TM 9-1622

WAR DEPARTMENT TECHNICAL MANUAL

U.S. Dept of Army

ORDNANCE MAINTENANCE

DESICCATION AND CHARGING OF HEIGHT FINDERS

WAR DEPARTMENT • 5 DECEMBER 1944

WAR DEPARTMENT TECHNICAL MANUAL
TM 9-1622

This Technical Manual supersedes Ordnance Field Service Technical Bulletin 1623-1, 1624-2, dated 5 October 1942, and Ordnance Field Service Technical Bulletin 1623-3, 1624-3, dated 10 April 1943.

ORDNANCE MAINTENANCE

DESICCATION AND CHARGING OF HEIGHT FINDERS

WAR DEPARTMENT • *5 DECEMBER 1944*

WAR DEPARTMENT
Washington 25, D. C., 5 December 1944.

TM 9-1622, Desiccation and Charging of Height Finders, is published for the information and guidance of all concerned.

[A.G. 300.7 (4 Dec 43)
O.O. 461/52983]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION: Armies (10); Corps (10); SvC (10); Depts (10); D (2); IBn 9 (2); IC 9, 44 (3); Tech Svs (2); Arm & Sv Boards (2); P, C, or Stas (1); Gen & Sp Sv Schools (10); Ord Decentralized Sub-O (3); PE's "Mark for Ord O" (5); Ord Dist O (5); Ord Reg O (3); Ord Dist Br O (3); Ord Establishments (5).

IBn 9—T/O&E 9-65, 9-76.

IC 9—T/O&E 9-7, 9-9, 9-57, 9-67, 9-318, 9-377.
44—T/O&E 44-17, 44-27, 44-117, 44-127.

(For explanation of symbols, see FM 21-6.)

CONTENTS

This page has been intentionally left blank.

RESTRICTED

This Technical Manual supersedes Ordnance Field Service Technical Bulletin 1623-1, 1624-2, dated 5 October 1942, and Ordnance Field Service Technical Bulletin 1623-3, 1624-3, dated 10 April 1943.

Section I
INTRODUCTION

1. GENERAL.

a. Scope. This Technical Manual is published for the information and guidance of ordnance maintenance personnel. It contains a description of the apparatus (including Helium Filling Kits M6A1 and M8) and instructions pertaining to testing, desiccating, and charging height finders with helium or nitrogen.

b. Records. Both ordnance maintenance and using arms must, whenever the height finder is tested for helium purity or charged with helium, insert a record of the operation in the height finder log book.

2. STRATIFICATION AND CORRECTION.

a. When the height finder is subjected to rapid temperature changes (greater than 3°F an hour, or 12°F in 4 hours) caused by the sun shining on the instrument or by transportation from a warm storage place to a cold operating place, temperature difference within the instrument will set up stratified layers of varying density in the gaseous medium. The layers vary in power to refract light rays, causing the light rays passing through them to follow a curved path rather than a straight path. This results in "fuzzy" images and unreliable readings.

b. Air is a poor heat conductor. It tends to retard even distribution of heat and thereby increases stratification. Errors due to temperature stratification are reduced, therefore, by replacing the air inside of the height finder with helium which is a much better conductor.

3. CHARACTERISTICS OF HELIUM, NITROGEN, AND AIR.

a. The table below shows a comparison of air, nitrogen, and helium in respect to density (weight), refractive power, and heat conductivity in standard units of metric measurement. These figures are given for purposes of comparison. For exact meaning and methods of determining, see reference books on chemistry or physics.

	Air	Nitrogen	Helium
Density	1.2929	1.2506	0.1784
Index of refraction	1.0002926	1.000295	1.000036
Heat conductivity	0.0000568	0.0000524	0.000339

b. Although dry air is a mixture of gases, it could be used, and formerly was used, in height finders.

c. Air must be dried and filtered, however, before it is safe to use in height finders. Because of its oxygen content, air also tends to corrode the inside of instruments more than nitrogen. It is occasionally used, therefore, for desiccating instruments, but is rarely used for charging them. It can be seen from the above table that air behaves similarly to nitrogen. It will also be observed that the index of refraction and heat conductivity for helium are considerably smaller than those for air and nitrogen.

4. PARALLAX.

a. All gases possess the ability to deflect light rays as the rays enter and leave the gas. Within the height finder, this happens several times as the light rays pass from one optical element to another. The index of refraction of a gas (par. 3 a) is a measure of the ability of the gas to change the direction of light. This ability is practically identical for nitrogen and air but differs for helium.

b. The index of refraction of a gas also changes with changes in temperature.

c. Variations in the refractive power of the gas cause deflection of the light paths passing through the prisms and shifting of the focal planes of the lenses within the height finder, resulting in parallax.

d. The height finder may be adjusted for parallax resulting from changes in temperature, but a relatively large correction (sec. VIII) must be inserted when the gas is changed from helium to nitrogen or air or vice versa. No correction is necessary when changing from nitrogen to air, or vice versa.

5. HELIUM PURITY.

a. Helium purity in the height finder is to be maintained above 90 percent. If the purity falls below 90 percent and helium cannot be obtained, the entire gas content should be replaced by nitrogen. Less error due to stratification would occur with some helium present than would occur when none is present, but with purity below 90 percent, the parallax introduced would offset the advantage.

6. CHARGING SCHEDULE FOR HELIUM.

a. Following the Oliver method, the using arm recharges the height finder with helium once a week or as often as the records for a particular instrument indicate the necessity.

b. In addition, ordnance personnel will charge the height finder with helium once a month as a check, using the purity indicator method if available, the Oliver method if not.

7. CONSERVATION OF HELIUM.

a. Virtually the entire available supply of the world's helium is possessed by the United States. The gas is a strategic and critical material because of its importance in many commercial and military applications. The supply even in the United States is limited. Every effort therefore must be exerted to conserve it.

8. EFFECT OF MOISTURE.

a. Height finders are charged with dry gas. Extreme variations of temperature, however, may cause excess pressure difference between the inside of the height finder and the atmosphere, and cause the instrument to breathe through its seals. The dry gas within the instrument then becomes laden with moisture from the atmosphere. The moisture may then condense on the inside surfaces of the windows and on optical parts, causing diminished visibility and detrimental effect on the inside parts of the height finder. Condensation usually begins at lower operating temperatures and disappears as the temperature rises. As soon as condensation is noticed, the height finder should be checked for leaks and desiccated.

9. INTERNAL GAS PRESSURE.

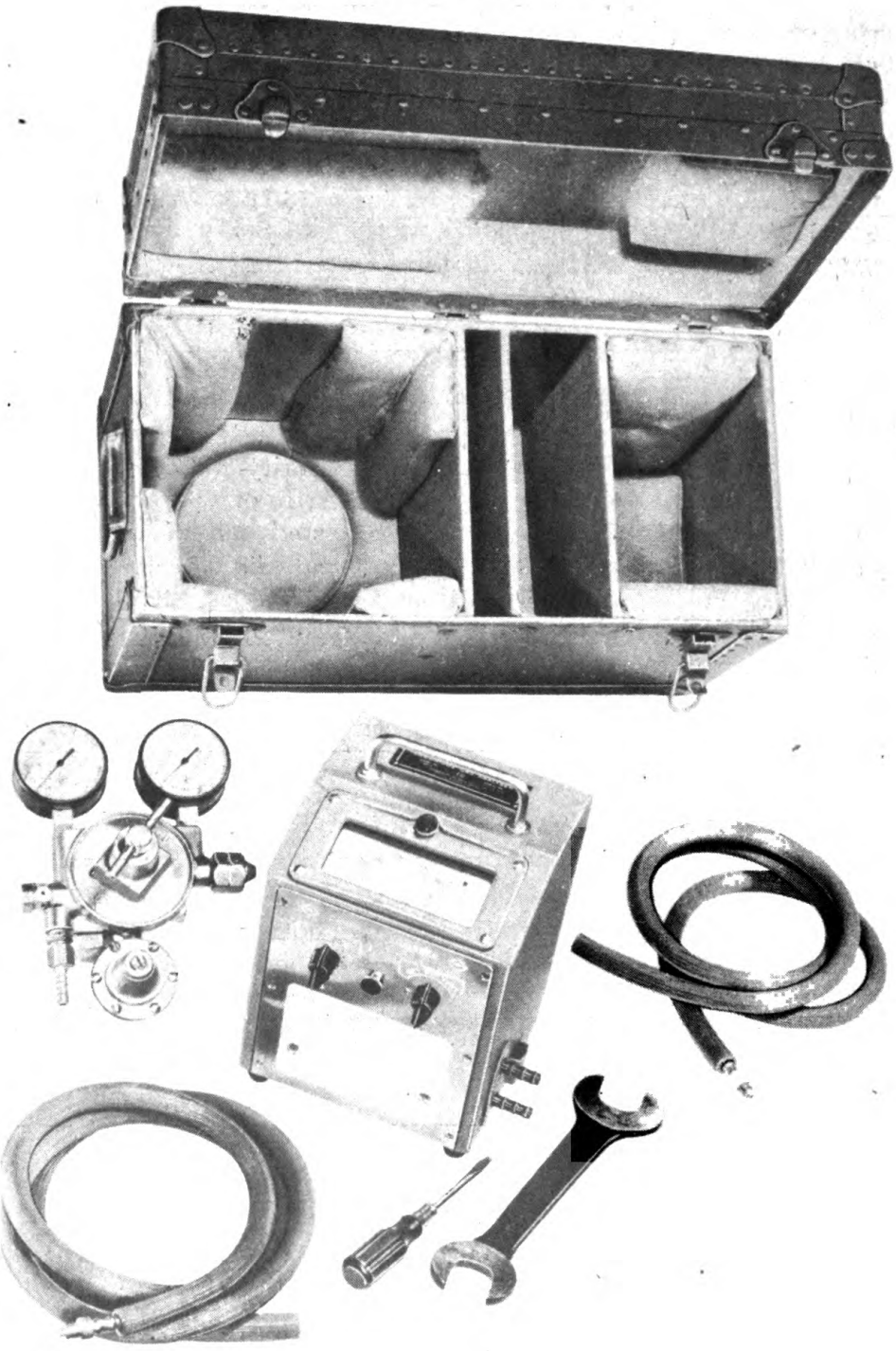
a. The tendency of moisture and air to infiltrate with the gas contents and cause condensation and stratification is decreased when the pressure within the height finder is greater than that outside. The pressure within the instrument, however, must be kept as low as practicable in excess of air pressure, in order that the pressure shall not damage the seals of the instrument. This internal gas pressure should be maintained not in excess of 3 psi (pounds per square inch), as an upper limit of safety. Reasonable pressure in height finders is about 2 psi.

Section II
EQUIPMENT

10. HELIUM FILLING KIT M6A1 AND M8.

a. Helium Filling Kit M6A1 used with the purity indicator method of helium charging comprises the items listed below and shown in figure 1. Helium Filling Kit M8 used with the Oliver method of charging consists of the same items minus the helium purity indicator.

ORDNANCE MAINTENANCE—DESICCATION AND CHARGING OF HEIGHT FINDERS



RA PD 81264

Figure 1—Helium Filling Kit M6A1

EQUIPMENT

Item	Fed. Stock No.	Number of Items
INDICATOR, purity helium	17-I-314	1
REGULATOR, pressure, helium, assembly	45-R-3565	1
CONNECTOR, brass (for rubber hose)	45-C-2692-300	3
CHEST (for kit, helium filling, M6A1)	41-C-873	1
HOSE, rubber, 5/16 I.D., 6ft. long	33-H-388-75	2
SCREWDRIVER, 3 in. blade	41-S-1101	1
WRENCH, engrs., dble-hd., alloy-S., 1⅛ x 1¼ in.	41-W-1026	1
Instructions	TM 9-1622	1

11. HELIUM PURITY INDICATOR.

a. This instrument is used with the purity indicator method of helium charging. It contains two chambers: in one is pure helium gas and through the other the gas being tested can be passed. Each chamber is also provided with an electrical filament operating from dry cells. The instrument is arranged to convert the difference in temperature of the two filaments into per cent of helium content. The difference in temperature between the filaments results from the difference in rate of heat transmission of the pure helium in one chamber and the mixture of helium and air being tested in the other. When the heat action in the chamber of the gas being tested is the same as in the "standard," the needle points to 100 percent.

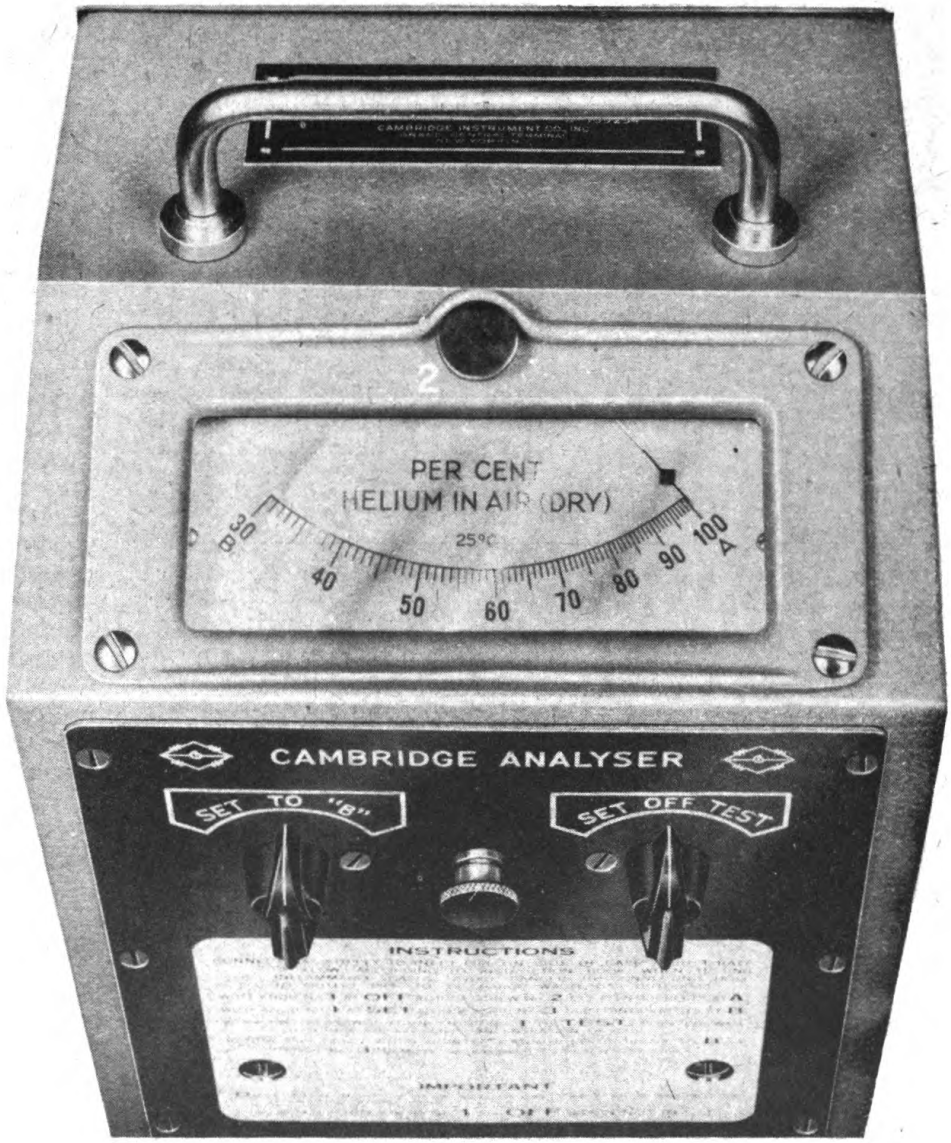
12. PRESSURE REGULATOR.

a. The pressure regulator is used with both the Oliver method and helium purity indicator method of helium charging. It consists essentially of a valve and two pressure gages. When the regulator is connected to a gas cylinder, the cylinder pressure registers on the high-pressure gage. The flow of gas is regulated to any desired pressure by the control handle and is registered on the low-pressure gage.

b. To protect the height finder, a safety valve is provided which limits exit pressure to 6 psi (pounds per square inch). When pressure exceeds this amount, the valve releases the gas, which exits through the threaded hole opposite the valve (fig. 3). A cork is kept in this hole to prevent entrance of dust and dirt. When the valve releases the gas, it blows out the cork.

13. VENTURI VALVE.

a. The venturi valve is furnished as an accessory with Height Finder M1, but not with Height Finder M2. It is used to evacuate



RA PD 81261

Figure 2—Helium Purity Indicator

the height finder when desiccating or changing gas. The valve works on the principle that a rapid flow of air from a compressor past a chamber containing gas will tend to draw out gas from the container.

b. When used as a vacuum pump, the valve is turned by means of the knobs so that the face reads "VACUUM" opposite the detent of the valve (fig. 4). Air from the compressor empties into the atmosphere, carrying with it gas from the height finder. When it is

EQUIPMENT

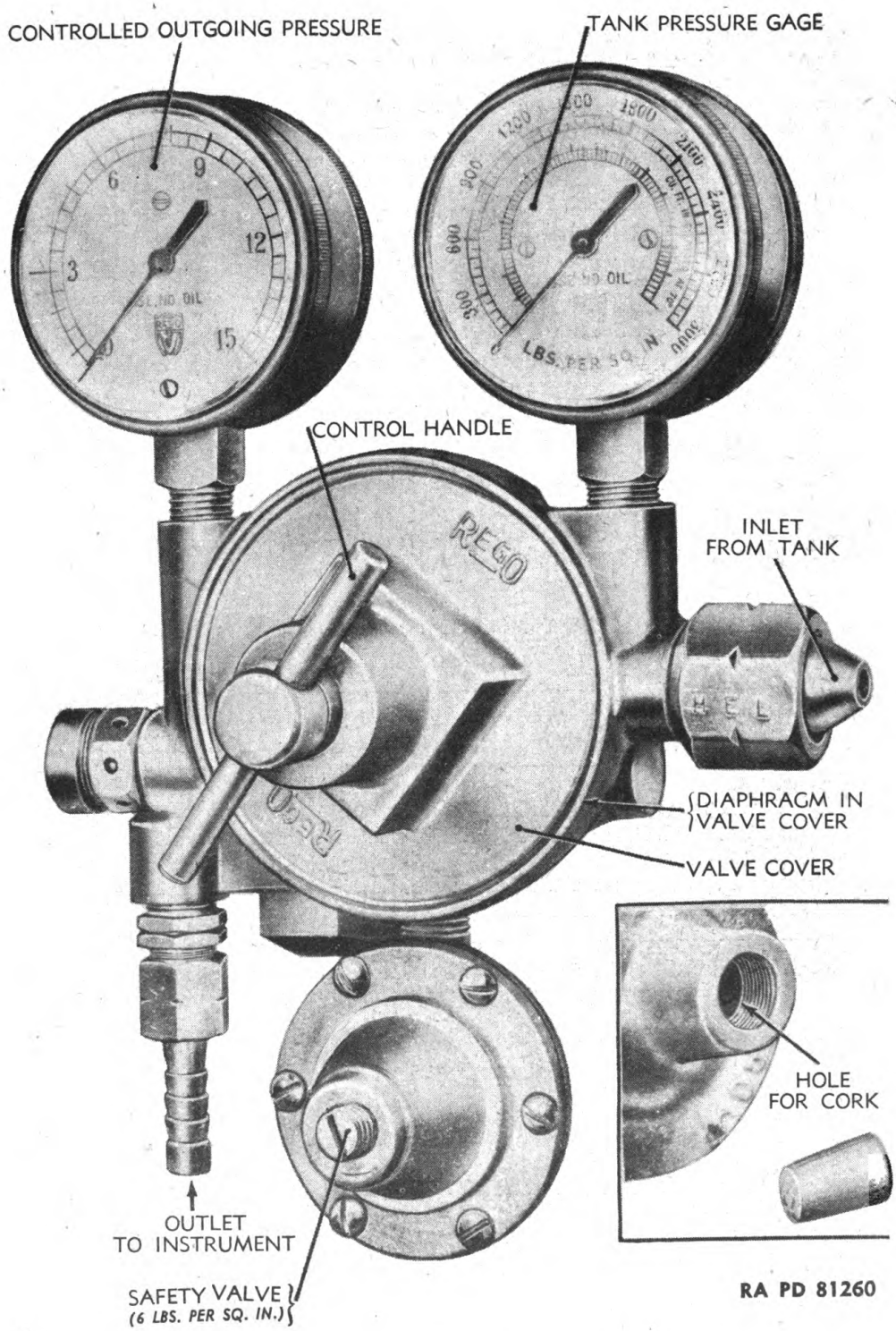
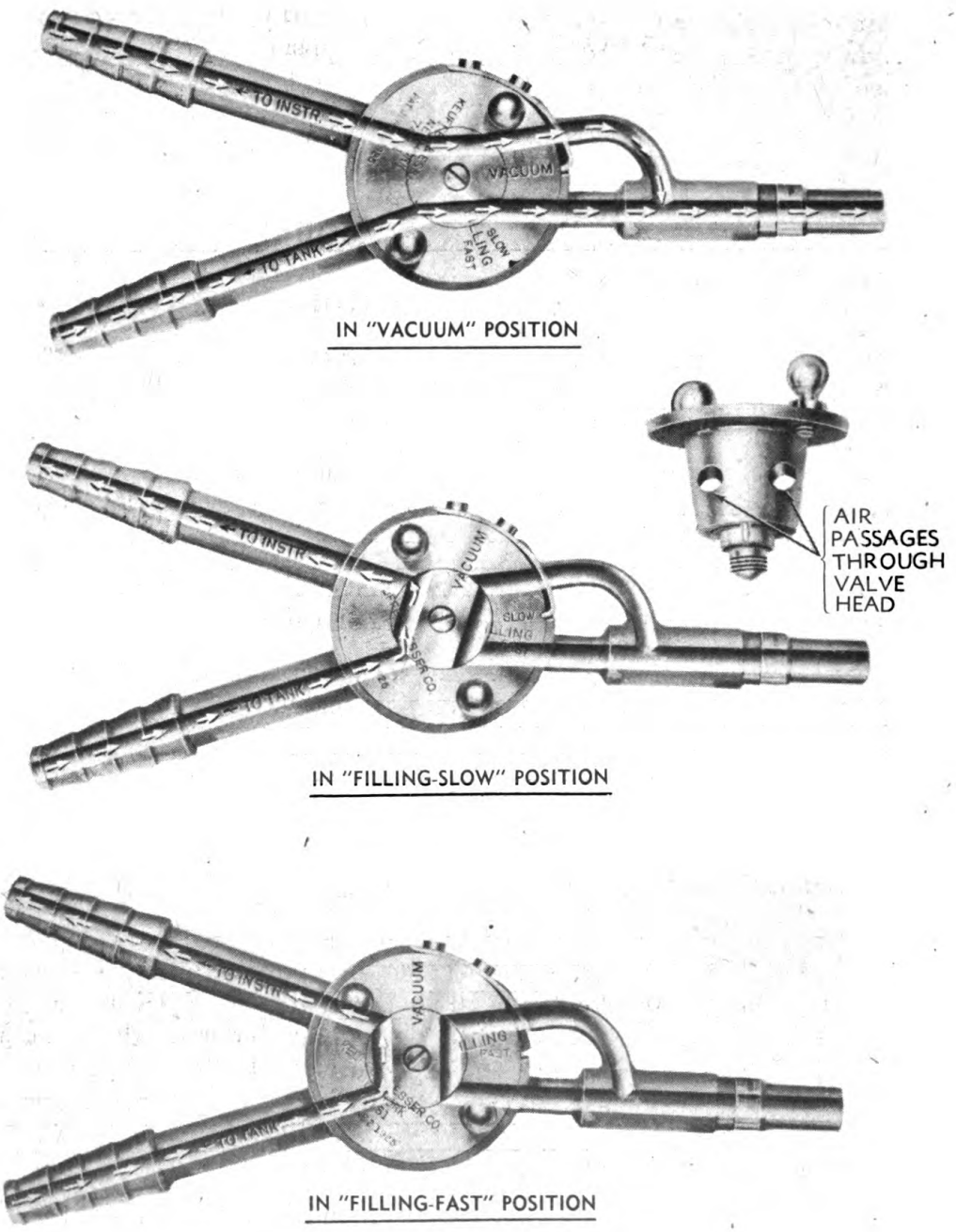


Figure 3—Pressure Regulator—Front View

ORDNANCE MAINTENANCE—DESICCATION AND CHARGING OF HEIGHT FINDERS



RA PD 81267

Figure 4—Flow Diagrams for Venturi Valve in Its Three Positions

desired to stop the evacuating process (fig. 4), the face is turned so that the holes do not line up.

c. The valve may also be used to shut off or regulate flow of gas from a supply cylinder to an instrument during filling operations. The "FILLING FAST" and "FILLING SLOW" positions of the face are used for this purpose.

Section III
GENERAL PROCEDURES

14. CARE AND STORAGE OF HELIUM CYLINDERS.

a. *The extremely high pressure in helium cylinders makes careless handling especially dangerous.* When fully charged, the gas pressure is 2,400 psi (pounds per square inch).

b. Store helium cylinders in a cool, shaded place. Expansion of helium in heat and sun may increase pressure sufficiently to cause a leak in the valve.

c. Upon removal of the regulator, cover the valve with its protecting cover, and keep covered while not in use.

d. Carefully observe the instructions in paragraphs 17 and 18 for attaching and removing the pressure regulator.

15. PRECAUTIONS FOR HANDLING HOSE.

a. All hose and connections must be kept absolutely free from dirt so that none will be introduced into the height finder or helium purity indicator during testing or charging.

b. In order to insure that dust in the hose is not blown into the instrument, that the hose is perfectly clean, and that all air is driven out, allow helium to blow through the hose at 5 psi pressure for 10 to 15 seconds, before attaching to the height finder or the helium purity indicator. Practically all helium purity indicator failures have been due to excessive accumulation of dirt inside the indicator which has collected in the hoses and blown into the indicator. It also is very injurious to the height finder to have dirt blown into it.

c. Do not allow the hose to trail on the ground at any time.

d. Do not allow heavy objects to rest on or run over the hose.

e. If there is any indication or suspicion that the hose is wet, do not use the hose until it is absolutely dry. Blowing helium through

ORDNANCE MAINTENANCE—DESICCATION AND CHARGING OF HEIGHT FINDERS

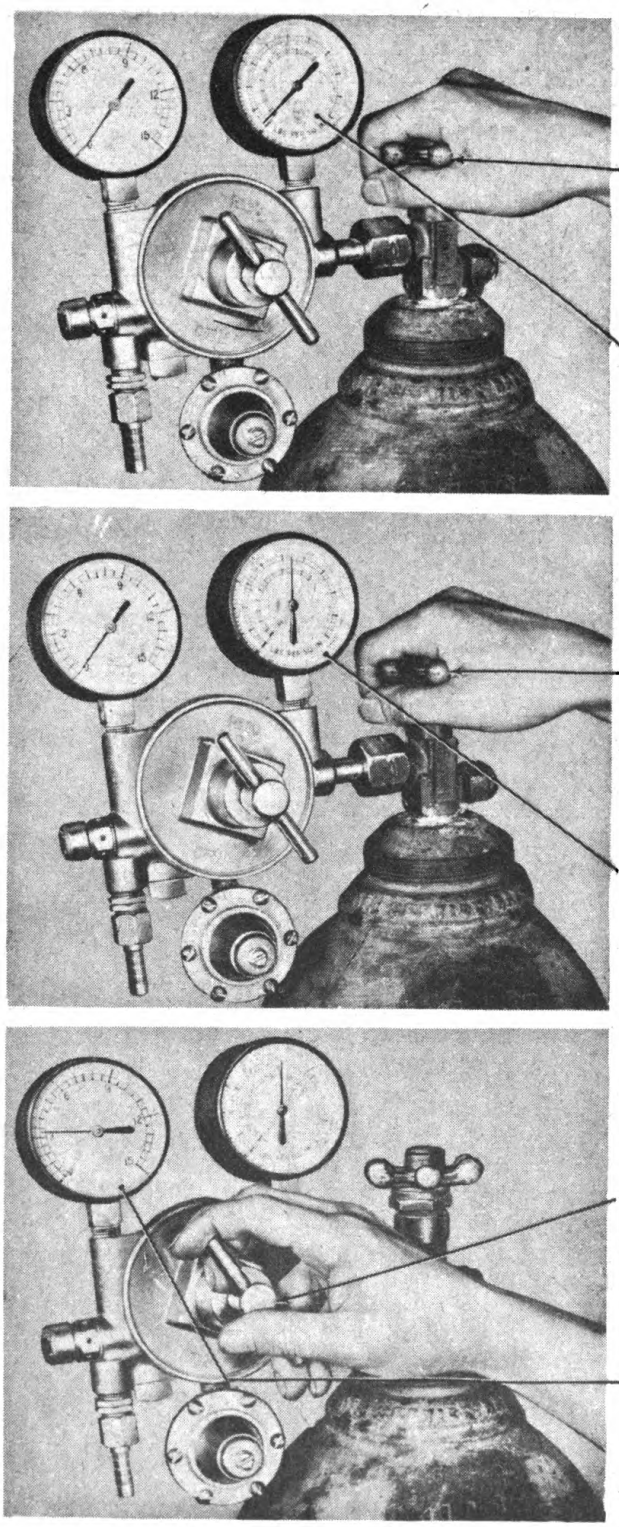


Figure 5—Releasing Helium to Pressure Regulator

the hose will remove dry dust but will not remove condensed moisture in the brief period of its use.

f. If the hose is clogged or dirt or mud clings to it (even if the condition cannot be seen but is suspected), the hose should be washed with water and thoroughly dried.

16. HOSE CONNECTIONS.

a. All hose connections should be tight; push the hose as far onto the connection as possible.

b. Leave connectors on hose whenever possible. If taken on and off, the hose becomes scuffed and damaged, finally resulting in loose fit and escaping gas.

c. When screwing the brass hose connectors into the valve plug hole of the height finder, do not use a wrench, as it is very easy to strip the threads.

17. PROCEDURE FOR CONNECTING PRESSURE REGULATOR TO CYLINDER.

a. The pressure regulator must always be connected to the cylinder during charging or desiccating operations to protect the height finder and purity indicator from excessive pressures. CAUTION: *Due to the high pressures within the cylinders, damage to instruments and injury to personnel are possible if the procedure below for attaching the regulator is not carefully followed.*

(1) Hold the pressure regulator so that both gages can be read and so that the attaching nut is in line with the cylinder outlet (fig. 5).

(2) Since the cylinder outlet has left-hand threads, turn the attaching nut *counterclockwise and tighten with a wrench.*

(3) Turn the pressure regulator handle counterclockwise until it turns loosely without any tension. This will cut off any flow and avoid waste of gas. This must be done before the cylinder valve is opened.

(4) Slowly turn the cylinder valve knob counterclockwise. Three turns are usually enough for the gas to begin registering on the high-pressure gage. If no gas is released after three turns, continue turning cautiously until the gage begins to register.

(5) Continue to turn knob slowly until fully open. Then observe whether cylinder pressure is above required limit.

(6) Helium should not be used if maximum pressure is below 250 psi.

ORDNANCE MAINTENANCE—DESICCATION AND CHARGING OF HEIGHT FINDERS

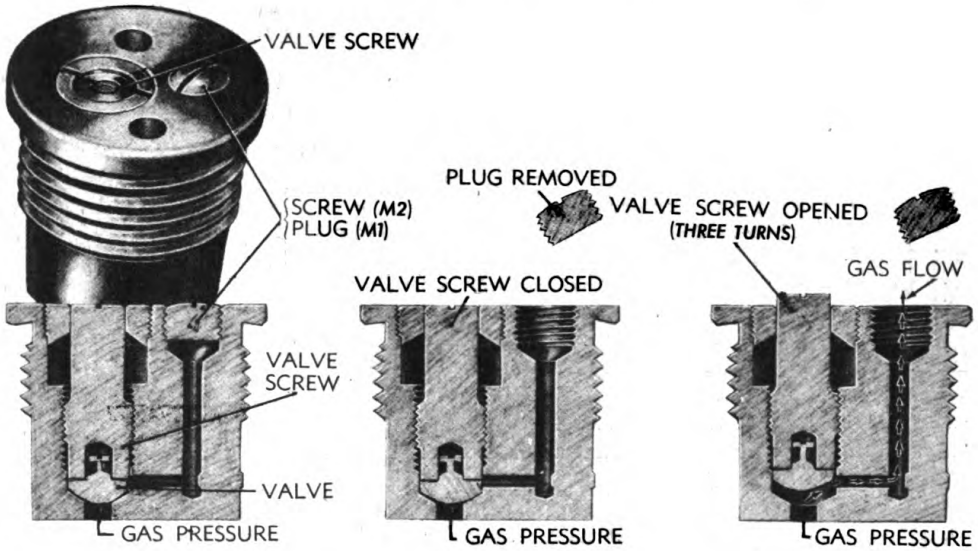


Figure 6—Functioning of Charging Valve

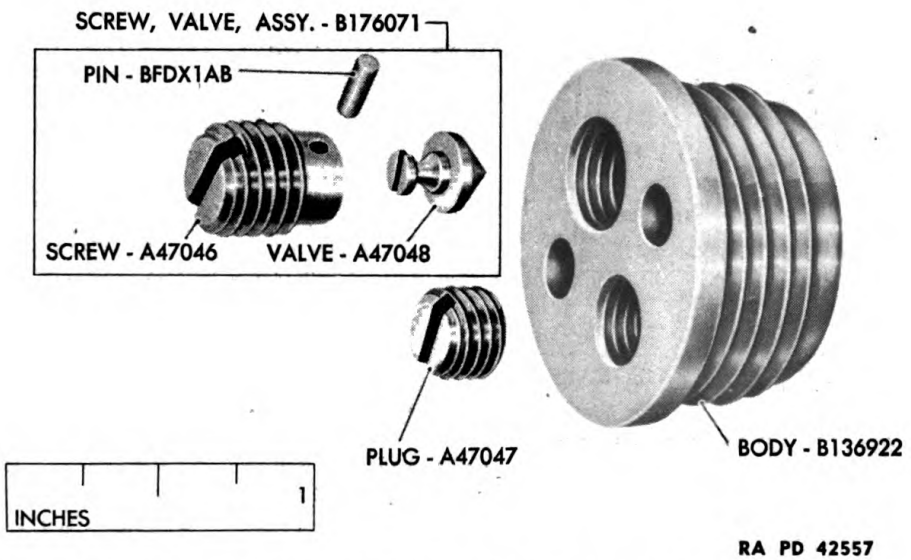


Figure 7—Charging Valve of Height Finder M1

(7) Before connecting hose to regulator, turn the regulator handle clockwise until the low-pressure (control) gage begins to register pressure. When satisfied that pressure regulator is in working condition and that dust has been blown from regulator, turn pressure regulator handle counterclockwise until it again turns freely, indicating that gas flow has been shut off.

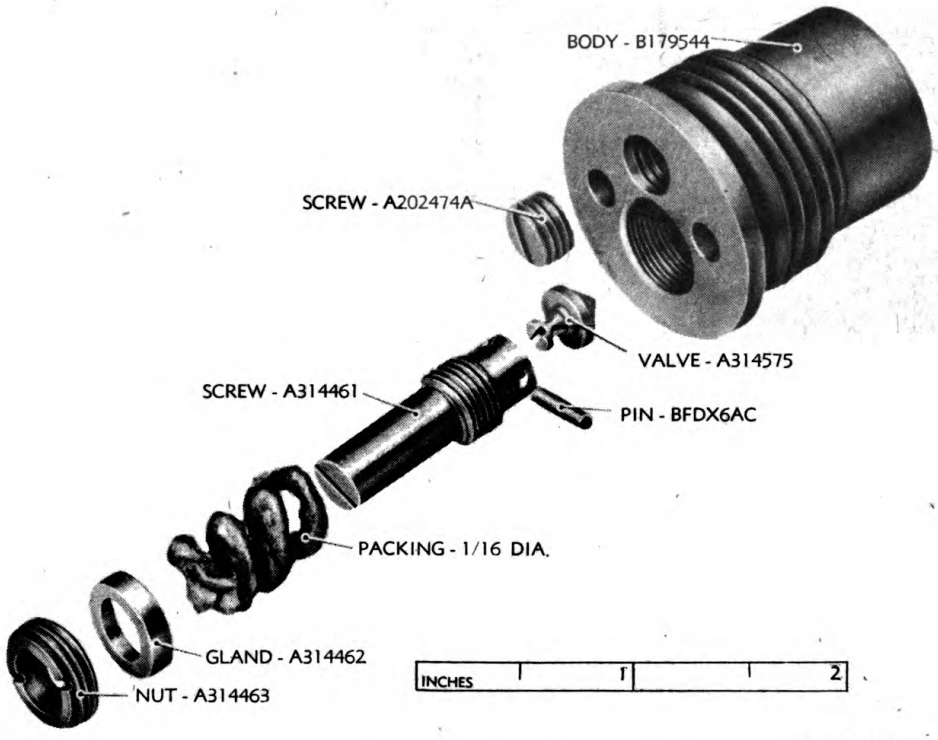


Figure 8—Charging Valve of Height Finder M2

18. PROCEDURE FOR REMOVING PRESSURE REGULATOR FROM CYLINDER.

CAUTION: *Do not remove the regulator from a cylinder without observing these instructions carefully. Failure to do this will result in a waste of gas, or may cause personal injury due to bodily contact with the escaping gas.*

a. Turn the pressure regulator handle counterclockwise until it is turning loosely, so that there is no flow of helium out of the pressure regulator and the pressure regulator control gage shows zero.

b. Close the valve on the cylinder tightly.

c. Remove any attached hose from the regulator outlet nozzle.

d. Release the pressure on the cylinder pressure gage by turning the regulator handle clockwise. Leave on for 15 or 20 seconds and observe control gage to see that no pressure is indicated. If pressure regulator indicates a pressure while cylinder valve is turned off, first tighten knob. If this does not remove pressure, a serious leak is indicated in the cylinder valve. The leak should be reported to the Corps of Engineers.

ORDNANCE MAINTENANCE—DESICCATION AND CHARGING OF HEIGHT FINDERS

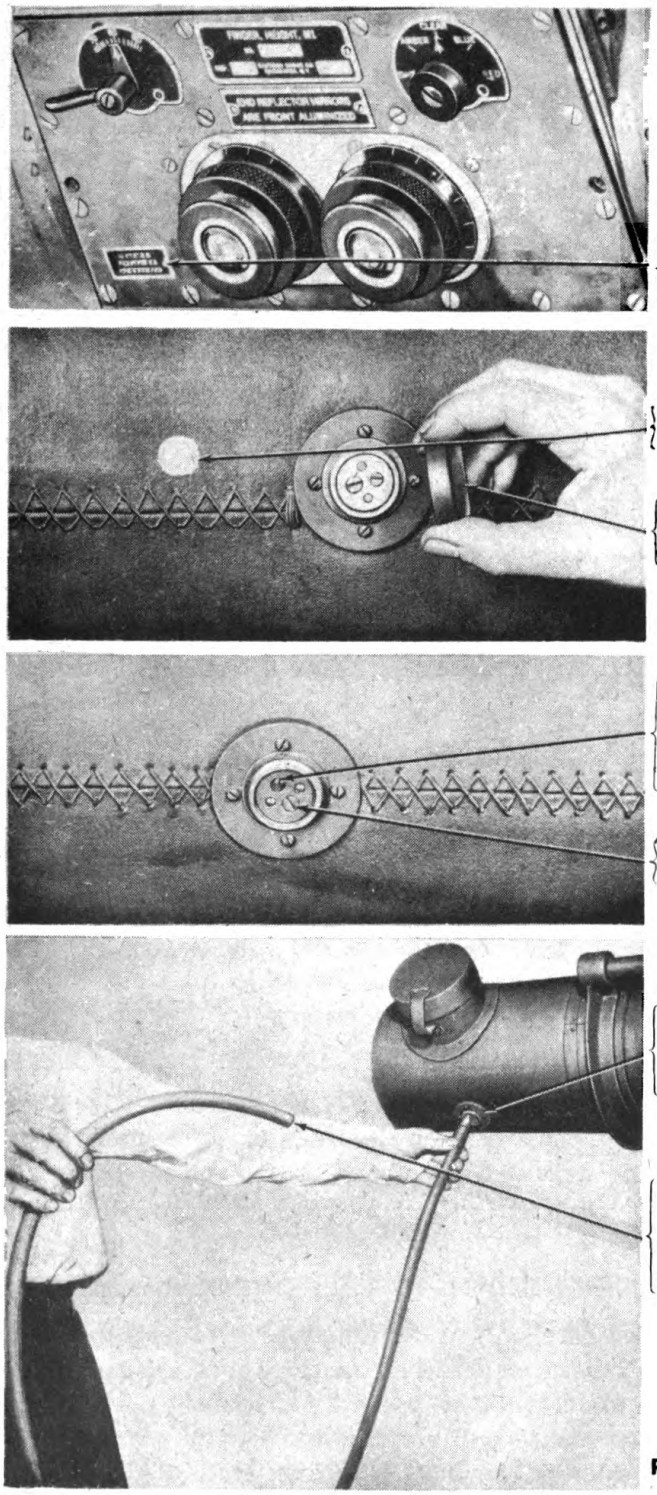


Figure 9—Connecting Hose to Height Finder

e. If no leak is in evidence, turn the regulator handle off (counterclockwise) until the handle turns loosely.

f. Remove pressure regulator from cylinder by turning the attaching nut clockwise.

19. CONNECTION TO THE HEIGHT FINDER.

a. The height finder is equipped with a charging valve, protected by a metal cover, at each end on the under side. Since both valves are identical, the height finder may be charged from either end. Functioning of the valve is shown in figure 6. Charging apparatus is connected to the height finder by removing the protective cover, unscrewing the plug or screw at the right on figure 6, and screwing the connection into the hole from which the plug or screw was removed. To allow the gas to enter or leave the height finder, the valve screw at the left is backed out three revolutions. To shut off the flow to and from the height finder, the valve screw is tightened.

Section IV
OLIVER METHOD OF HELIUM CHARGING

20. GENERAL.

a. The Oliver method is the using-arm method for checking the helium purity and recharging. It is based on the fact that range readings are affected by the purity of helium. Range readings are made before charging to test helium purity and, if below standard, charging is begun with readings made at 3- to 5-minute intervals.

21. RECORD.

a. The following form is suggested for recording the readings while charging. Final results of the check must be recorded in the height finder log book.

I.A.C.S. Readings	Range Readings Taken During Charging
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
Median	6.
	7.
	8.
	9.
	10.
	11.
	12.
	13.
	14.
	15.
	16.
	17.
	18.
	19.
	20.

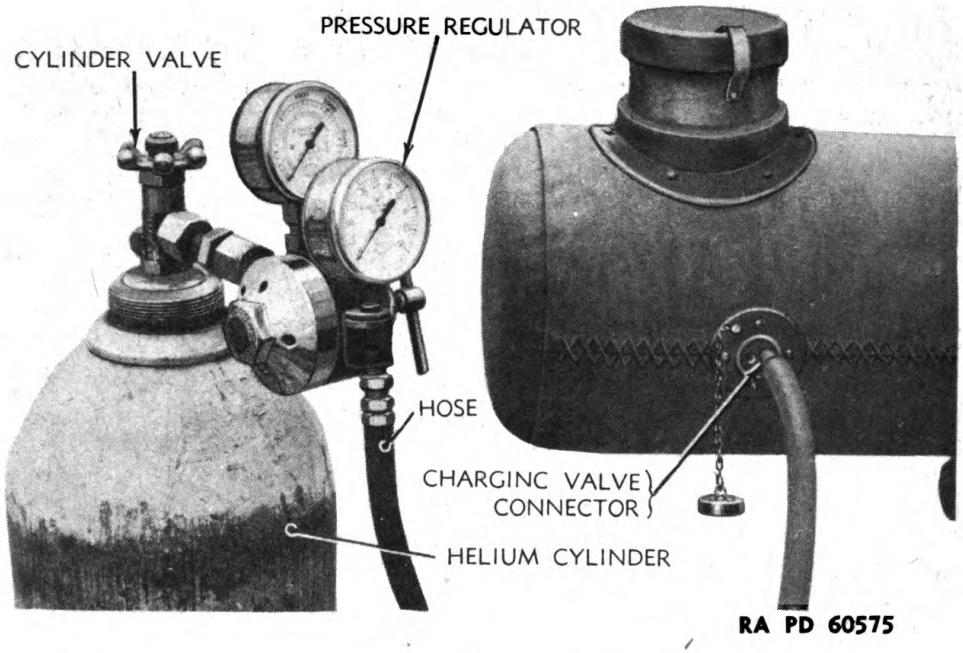


Figure 10—Arrangement of Apparatus for Oliver Method

22. ATTACHMENT OF APPARATUS.

a. Set the height range lever of the height finder to the range position and take five I.A.C.S. readings as explained in paragraph 19 b through f, TM 9-623, Height Finders, 13½-ft, M1 and M1A1, dated 5 November 1943; or paragraph 19 b through f, TM 9-624, Height Finders, 13½-ft, M2 and M2A1, dated 27 November 1943. Turn the correction wedge scale to the median of these readings and close the cover so that the knob cannot be changed during the rest of the test.

b. Elevate the instrument to 1,600 mils and remove the two charging valve covers, exposing two screws under each one. Remove the smaller of these two screws★ from both valves.

c. Insert a pressure gage or connector into one of these openings.

d. Remove helium cylinder valve cover. This valve connection has a "left-handed" thread necessitating a clockwise rotation to remove the cover.

e. Attach the pressure regulator to the helium cylinder using

★The standard nomenclature for the smaller screw in charging valves on M1 Height Finders is PLUG (fig. 6).

the procedure in paragraph 17. Note that the precautions in paragraph 17 are very important.

f. Attach hose to pressure regulator. Using 3 psi pressure, force dust and air out of hose. Then shut off helium supply by means of regulator handle and fasten hose to pressure gage or adapter on instrument.

23. CHECKING.

a. Open charging valve on each end of instrument, and carefully open regulator handle until a flow of 3 psi pressure is indicated on low-pressure gage.

b. Obtain stereo contact of internal target by using the measuring knob, not the correction knob. At first the new gas may cause a turbulence making a reading impossible for a few moments.

c. If readings on the measuring scale remain within one-quarter inch from the infinity (∞) position, the instrument is properly charged with a helium purity of over 95 percent. If these readings remain above 50,000 yards, the helium purity is between 90 and 95 percent and may be considered satisfactory.

d. Should the readings drop below 50,000 yards, the helium purity may be below 90 percent, indicating a charging is probably needed as described below in paragraph 24. If the reading is much below 50,000 yards, the instrument should be checked at more frequent intervals.

24. CHARGING.

a. Continue charging with 3 psi pressure.

b. Depress the instrument to zero mils and charge for 3 minutes.

c. Slowly elevate to 1,600 mils and obtain a reading with the measuring knob.

d. Repeat steps in subparagraphs **b** and **c**, above, until scale reads beyond 50,000 yards. Then, with instrument elevated to 1,600 mils, continue charging until stereo contact is obtained one-quarter inch from infinity (∞).

e. Close exit valve on instrument and continue charging until instrument pressure reaches 2 psi. The instrument pressure may be tested by pinching the hose and reading the pressure gage on the height finder, or by turning off the pressure regulator valve and reading the low-pressure gage.

f. When the 2 psi pressure is obtained, shut off the pressure regulator valve and close the intake valve on the instrument. Turn off cylinder valve *tightly*.

g. After an interval of 10 minutes, check the I.A.C.S. readings with the measuring drum set at infinity and the height range lever set in "RANGE." Take a set of five readings at zero mils and at 1,600 mils elevation. The medians of these two sets of readings should not differ by more than two units of error.

25. DISCONNECTION OF APPARATUS.

a. Elevate instrument to 1,600 mils.

b. Remove tubing.

c. Remove pressure gage or adapter from intake valve. Replace small screw in each end and replace charging valve housing covers.

d. Turn on pressure regulator for 1 minute and note if any pressure is indicated by the low-pressure gage. If there is any flow of helium through this gage, the cylinder valve must be turned still tighter.

e. When no pressure is indicated, turn off (counterclockwise) pressure regulator and unscrew (clockwise) from cylinder.

f. Replace cylinder valve cover.

Section V
PURITY INDICATOR METHOD OF HELIUM CHARGING

26 GENERAL.

a. The purity indicator method of charging with helium simply involves the use of a helium purity indicator to measure the purity while the instrument is being charged. This method of charging will only be used by qualified ordnance personnel.

b. The method involves the testing of gas purity, at 3- to 5-minute intervals during the charging with helium, by means of the purity indicator. The helium enters one end of the height finder under pressure of the helium cylinder, and passes out the other end into the helium purity indicator (fig. 2) until two successive readings are the same, indicating that the maximum helium purity has been attained.

PURITY INDICATOR METHOD OF HELIUM CHARGING

27. CHECKING PURITY OF HELIUM SUPPLY.

a. Before charging an instrument by the purity indicator method, the purity of the helium in the supply cylinder should be checked, even if the cylinder is new.

b. Attach pressure regulator to helium cylinder as described in paragraph 17.

c. Connect a hose between pressure regulator nozzle and "IN" nozzle of purity indicator. Set the indicator on a convenient box or table to provide a secure place on which it can rest.

d. Perform calibrations Nos. 1 and 2 as described in paragraphs 28 and 29.

e. Turn pressure regulator handle until control gage shows 5 psi pressure. CAUTION: *Never allow the pressure to rise above 5 psi. Higher pressure will damage the purity indicator.*

f. Repeat calibration No. 2. Then turn switch 1 (fig. 13) to "TEST." Pointer should indicate purity of helium in cylinder. Note indicated reading and turn switch 1 to "OFF."

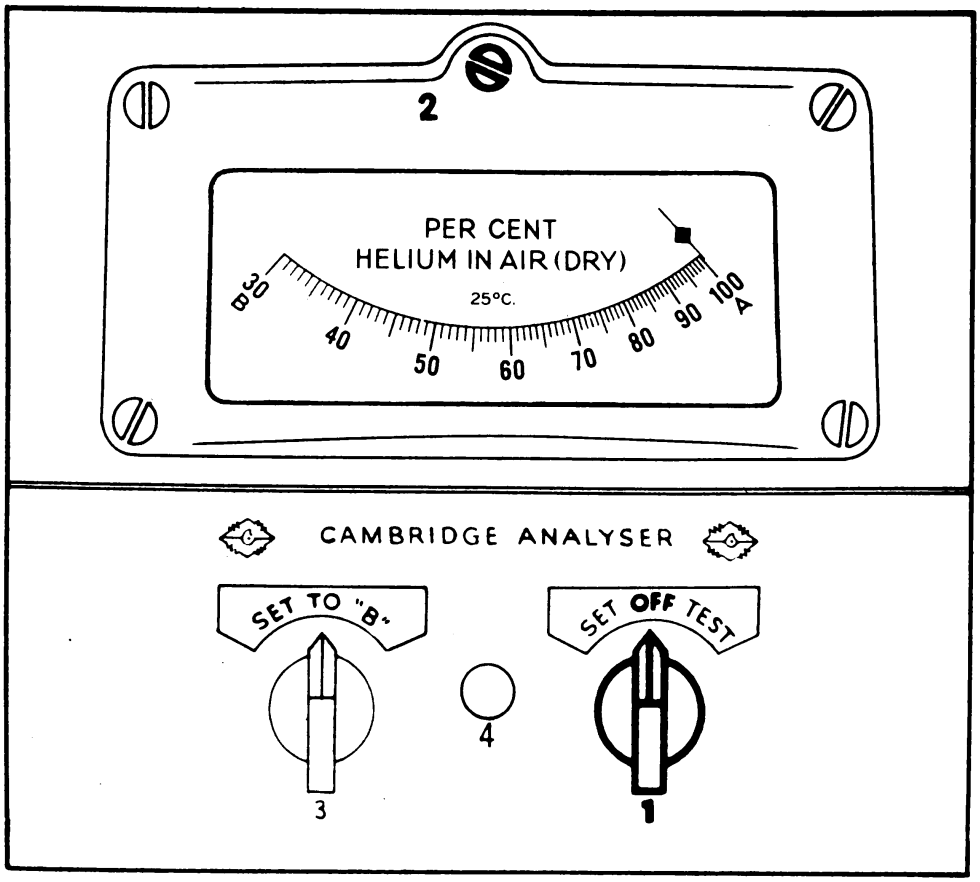
g. If the reading taken in subparagraph **f**, above, is more than 100 percent, the helium purity indicator is in need of repair or adjustment and should be turned over to the ordnance depot and a replacement secured.

h. If the reading taken in subparagraph **f**, above, is less than 97.5 percent, either the helium purity indicator is in need of repair or adjustment, or the helium cylinder tested should not be used. To be certain of the indicator's condition, readings should be taken for at least two additional cylinders of helium. If the readings for both of these cylinders are less than 97.5 percent, the helium purity indicator can be assumed to be in need of repair.

28. MECHANICAL ZERO (CALIBRATION NO. 1).

a. General. The "mechanical zero" calibration is actually a level test and adjustment. The reading is affected by the level position of the indicator. It is very important not to disturb the position of the purity indicator throughout measuring operations, as any shift of position may change the level and throw the purity indicator out of adjustment.

b. When Calibration No. 1 Should Be Made. This calibration should be performed each time the helium indicator is set up or disturbed, and at least every hour thereafter while in use.



RA PD 81253

Figure 11—Setting and Reading in Calibration No. 1 (Mechanical Zero)

c. Procedure.

(1) Knob No. 1 should be in "OFF" position (fig. 11).

(2) Pointer should be on "A-100" line of the scale.

(3) If not, remove cover from screw No. 2 and, with a screwdriver, turn screw (fig. 12) until pointer comes to "A-100" position.

(4) Having made calibration No. 1 at the beginning of operation, it is merely necessary to glance occasionally at the scale to see if pointer is in "A" position. It generally should remain so, but occasionally verification is necessary in case the purity indicator had been jostled or moved out of position.

29. ELECTRICAL ZERO (CALIBRATION NO. 2).

a. General. The ability of the helium purity indicator to read correctly is dependent on the current supplied by its dry cells. Dry

PURITY INDICATOR METHOD OF HELIUM CHARGING

RA PD 81252

Figure 12—Making Mechanical Zero Adjustment (Calibration No. 1)

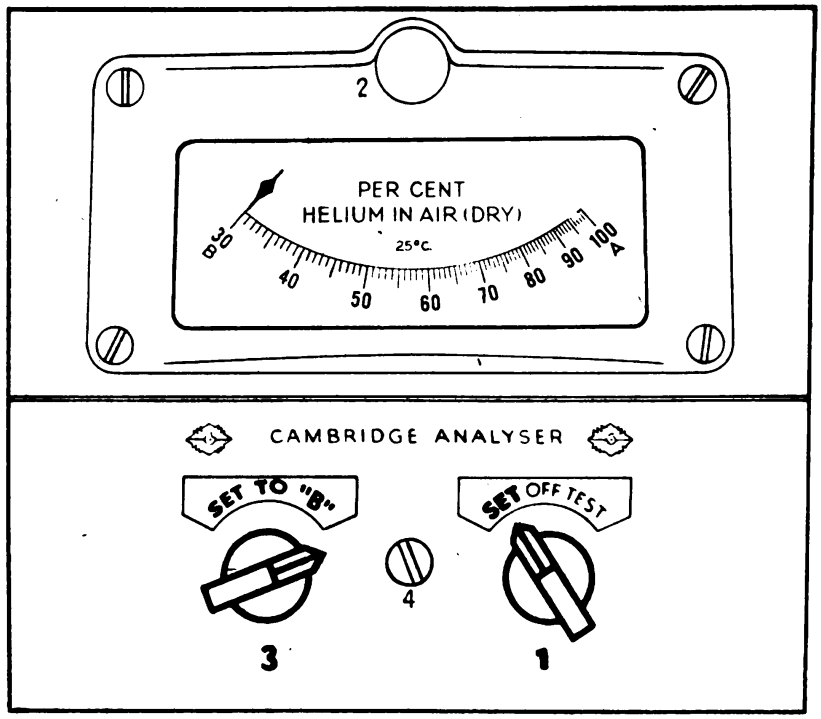


Figure 13—Setting and Reading of Electrical Zero in Calibration No. 2

cells, however, weaken with use. It is necessary, therefore, to compensate for any variation in electrical voltage from the cells. This is the purpose of the "electrical zero," calibration No. 2.

b. When Calibration No. 2 Is Made. This calibration should be made before taking each helium purity reading.

c. Procedure.

(1) Turn knob No. 1 to "SET" (fig. 13).

(2) Turn knob No. 3 slowly to the right, at the same time watching the pointer, until pointer coincides with "B-30" at the left end of scale.

(3) If the pointer fails to move to "B" by the moving of the knob No. 3, then remove cap from screw No. 4 (fig. 13) and turn screw until pointer moves to "B." If it is impossible to get pointer to move to "B" in this manner, it indicates that the dry cells require replacing.

(4) Turn knob No. 1 to "OFF."

(5) Do not disturb knob No. 3 before taking the helium purity reading.

PURITY INDICATOR METHOD OF HELIUM CHARGING

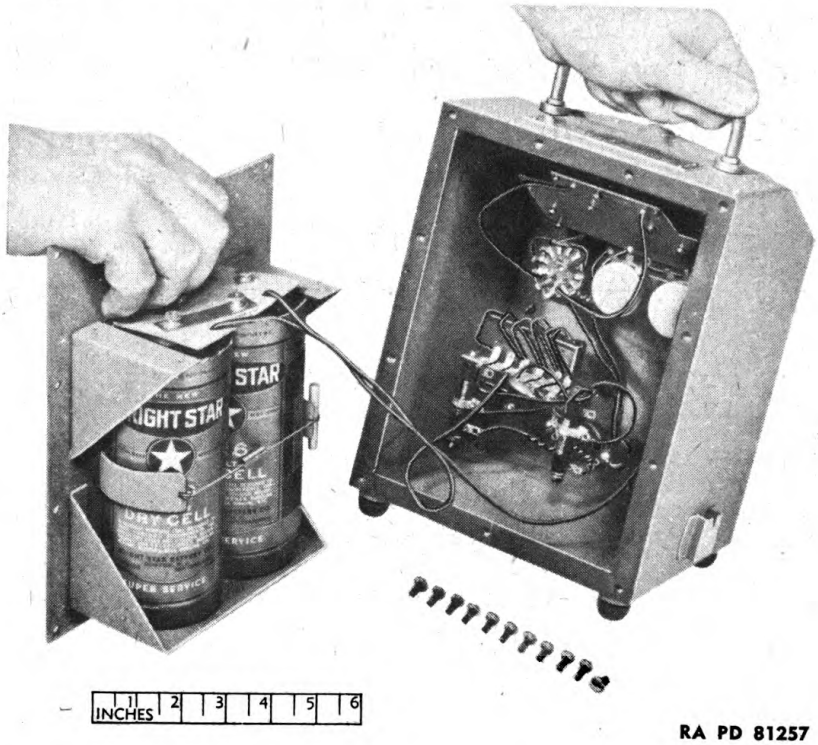


Figure 14—Replacing Dry Cells in Helium Purity Indicator

30. REPLACING DRY CELLS.

a. Remove the screws holding rear cover plate to indicator.

b. Pull out the cover plate holding the dry cells.

c. Before disconnecting the wires from the cells, tag or note which wires are connected to which terminal; then disconnect.

d. Replace the old cells with new ones (1½-volt dry-cell battery BA-23) by disconnecting the terminal nuts and plate as illustrated in figure 14.

e. In replacing wires, be sure to connect them to the same terminals as before.

f. Be sure to tighten terminal nuts in order to secure contact.

31. CONNECTING APPARATUS FOR CHECKING PURITY AND CHARGING.

a. Elevate the instrument to about 1,200 mils and remove the two charging valve covers. Remove the smaller screw (PLUG in Height Finder M1) from both valves (figs. 7 and 8).

ORDNANCE MAINTENANCE—DESICCATION AND CHARGING OF HEIGHT FINDERS

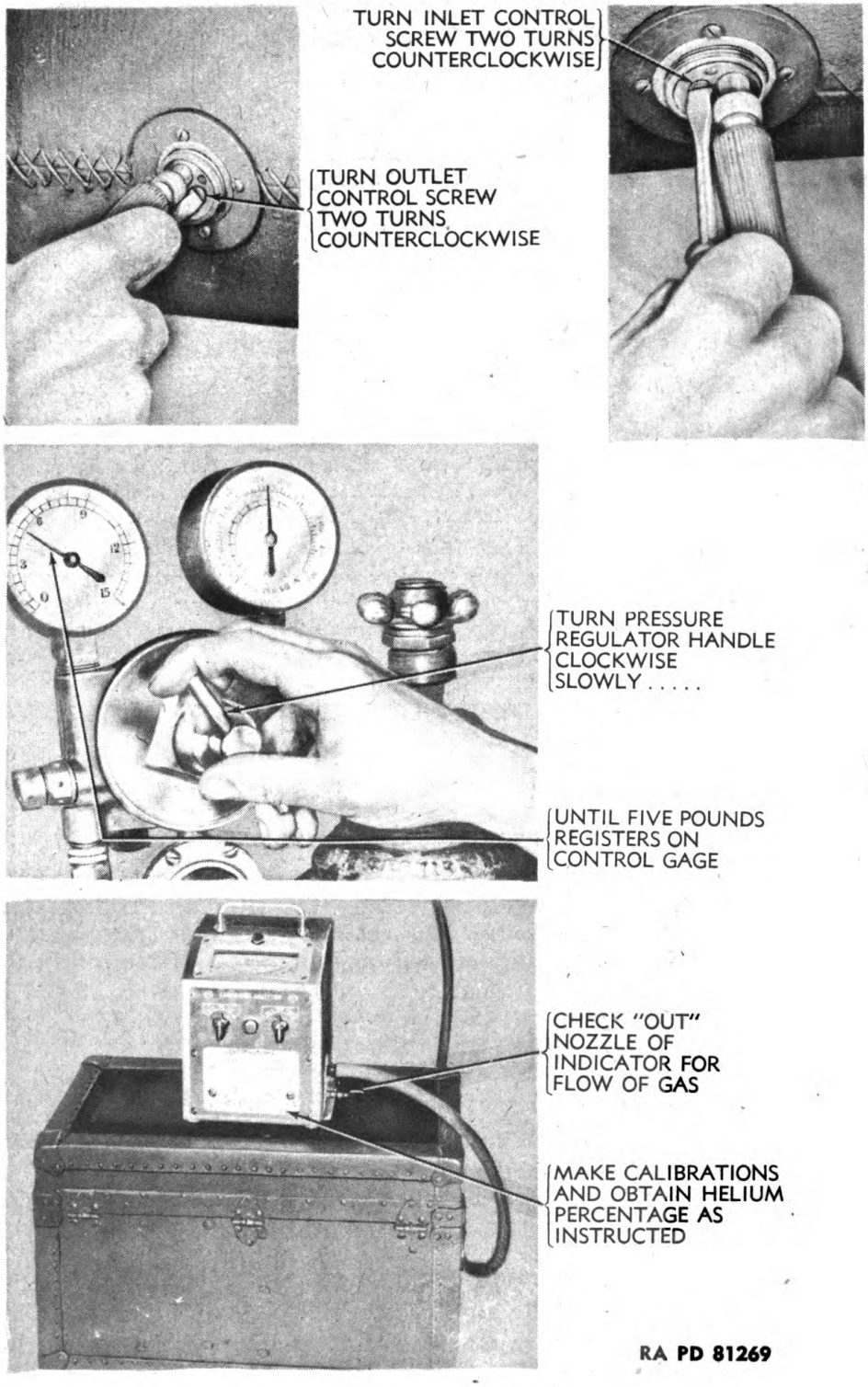


Figure 15—Starting Flow of Helium Through Height Finder

b. Connect pressure regulator to helium cylinder as described in paragraph 17.

c. Screw a connector (with hose attached) into the opening from which the screw or plug has been removed in one of the height finder valves. Connect other end of hose to pressure regulator nozzle.

d. Connect a hose between the other height finder valve in "IN" nozzle of helium purity indicator. Set the indicator on a rigid box or table.

32. STARTING FLOW OF HELIUM THROUGH HEIGHT FINDER.

a. Check that the cylinder pressure is above 250 psi, and that the control gage is at zero, with the pressure regulator handle turning freely.

b. Turn the outlet and intake valve control screws on the height finder about two full turns in a counterclockwise direction (fig. 15).

c. Turn the pressure regulator handle slowly in a clockwise direction until 5 psi registers on the control gage.

d. Check the outlet nozzle on the helium purity indicator to make sure helium is flowing.

33. CHARGING AND READING HELIUM PURITY.

a. As soon as helium begins to flow through instruments, depress height finder to zero elevation and make calibration No. 1 and calibration No. 2.

b. After 5 minutes, repeat calibration No. 2. Then, immediately obtain a helium purity reading by turning switch 1 (fig. 13) to "TEST." Take readings at 5-minute intervals until helium purity percentage approaches 90 percent.

c. As soon as the percentage of helium indicated is greater than 90 percent, reduce helium pressure (by turning pressure regulator handle counterclockwise) to 2 psi. Continue taking readings at 3-minute intervals until two identical successive readings are obtained, representing the ultimate helium percentage purity obtainable. (This percentage should be greater than 95 percent).

d. Close the outlet valve and permit height finder to continue charging for at least 5 minutes so that pressure within height finder may build up to control gage pressure of 2 psi.

e. It is possible but not necessary to check the helium pressure within the height finder by connecting a gage between pressure regu-

lator and height finder. (A gage is supplied with the height finder.)

f. Close intake valve with a screwdriver until snug.

34. DISCONNECTING THE APPARATUS.

a. Disconnect pressure regulator by carefully following the procedure described in paragraph 18.

b. Remove connectors and hose from apparatus and replace height finder valve plugs or screws. Tighten plugs snugly, but do not apply force which may strip the threads or mutilate the slots.

c. Replace valve covers by hand. Do not use a wrench.

Section VI

LEAKAGE

35. PRESSURE VARIATIONS OR BREATHING.

a. If the instrument is subjected to wide variations of temperature, breathing may become pronounced. With excessive temperature rise, the increased pressure within the instrument accelerates the passage of gas through the seals and may force the seals, causing leakage. Similarly, excessive temperature drop results in contraction of gases with attendant drop in pressure inside the instrument and accelerated infiltration of moisture-laden air.

36. INDICATIONS OF LEAKAGE.

a. Height finders should retain a gas pressure of 2 psi for at least 3 weeks.

b. Leakage from breathing or other causes is indicated usually by failure of the instrument to hold its charge; but should condensation occur within the instrument it indicates that charging has been neglected or that the instrument is leaking badly. If either of these signs of leakage occurs the instrument should be checked for gas tightness. If condensation has occurred, after the cause has been determined and the trouble corrected, the instrument must also be desiccated (sec. VII).

c. It is desirable to test the tightness of height finders if internal condensation has been experienced, even if not sufficiently to inter-

fere with the operation of the instrument. After disassembly and assembly it is always desirable to test the gas tightness to determine the quality of the hermetic seal at the various mounting plates and shaft packings.

37. CHECKING FOR LEAKAGE OF HEIGHT FINDER.

a. Increase the charge in the instrument to 4 psi pressure with nitrogen or helium, whichever is already present.

b. Record the exact pressure and temperature. A more exact value of pressure and temperature can be obtained by starting the test an hour or two after filling. By that time temperature stabilization will have taken place.

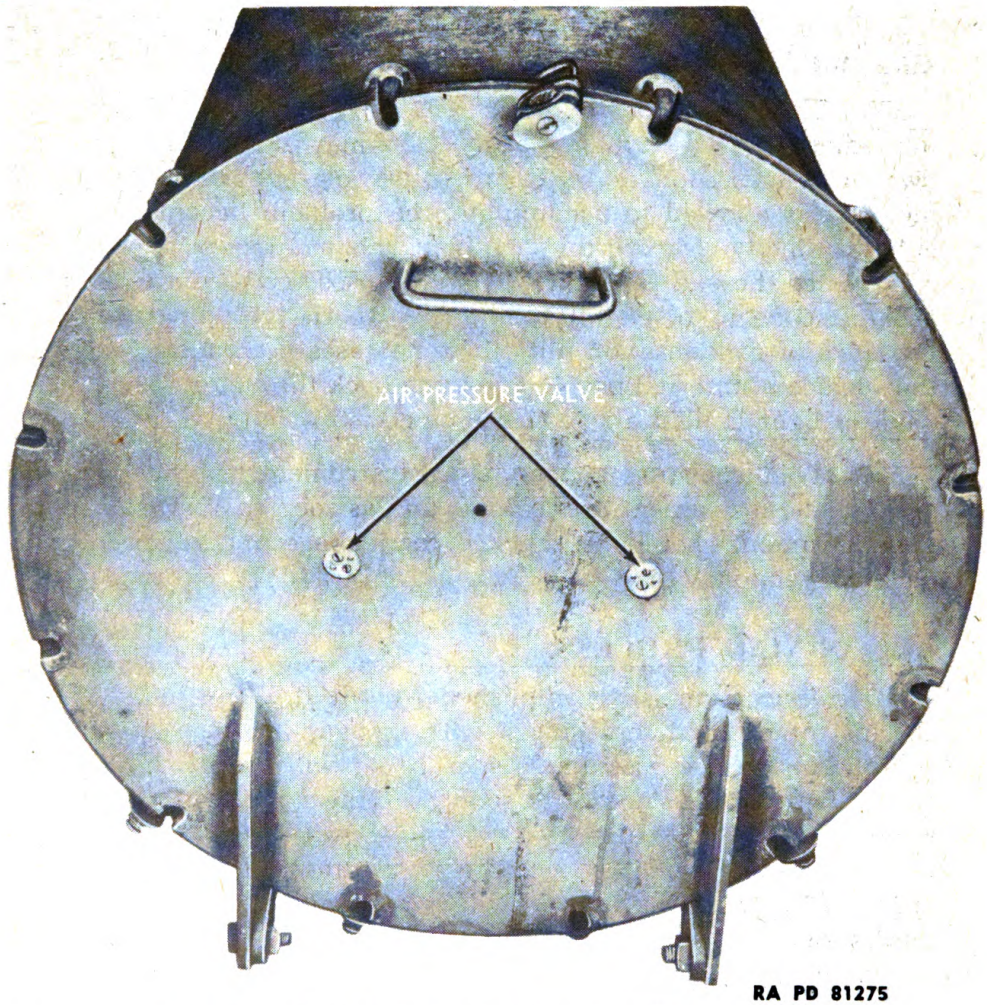
c. After a period of 8 hours, the pressure must not have dropped below 3 psi. Allowance should be made for a differential between starting and finishing temperature, if temperature change is appreciable. Roughly, a 30°F rise or drop in temperature, starting at 4 psi, will cause a similar rise or fall in pressure of 1 psi. For example, an increased temperature of 15°F will increase the pressure ½ psi which should therefore be subtracted from the final pressure to ascertain the pressure drop, if any. When temperature changes are small they will not appreciably affect the results.

d. If pressure is found to remain above 3 psi, let out enough gas to reduce pressure to approximately 2 psi. If the pressure drops below 3 psi, a leak is indicated.

38. TESTING FOR SOURCE OF LEAKS IN HEIGHT FINDERS.

a. While the height finders is charged to 4 psi, apply soapy water made from mild soap (but do not use soapsuds) to all joints, packings, and plugs which are a possible leak source. A leak may be spotted by the bubbling of the soapy water where the leak exists, sometimes accompanied by a faint hiss. Bubbles sometimes come out far from the leak due to the gas or air traveling under the canvas cover. In tracing the leak it may be necessary to remove part of the canvas cover; this should be avoided where possible, since the cover is cemented on. If the various adapters are not soldered tightly to the tube, gas can travel between the adapter and the tube. It is therefore necessary to solder at the source of the leak rather than where the bubbles appear.

b. Apply the proper corrective measures to any leak or leaks. When completed, wash with clear water all places affected by the



RA PD 81275

Figure 16—Packing Case—End View

soapy water. Wash all soldered joints with ethyl alcohol and then coat with synthetic glyptal paint.

39. AIR TIGHTNESS OF PACKING CASE.

a. The height finder packing case for Height Finder M1 (from serial numbers 33 and above) and for Height Finder M2 is provided with inlet and outlet valves and may be tested for pressure tightness in a manner similar to the above method. Air from a compressor should be used for this test since it is not necessary to employ a dry gas for the packing case. Helium or nitrogen should not be used. No pressure is maintained in the packing case, except for testing air tightness.

Section VII

DESICCATION

40. WHEN DESICCATION SHOULD BE PERFORMED.

a. When condensation occurs, the instrument should be desiccated immediately, even though the moisture may slowly disappear of its own accord as soon as the temperature of the instrument rises. If moisture is allowed to accumulate, the problem becomes more difficult to remedy. Moisture in the instrument damages the aluminized surfaces of the end reflectors. It also causes the mechanical parts of the telescope to rust and is conducive to the growth of fungi. The presence of condensation may in some cases be readily observed on the surface of internal parts by looking back through the end windows while a light is held above the eyepiece.

b. When moisture appears in an instrument it indicates that the seals of the instrument are leaking, and as soon thereafter as possible the instrument should be checked for leakage and repaired as indicated in section VI.

41. DRYING PROCESS.

a. Desiccation is accomplished by withdrawing moist gas from the instrument and replacing it with dry gas. As long as moisture is present inside the instrument, gas being withdrawn remains "saturated" with water vapor. As soon as some vapor is withdrawn, the space inside the instrument is no longer saturated and the moisture deposits inside begin to evaporate, tending to again saturate the space. Dry gas entering the instrument mixes with the vapor and passes out saturated or nearly so. It would become saturated if sufficient time were allowed.

b. The vaporization process can be speeded up by lowering the pressure inside the height finder. Procedure for evacuating the instrument, therefore, in addition to running dry air or nitrogen through it, is described in this section.

c. Due to its scarcity, helium should not be used for desiccating. Also, since air must be desiccated before it can be used, nitrogen from cylinders is more convenient for use in the field.

42. PROCEDURE FOR DESICCATING WITH NITROGEN WITHOUT EVACUATING.

a. Connect pressure regulator to nitrogen cylinder, observing the precautions given in paragraph 17. Connect pressure gage to one of the height finder charging valves and connect a hose between regulator and pressure gage.

b. Remove plug in other charging valve. Open both charging valves and allow 5 psi at the regulator to flow through the instrument for about 20 minutes.

c. If instrument is to be charged with nitrogen, after 20 minutes adjust pressure regulator to 2 psi and close outlet valve. Allow the pressure within the instrument to come to 2 psi over a 5-minute period; then close the intake valve.

d. Remove pressure gage and replace charging valve plugs and covers.

43. PROCEDURE FOR DESICCATING WITH AIR WITHOUT EVACUATING.

a. Limitations. Units which desiccate instruments frequently may effect an economy by using air from the atmosphere instead of nitrogen. This method requires an air compressor and equipment for cleaning and drying the air before it passes into the instrument. Moisture-laden air should never be introduced into the height finder.

b. Method.

(1) Connect a hose between the "dry air" end of the air desiccating apparatus and one of the height finder charging valves. Inspect the hose before connecting to be sure that it is clean and dry.

(2) Connect the pressure gage and venturi valve to the other end of the height finder as shown in figure 17. Connect a hose from the air compressor source to the venturi valve. Be sure the venturi valve connection marked "TO INSTRUMENT" is connected to the pressure gage and connection marked "TO TANK" is attached to the compressor line. Turn the venturi valve to "VACUUM."

(3) With the compressor supply valve off, open the height finder charging valves. Then gradually open the compressor supply valve until a vacuum of 5 to 10 inches of mercury is indicated on the pressure gage. Continue to draw air through the instrument for 20 minutes after all signs of moisture have disappeared, or when the instrument has been opened up for repairs in a humid atmosphere. Do not allow evacuating pressure to fall below 10 inches to avoid damage to the seals. Exercise care to insure that air from the compressor is not allowed to pass accidentally through the venturi valve into the height finder.

(4) Close the height finder valves. Connect proper charging equipment to the instrument and restore the helium or nitrogen charge.

DESICCATION

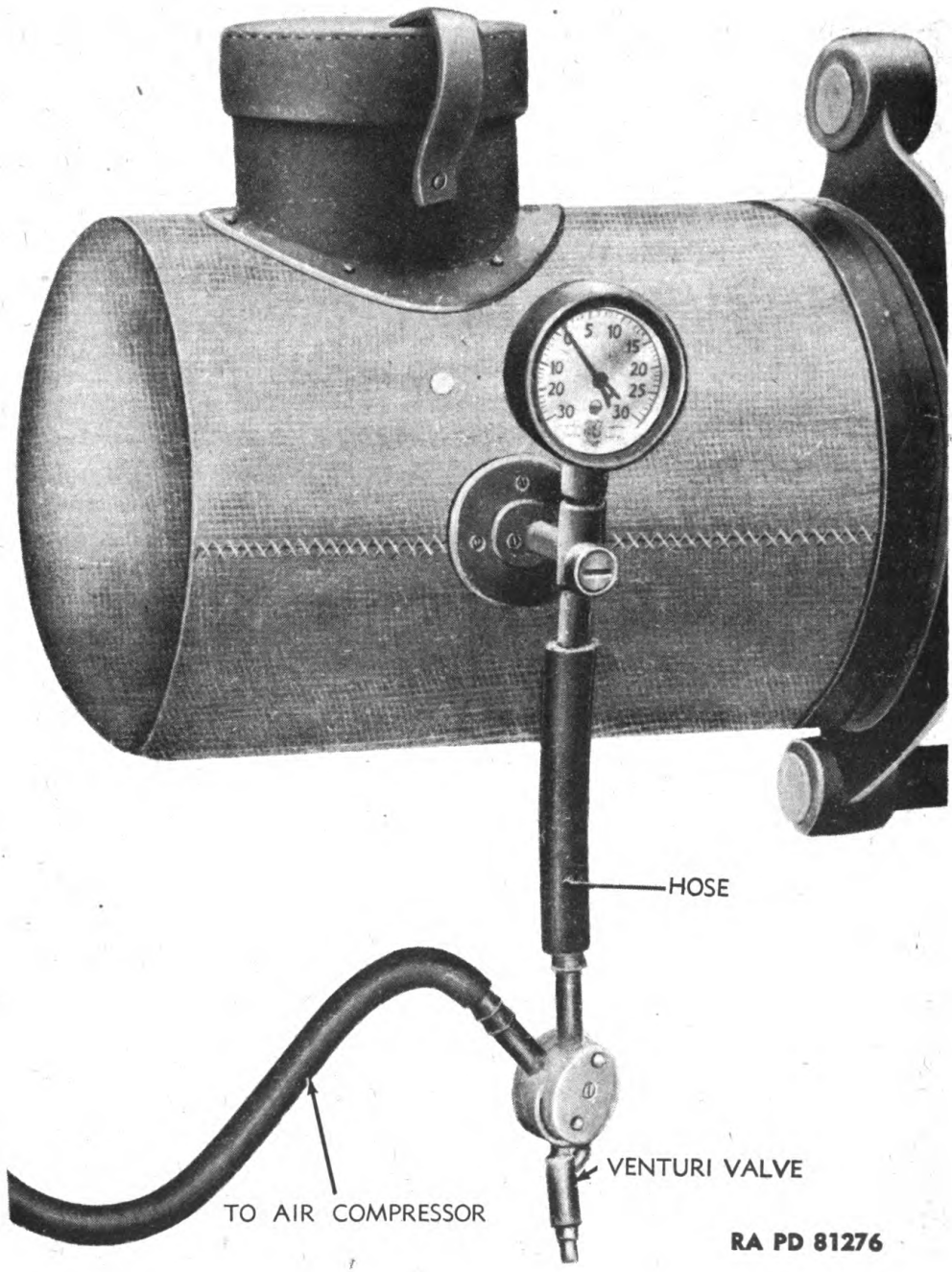


Figure 17—Arrangement of Apparatus for Evacuation When Desiccating With Air

ORDNANCE MAINTENANCE—DESICCATION AND CHARGING OF HEIGHT FINDERS

44. AIR DESICCATING UNIT.

a. Desiccation of air can be accomplished by passing it through a compartment containing a drying agent such as silica gel.

b. An airtight container containing silica gel of the indicating type and provided with a window for observing the condition of the drying agent and outlet and inlet tubes, makes a suitable desiccating unit. The inlet tube should carry the air to the bottom of the container. A wire screen should hold the filtering and drying agents off the bottom, followed by a 2-inch layer of absorbent cotton, 3 inches of desiccant, and another layer of cotton on top.

c. The desiccant used must be crystalline to avoid introduction of powdery dust into the instrument. It also must be of the indicating type. CAUTION: *The use of calcium chloride is prohibited, as the chlorine released by it will damage the instrument.* Indicating type of silica gel can be reactivated by baking in an oven at 350°F for an hour or until it turns blue. When the silica gel takes up moisture, it turns pink. Its crystalline character must be preserved by slow heating; otherwise it cannot be used.

45. PROCEDURE FOR DESICCATING, USING EVACUATION.

a. If it is desired to conserve nitrogen or reactivate improvised air dryers less often, or to remove particularly stubborn moisture deposits, the following method of desiccation should be used:

(1) Connect the venturi valve described in paragraph 43 **b** (2) so that it will use air from an air compressor to evacuate gas from the instrument.

(2) Connect the dry air or nitrogen supply to the other end of the instrument.

(3) To evacuate, set the venturi valve to read "VACUUM," open the height finder valve, and slowly turn on the compressed air until 10 inches of mercury is indicated on the pressure gage. Allow a few minutes for the pressure inside the height finder to come to equilibrium, taking care that 10 inches pressure is not exceeded. CAUTION: *A vacuum of more than 10 inches may damage the seals of the instrument.* The pressure within the instrument can be checked by cutting off flow at the venturi valve; it will probably be necessary to shut off the supply from the air compressor at the same time in order to keep it from blowing off the hose. Take care not to allow air from the compressor to pass into the instrument when adjusting the venturi valve. Close the height finder valve at the vacuum end.

(4) If dry air is being used, open the other height finder valve and allow air to enter the instrument.

(5) If nitrogen is used, regulate the pressure from the supply cylinder to 2 psi before opening the valve and maintain that pressure while the height finder fills.

(6) Close the intake valve when the instrument is charged.

Section VIII

CONVERSION FROM NITROGEN TO HELIUM

46. GENERAL.

a. When an instrument is converted from air or nitrogen to helium, or vice versa, it is necessary first to make a parallax correction, because helium, air, and nitrogen have different refractive indices (par. 3). Air and nitrogen have almost the same refractive indices (par. 3). Instruments charged with helium and corrected for parallax (par. 4 **d**) may be identified by the presence of a helium parallax correction plate and an orange dot located as shown in figure 9. When changing from helium to air or nitrogen (because of the lack of helium), it will be necessary to reverse the parallax correction as indicated on the correction plate. The orange dot and helium parallax correction plate should be removed when converting to nitrogen, and installed when converting to helium.

b. To make the helium parallax correction, it is necessary to adjust the objectives by moving them in toward the reticles as described below, after they have been focused for air. Parallax will then be quite noticeable but will disappear when the height finder is charged with helium.

47. HELIUM PARALLAX CORRECTION FOR HEIGHT FINDER M1.

a. The helium parallax correction for Height Finder M1 is made by unscrewing round nuts A49178 (fig. 18) as nearly as possible 2.4 holes or slightly over one-fifth turn, before locking them and tightening the clamping rings. Check the end window setting after charging. For detailed instructions, see TM 9-1623.

48. HELIUM PARALLAX CORRECTION FOR HEIGHT FINDER M2.

a. The helium parallax correction is made in Height Finder M2 by moving each objective lens about 0.4 millimeters towards the center of the instrument, or approximately 9¼ holes adjustment in the inner retaining rings (fig. 19). In this operation use an adjusting pin. After completing the operation, move outer ring until snug. Check the end window setting after charging. For detailed instructions, see TM 9-1624.

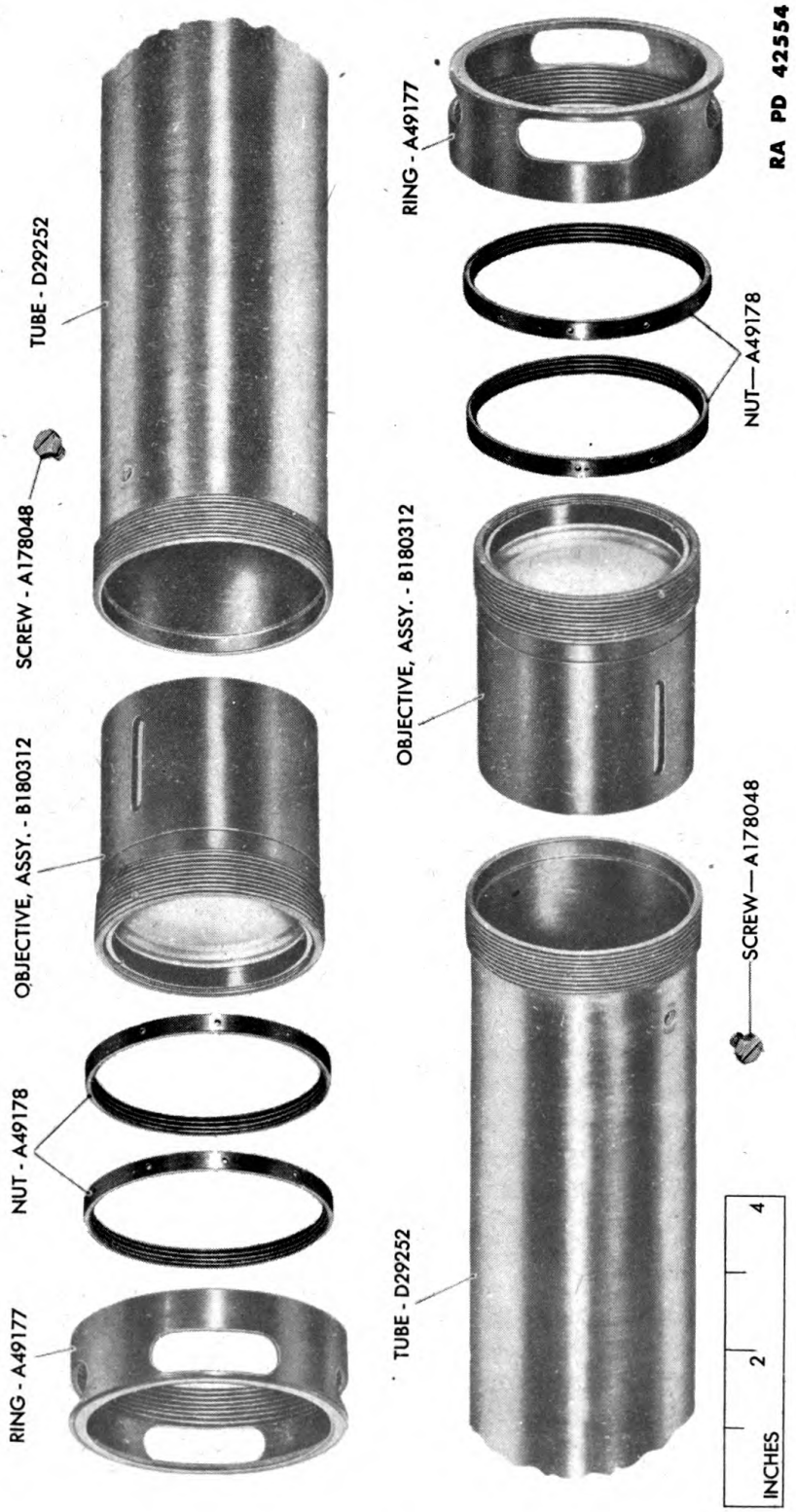


Figure 18—Height Finder M1—Optical Tube Objective Group Assembly—Exploded View

CONVERSION FROM NITROGEN TO HELIUM

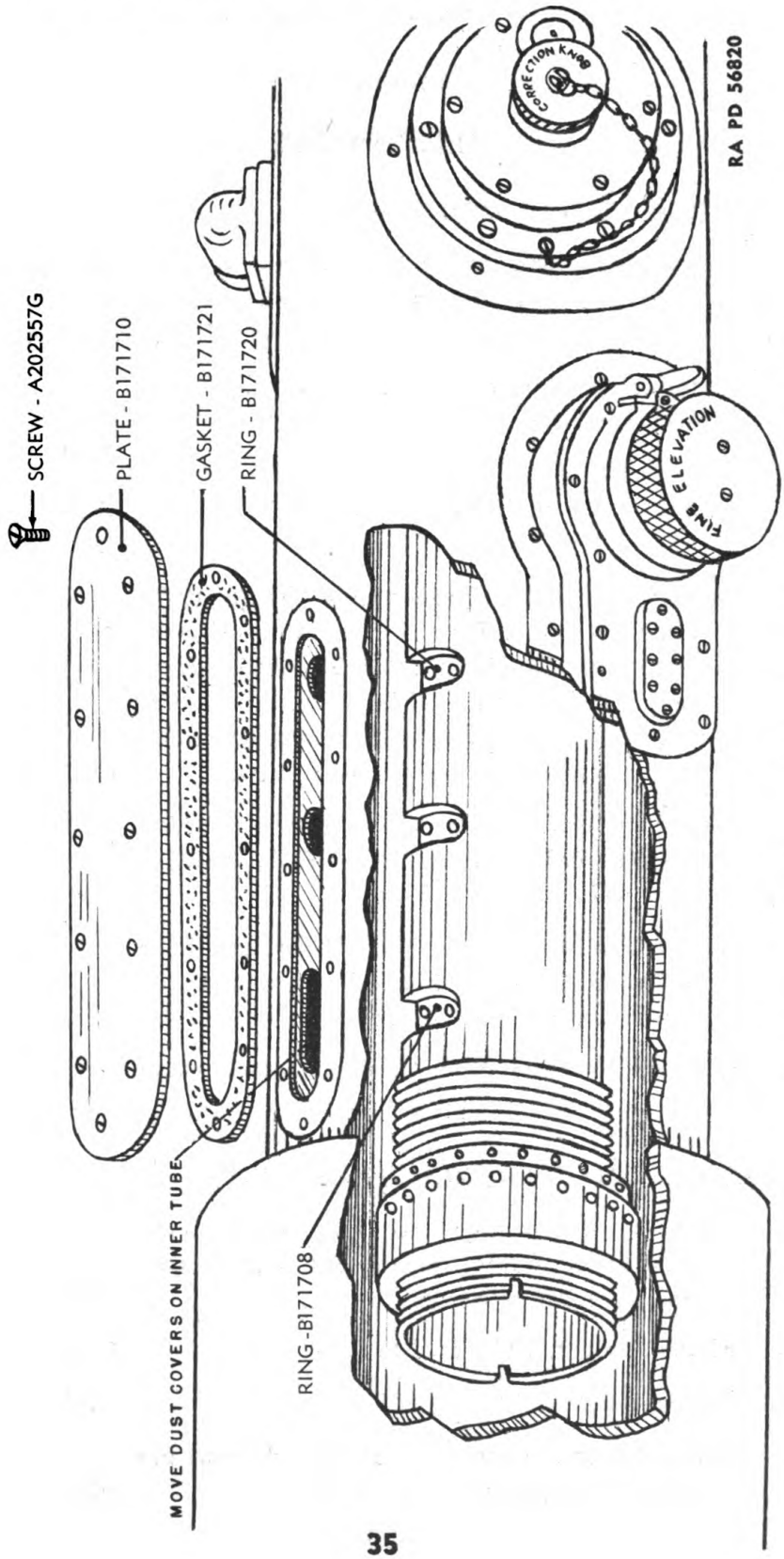


Figure 19—Left Optical Tube Objective of Height Finder M2

ORDNANCE MAINTENANCE—DESICCATION AND CHARGING OF HEIGHT FINDERS

Section IX

REFERENCES

49. PUBLICATIONS INDEXES.

The following publications indexes should be consulted frequently for latest changes or revisions of references given in this section and for new publications relating to materiel covered in this manual:

a.	Introduction to Ordnance Catalog (explaining SNL system)	ASF Cat. ORD 1 IOC
b.	Index (index to SNL's)	ASF Cat. ORD 2 OPSI
c.	Index to Ordnance Publications (listing FM's, TM's, TC's, and TB's of interest to ordnance personnel, OPSR, FSMWO's, BSD, S of SR's, OSSC's, and OFSB's, and including alphabetical listing of ordnance major items with publications pertaining thereto)	OFSB 1-1
d.	List of Publications for Training (listing MR's, MTP's, FM's, TM's, TR's, TB's, MWO's, SB's, WDLO's, and FT's)	FM 21-6
e.	List of Training Films, Film Strips, and Film Bulletins (listing TF's, FS's, and FB's by serial number and subject)	FM 21-7
f.	Military Training Aids (listing graphic training aids, models, devices, and displays)	FM 21-8

50. STANDARD NOMENCLATURE LISTS.

a.	Cleaning, preserving, and lubricating materials; recoil fluids, special oils, and miscellaneous related items	SNL K-1
b.	Finder, height, 13½ ft., M1	SNL F-171
c.	Finder, height, 13½ ft., M2	SNL F-189
d.	Tool-sets for maintenance of sighting and fire control equipment	SNL F-272

REFERENCES

51. EXPLANATORY PUBLICATIONS.

a.	Basic maintenance manual	TM 38-250
b.	Cleaning, preserving, sealing, lubricating, and related materials issued for ordnance materiel	TM 9-850
c.	Dictionary of United States Army terms	TM 20-205
d.	Height finders, 13½ ft., M1 and M1A1	TM 9-623
e.	Height finders, 13½ ft., M2 and M2A1	TM 9-624
f.	Instrument repairman	TM 9-2602
g.	Ordnance maintenance: Height finders, 13½ ft., M1 and M1A1	TM 9-1623
h.	Ordnance maintenance: Height finder M2	TM 9-1624
i.	Service of height finders M1 and M2	FM 4-142
j.	Stereoscopic range and height finding	TM 4-250

ORDNANCE MAINTENANCE—DESICCATION AND CHARGING OF HEIGHT FINDERS

INDEX

NOTES

NOTES