5-3. REPLACEMENT OF DESICCATOR TUBE.

5-4. The desiccator tube has a small protective dished plastic disc, shaped like a watch glass, cemented to the perforated end of the tube to seal the desiccant against moisture until the tube is put into use. Immediately before inserting a new desiccator tube into the panel, this protective plastic disc must be removed. When installing the new desiccator tube, be sure first, that the rubber O-ring (which will seal the tube to the panel) seats properly in the counter bore around the hole in which the desiccator tube is mounted, if this is not properly done, the seal will not serve its proper function; and second, that the desiccator tube is turned up snugly against the O-ring so as to make a tightly sealed connection. Figure 5-1 shows two desiccator tubes; the one at the top with the protective plastic disc attached, and the one at the bottom with the disc removed.

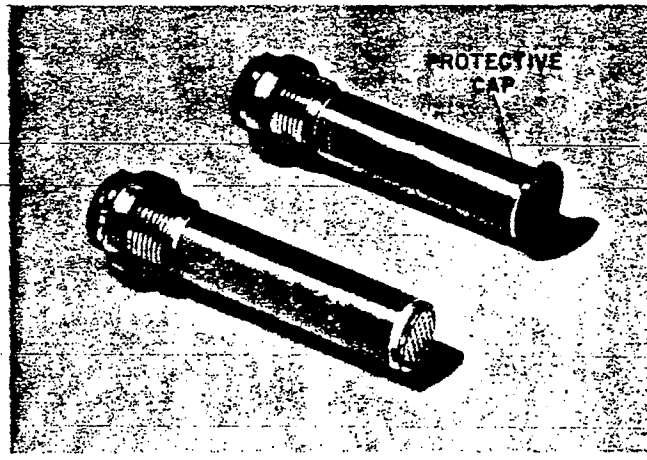

Figure 5-1. Two Desiccator Tubes - Top one showing Protective Disc attached; Bottom one showing Protective Disc removed.

5-5. MAINTENANCE.

5-6. The tester is a self-contained precision instrument and no maintenance work other than that given in Table IV, should be done. If the tester, along with the connector cables and tee adaptors, does not function satisfactorily it should be returned to the depot for maintenance work.

5-7. CLEANING METHODS.

5-8. When cleaning the tester use only a dry clean cloth, or a very soft hair brush. When cleaning the panel of the tester be especially careful not to damage the glass windows over the main and vernier dials. Clean the Correction Chart only with a slightly water-moistened clean cloth; do not use any type of solvent to clean this chart. Clean the connector cables and tee adaptors only with a dry cloth. Never use a damp cloth to clean the cables.

5-9. If dirt or corrosion exists on the exterior of the

transit case that cannot be removed with a dry cloth, use a cloth moistened slightly with cleaning solvent, and then wipe thoroughly dry. For dirt and corrosion that cannot be removed with solvent alone use crocus cloth; then after cleaning, reclean with solvent and wipe dry. Never use steel wool to clean the transit case; minute particles may somehow enter the tester and cause damage.

5-10. If the finish on the exterior of the transit case becomes badly scarred or damaged, corrosion may be prevented by touch-up painting of the damaged places. To do so, first clean the damaged spots down to a bare metal surface using a No. 00 or 000 sandpaper (do not use steel wool). When ready to paint, refer to service manuals for type of paint to use.

5-11. CONNECTOR CABLES AND TEE ADAPTORS.

5-12. Each connector cable and tee adaptor should be periodically checked for continuity. The direct-current resistance of each cable and adaptor shall be measured with a reliable megohm-meter. The measurements shall be taken between the center conductor and each respective connector shell. The readings established shall be not less than 1000 megohms. Each separate tee adaptor shall be checked for proper continuity and also direct-current resistance. The direct-current resistance readings shall be not less than 1000 megohms.

5-13. LUBRICATION.

5-14. While in service, and during periodic inspection, no lubrication is required for the tester. If the tester is returned to a depot for maintenance (Refer to Paragraph 6-1) or the unit is completely overhauled, lubricant in accordance with MIL-G-3278 should be applied to (1) the worm (2) to worm shaft bearings (3) condenser rotor shaft bearings. No other lubrication is required.

TABLE IV. PERIODIC INSPECTION CHART

What to Check	How to Check	Precautions
MONTHLY		
1. Operation check.	a. Follow operation instructions given in Section IV.	a. If tester does not function property return to depot.
2. Exterior of transit case and front panel.	a. Visually inspect for dirt, corrosion, and fungus growth.	a. Clean as directed in paragraph 5-7.
	b. Check for loose panel screws and control knobs.	b. Tighten, but not beyond a firm fit.
	c. Visually check condition of desiccator tube (refer to paragraph 1-15).	c. Install new desiccator tube if necessary (refer to paragraph 5-3).
3. Connector cables and tee adaptors.	a. Visually inspect for dirt, corrosion, and fungus growth.	a. Clean as directed in paragraph 5-7.
	b. Visually inspect for broken or defective connector receptacles and cables.	b. Return to depot if repairs are needed.
	c. Check each cable and tee adaptor for continuity and resistance.	c. Refer to paragraph 5-11. for method of making continuity and resistance tests.
SIX-MONTHS.		
1. Same as MONTHLY check.	a. Same as MONTHLY check.	a. Same as MONTHLY check.
2. Calibration.	a. Follow procedure given in Section VII.	a. Only trained personnel should calibrate the tester.

SECTION VI

TROUBLE SHOOTING

6-1. If the Fuel Quantity Gage Tester, Type MD-1, is suspected of being out of adjustment, or has been subjected to rough usage or handling, or if damage is suspected, no attempt should be made in the field to do any trouble shooting or repair work of any kind. Accordingly, if the tester requires trouble shooting, maintenance, or repair, it must be returned to the pot designated by the service involved, where the s cialized facilities required for maintenance work, ca bration, and adjustment are available (refer to pa graph 7-1).

SECTION VII

CALIBRATION

7-1. The Fuel Quantity Gage Tester, Type MD-1, is a precision instrument. It has been laboratory calibrated and, therefore, whenever calibration and adjustment of the instrument is necessary (refer to paragraph 6-1) it must be returned to the depot designated by the service involved, where the specialized facilities required for calibration and adjustment including the Tester, Capacitance Bridge, Precision, Type ME-1 or other equipment suitable for making the required measurements, will be available. Under no circumstances, attempt to adjust the calibration in the field. Any tampering with the tester will disturb the calibration and render the instrument useless.

7-2. At the designated depot, capacitance measuring equipment should be available which is capable of making measurements to assure that the tester when calibrated and ready for trans-shipment will meet the following accuracy requirements quoted from governing specification MIL-T-8579.

a. Direct-Reading Accuracy of Fuel Quantity Gage Tester, Type MD-1 and Accuracy of Correction Chart. See Table V.

b. Dissipation Factor. Dissipation factor of fixed or variable capacitors not to exceed 0.001 at a frequency of 400 cycles per second at a temperature of ± 25°C.

c. Backlash. Backlash less than 1/2 division. (This corresponds to 0.01% of full-scale value.)

d. Drum and Circular Dial Synchronization. Within 1 uuf for C1, and within 0.2 uuf for C3.

e. Dial Lock Operation. Operation of the Dial Lo shall not change dial readings by more than 0.1 uuf f C1 or 0.03 uuf for C3.

f. Test Equipment. Test equipments which will fulf requirements of the above sub-paragraphs a, b, c, and e are:

(1) Type ME-1 Tester Capacitance Bridge Pr cision.

(2) The following assembly of instruments manufactured by General Radio Company.

(a). Type 716-CMS4 Capacitance Bridge
(b). Type 1214-A Oscillator
(c). Type 1231-BMA Amplifier & Null De- tector
(d). Type 1231-P2 Filter
(e). Type P-585 Capacitor Box
(f). Type 722-S59 Capacitor
(g). 2 Type 874-T Connector
(h). 4 Type 874-R21 Patch Cord
(i). 2 Type 274-NEO Patch Cord

7-3. Even though the tester is not suspected of inco rect operation and calibration, the instrument shou have its calibration checked at least once every s months (or at periods specified by the service i volved) in order that it may be considered reliable a accurate. Such re-calibration checks must be do only by a designated depot (refer to paragraph 7-1.)

TABLE V. DIRECT READING ACCURACY OF FUEL QUANTITY GAGE TESTER, TYPE MD-1, AND ACCURACY OF CORRECTION CHART

Capacitor	Capacitance Range, uuf	Direct-Reading Accuracy	Chart Accuracy
C1	50-1100	± 0.75 uuf or ± 0.5%*	± 0.1% Upscale
C3	10-210	± 0.5 uuf or ± 1.5%*	± 0.2%
C2	0-5000	± 0.5%	± 0.1%

*Whichever is greater.