TM 9-850

WAR DEPARTMENT

TECHNICAL MANUAL

CLEANING, PRESERVING, LUBRICATING, AND WELDING MATERIALS AND SIMILAR ITEMS ISSUED BY THE ORDNANCE DEPARTMENT

April 13, 1942

TM 9–850
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CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON 25, D. C., 23 December 1943.

TM 9–850, 13 April 1942, is changed as follows:

33.1. (Added.) Preventive cleaning of automotive internal combustion engine cooling systems.—Materials and tools available for this purpose, as well as instructions covering cleaning, neutralizing, flushing, examining for leaks, and cooling are given in section X.

[A. G. 300.7 (23 Oct 43).] (C 1, 23 Dec 43.)

SECTION X (Added)

PREVENTIVE CLEANING OF AUTOMOTIVE INTERNAL COMBUSTION ENGINE COOLING SYSTEMS

131. General.—This section provides instructions for preventive cleaning of automotive internal combustion engine cooling systems, to be performed by second echelon of maintenance.

132. Materials.—The materials required for this purpose are listed and available under the following Federal stock numbers:

	Federal stock number
Compound, cleaning	51–C–1568–500
Compound, inhibitor, corrosion	51–C–1600

compound, cleaning, consists of the cleaner compound and the neutralizer compound, packed in separate containers within a single package.

133. Preventive service.—It is recommended that the following procedure be performed at least twice a year. The cooling system should be cleaned before the compound, antifreeze (ethylene glycol type) is put into the system, and again after it is removed. Cleaning at the prescribed intervals will reduce clogging and overheating to a minimum, and will largely eliminate the necessity for corrective cleaning by a higher echelon. If the cooling system is very dirty or clogged so that overheating occurs, ordnance personnel should be notified. The entire cooling system should be examined for leaks both before and after cleaning and flushing. *The cleaning solution should never be mixed with antifreeze compound or other antifreeze solutions, or with inhibitors.*

a. Cleaning.—(1) Open the petcocks which shut off the coolant from the heaters or other accessories, to allow for complete circula-

tion during the cleaning, flushing, and draining. Run the engine, with the radiator covered if necessary, until the temperature is within operating range. Stop the engine, remove the radiator cap, and drain the system by opening the drain cocks in the radiator and block; check with the cooling system drain caution plate on the instrument panel for position of drains, if the vehicle is equipped with such a plate. If necessary, use a wire to keep open any drain hole which tends to become clogged.

(2) Allow the engine to cool. Disconnect the radiator overflow return tank if the vehicle is so equipped. Close the drain cocks; pour water slowly into the radiator until the system is approximately half full, then run the engine at idling speed. Add the cleaning compound in the proportion of one container of cleaner to every 4 gallons of cooling system capacity. Then complete filling the system with water. *Never mix the water and the cleaning compound before putting them into the system.*

Caution: *Do not spill the solution on skin, clothing or painted portions of the vehicle.*

(3) Place a clean drain pan in position to collect the overflow, using the overflow to maintain the level in the radiator if necessary.

(4) Replace the radiator cap and run the engine at fast idling speed, covering the radiator if necessary, until the coolant reaches a temperature above 180°, but not over 200° F. Do not drive the vehicle. Constantly check the level in the radiator.

(5) Stop the engine after it has run for 30 minutes at at least 180° but not over 200° F. Then remove the radiator cap and drain the system completely.

b. Neutralizing.—(1) Allow the engine to cool. Close the drain cocks; pour water slowly into the radiator until the system is approximately half full, then run the engine at idling speed. Add the neutralizer compound in the proportion of one container of neutralizer to every 4 gallons of cooling system capacity. Then fill the system with water.

(2) With the radiator covered, let the engine idle for at least 5 minutes at the normal operating temperature. Then stop the engine.

(3) Drain the system completely by removing the radiator cap and opening all the drain cocks.

c. Flushing.—(1) Allow the engine to cool. Close the drain cocks. Pour water slowly into the radiator until the system is approximately half full, then run the engine at idling speed and fill the system completely.

(2) Run the engine, keeping the radiator covered if necessary, until the coolant is heated to the normal operating temperature.

(3) Drain the system by removing the radiator cap and opening all the drain cocks. Repeat the flushing operation until the drain water is clear.

(4) Again allow the engine to cool and then clean all sediment from the radiator cap valves and the overflow pipe. Blow insects and dirt from radiator core air passages with compressed air, blowing from the rear. Use water if necessary to soften obstructions.

(5) If the system is equipped with an overflow tank, flush the overflow tank and pipe by filling with water and then draining both completely.

d. Leaks.—After completing the flushing operation, make certain that the engine has been allowed to cool again. Close the drain cocks. Pour water slowly into the radiator until the system is approximately half full, then run the engine at idling speed and fill the system completely. Stop the engine when the cooling system is completely full. Examine the entire cooling system for leaks. This is important because the cleaning solution uncovers leaks which already exist but are plugged with rust or corrosion. Leaks that cannot be corrected by the using arm should be reported immediately to ordnance maintenance personnel.

e. Coolant service.—(1) When servicing the vehicle for summer, fill the system nearly full with clean water. Add compound, inhibitor, corrosion, in the proportion of one container of inhibitor to each 4 gallons of cooling system capacity. Then complete filling the system with water.

(2) When servicing for winter, fill the system about one-quarter full of clean water. Add sufficient compound, antifreeze, (ethylene glycol type) for protection against the lowest anticipated temperature. Add water until the system is nearly full, then run the engine until the normal operating temperature is reached. Then add sufficient water to fill the system to the proper level, as indicated in the Technical Manual pertaining to the matériel. See TB 700–20 for antifreeze installation instructions.

[A. G. 300.7 (23 Oct 43).] (C 1, 23 Dec 43.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
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The Adjutant General.

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TECHNICAL MANUAL
No. 9–850

WAR DEPARTMENT,
WASHINGTON, April 13, 1942.

CLEANING, PRESERVING, LUBRICATING, AND WELDING MATERIALS AND SIMILAR ITEMS ISSUED BY THE ORDNANCE DEPARTMENT

SECTION I

GENERAL

1. Purpose.—*a.* The purpose of this manual is to present information to the using arms and services concerning the characteristics, application, and handling of cleaning, preserving, lubricating, welding, brazing, cutting, and other materials issued by the Ordnance Department and listed in SNL's K–1 and K–2. Information and directions given here will supersede those given in TR 1395–A and in the various Ordnance Field Service Circulars published prior to publication of this manual and dealing with materials within its scope.

b. Specific instructions are given in this manual on "cleaning, preserving, and lubricating materials, recoil fluids, special oils, and similar items of issue" as listed in SNL K–1, and no "soldering, brazing, and welding material, gases, and related items" as listed in SNL K–2.

*This pamphlet supersedes TM 9–850, August 21, 1941; TR 1395–A, January 9, 1930; and Advance Information on Care and Preservation of Seacoast Artillery, June 19, 1941.

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2. Scope.—*a.* Instructions in this manual concern materials issued by the Ordnance Department for specific purposes, and care should be taken that they are used for the purposes specified and in the manner prescribed.

b. Use of materials other than those authorized for the specific purposes mentioned is strictly forbidden.

c. Not all of the materials listed herein are authorized for issue to troops. Arsenals and depots of the Ordnance Department, and depots at line posts and small ordnance establishments are charged with the preservation of ordnance matériel under storage conditions. Because of the greater magnitude of this work and the problems of economical preservation over long periods of time, it may be found necessary to use the additional materials listed here which are not required for issue to troops.

3. References.—*a.* Allowances of cleaning and preserving materials initially issued to the various organizations of the Army are given in Tables of Allowances; those for the units of the National Guard, in National Guard Regulations and circulars; and those for the units of the Reserve Officer's Training Corps and Organized Reserves, in Army Regulations.

b. Unit prices, specification numbers, and packaging of cleaning, preserving, and lubricating materials, recoil fluids, special oils, and similar items of issue are published in SNL K–1. The unit prices, specification numbers, and packaging of welding, brazing, cutting, and soldering materials, and related items are published in SNL K–2.

c. Instructions for painting and marking of projectiles are covered by standard ordnance drawings (class 75, division 14) and U. S. Army specifications. To identify service markings of ammunition and ammunition containers, reference should be made to appropriate Technical Manuals and ordnance drawings.

d. Instructions for the application of lubricants, recoil oils, and preservatives (rust-preventive compounds or paints and related materials) are given in detail in the Technical Manuals covering the particular materials. However, general information applicable to most units will be furnished in this Technical Manual so far as it is possible to do so.

Section II

CLEANERS AND ABRASIVES

4. Cleaning of small bore arms.—*a.* Formerly it was thought that corrosion in the bores of small arms might be due to the action of powder gases actually squeezed into the pores of the metal. Investigation has shown that this is not the case. The bore of a small arm, under the action of pressure and heat from burning powder gases, is hardened in a manner similar to that which forms the so-called case-hardened surface on steel. Under the further action of heat, pressure, and abrasion, the hardened surface becomes covered with minute cracks. These cracks normally follow the tool marks. They extend, however, from the surface of the bore to a depth approximating a maximum of 0.0015 inch. These minute cracks accumulate fouling which is difficult to remove by merely wiping. A bore might after superficial cleaning appear to be in perfect condition, but subsequently will rust from the action of fouling and moisture remaining in these cracks.

b. Firing of a ball cartridge deposits in the bore the combustive products of powder and primer, together with plating or smears of metal from the jacket of the bullet. Combustion of the powder, being nearly complete, usually leaves a fouling of an almost harmless ash. Combustion of the primer mixture, however, deposits a

salt known as potassium chloride, similar to common table salt. This salt is deposited over the surface of the bore and gas system as in all cracks and tool marks. When first deposited it is harmless but it quickly absorbs moisture from the air. Steel rusts very quickly when covered with wet salt. This salt is not dissolved by oil. It is little affected by oil or by any solutions or solvents containing oil, and will continue to absorb moisture even when saturated with such solutions. It is, however, readily dissolved in water or in solutions containing water. In cleaning, therefore—

(1) Dissolve all of this salt from the bore surfaces, cracks, and tool marks with which it comes into contact, by using water or solutions containing water.

(2) Dry these parts thoroughly.

(3) Protect these parts and surfaces with a film of oil, grease, or preservative.

c. Oil or solutions containing oil will not free the bore or gas system from fouling. Only water or solutions containing water will do this. If the weapon is being made ready for use, oil, lubricating, for aircraft instruments and machine guns is to be applied; if for storage, a rust preventive.

d. Instructions for the insertion of cleaning rods in barrels of small arms, as given in Technical Manuals for particular arms, generally specify that cleaning rods be inserted from the breech end so the rifling at the muzzle will not be damaged. Submerge the muzzle in a vessel containing hot water and issue soap, soda ash solution, hot water alone, or, in the absence of these, cold water. Insert the cleaning rod, with a cloth patch assembled, in the breech and move up and down for about 1 minute, pumping the water in and out of the bore. While the bore is wet run a brass or bronze wire brush, if available, completely through the bore and then all the way back, three or four times. Again pump water through the bore with the cleaning rod and cloth patch. Then wipe the cleaning rod dry, remove the barrel from the water, and with dry clean flannel patches swab the bore until it is perfectly dry and clean. Be certain the chamber is also dried and cleaned, using flannel on a stick if necessary. Make the examination for metal fouling as described in paragraph 5. If no metal fouling is present, saturate a clean flannel patch with oil, lubricating, for aircraft instruments and machine guns, and swab the bore and chamber with the patch. Finally, draw the patch smoothly through the bore and out of the chamber, allowing the cleaning rod to turn with the rifling.

5. Metal fouling.—After the bore has been cleaned and dried as above, and before it has been oiled, examine it for metal fouling. Hold the breech of the barrel pointed toward the sky and examine the bore from the muzzle end, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore near or for about 6 inches down from the muzzle, this is metal fouling. Remove metal fouling at once, as it not only is detrimental to accuracy, but will cause the bore to rust very quickly on the portions covered.

6. Ammonia, 28 percent.—*a. Characteristics.*—(1) Ammonia, 28 percent, is a colorless solution of ammonia gas in water.

(2) This solution is volatile and gives off a strong pungent odor, irritating to the nose, throat, and lungs.

(3) The fumes of ammonia, 28 percent, are not classed as poisonous, but are very irritating to the throat and lungs. It is, however, dangerous if splashed in the eyes, and if this happens large amounts of water should be used for thorough washing. Fresh air is the antidote for nausea resulting from overexposure to ammonia fumes. If prolonged exposure to the fumes is necessary, use a gas mask.

(4) Ammonia on the skin causes smarting and burning. The antidote is to wash with large amount of water and apply vaseline, olive oil, lard, or similar greases or oils.

(5) If ammonia is kept tightly sealed in its container, it retains its strength indefinitely, but if exposed it loses strength rapidly. If so weakened, it may be used by increasing the percentage of ammonia until the desired result is obtained. Solutions of ammonia kept in glass containers will develop a slight turbidity during prolonged storage. This does not impair the value of the solution as a cleaner. It is, however, an indication that the solution has been slightly weakened and in making up the cleaning solution the ammonia content should be increased accordingly.

b. Container.—20-ounce bottle.

c. Method of handling.—(1) Do not handle or use this solution carelessly.

(2) Use only those amounts called for and keep the bottle closed when not in use.

(3) Be careful to keep the solution off the hands, body, clothing, or other personal belongings.

(4) Store the solution in a cool place.

(5) Do not inhale the vapors more than necessary and use in a well-ventilated place.

d. Use.—(1) It is used in ammonia swabbing solution.

(2) When ammunition containing bullets jacketed with copper (gilding metal) is used, ammonia swabbing solution will usually suffice to remove the thin plating of copper sometimes deposited on the surface of the bore by this ammunition. The bore should first be cleaned with hot water and issue soap, soda ash solution, hot water alone, or in the absence of these, cold water. After this preliminary cleaning, wet a number of cut flannel patches with the ammonia swabbing solution (described below) and swab the bore with them for about 5 minutes, or until the patches no longer show a blue color. Then swab again with clean water, dry thoroughly, and oil with oil, lubricating, for aircraft instruments and machine guns.

(3) Soda ash solutions mentioned above will be made by adding 1½ spoonfuls (mess kit spoon) of soda ash to a pint of water.

(4) Ammonia swabbing solution consists of—

28 percent ammonia	1½ parts.
Water	1 part.

(5) Keep the solution in a tightly stoppered bottle, removing only the necessary amount at the time of use. This is a dilute cleansing solution to be used in rifle barrels following the firing of copper-jacketed (gilding metal) bullets and after the barrel has been washed with soda ash solution.

(6) Ammonia swabbing solution is used only for removal of the rifle bore fouling causing by firing bullets jacketed with copper (gilding metal). Metal fouling solution, on the other hand, is used to remove fouling caused by firing bullets jacketed with cupro-nickel metal.

7. Ammonium carbonate.—*a. Characteristics.*—(1) White hard crystals that give off ammonia fumes.

(2) On exposure to air, ammonium carbonate gives off ammonia and carbon dioxide and then becomes powdery.

(3) At 104° F. (40° C.) this compound evaporates entirely.

(4) It is dissolved by acids with the production of foam.

b. Container.—8-ounce bottle.

c. Method of handling.—(1) Keep in an airtight container in a cool place.

(2) Do not keep the bottle opened longer than necessary when using and do not handle near any sources of heat.

(3) Pound the crystals to powder before dissolving in water.

(4) Avoid long storage prior to use.

d. Use.—Used in making solution, metal-fouling.

8. Ammonium persulfate. — *a. Characteristics.* — (1) White, powdered crystals.

(2) Decomposes slowly if exposed to air at ordinary temperatures.

(3) Powerful oxidizing agent.

b. Container.—8-ounce bottle.

c. Method of handling.—(1) Must be used only as directed since it can be dangerous if allowed to come in contact with certain other chemicals.

(2) Do not allow ammonium persulfate to come in contact with parts of the body or clothing.

(3) Store in an airtight container in a cool place.

(4) Avoid long storage prior to use.

d. Use.—Used in making solution, metal-fouling.

9. Solution, metal-fouling.—*a. Characteristics.*—(1) A perishable mixture to be prepared as needed for dissolving cupro-nickel metal fouling from the bores of small arms and machine guns.

(2) The use of this solution is restricted to ordnance establishments. There it may be used in the overhaul of small arms in which cupro-nickel jacketed projectiles have been fired. However, since cupro-nickel jacketed ammunition is no longer standard and its use at present is very limited, solution, metal-fouling, will seldom be required in the future.

b. Container.—Made up and stored in a clean quart-size bottle.

c. Method of handling.—(1) The solution has no appreciable effect on steel when not exposed to the air, but if allowed to evaporate it attacks the steel rapidly.

(2) It is important to prevent the solution from spilling on the mechanism.

(3) Wash the barrel out promptly after using the solution.

(4) Use solution, metal-fouling, within 30 days after mixing and do not use more than twice. Used solution should not be mixed with unused solution but should be bottled separately.

(5) The solution should be used economically.

(6) Serious damage to a weapon may result from improper use of the solution and the directions given herewith must be followed closely.

d. Preparation of solution, metal-fouling.—(1) *Components.*

Ammonium persulfate, 1 ounce (2 medium heaping tablespoonfuls).
Ammonium carbonate, 200 grains (1 heaping tablespoonful).
Ammonia, 28 percent, 6 ounces or 3/8 pint (12 tablespoonfuls).
If ammonia, 28 percent, has been weakened for any reason, it may still be used by increasing the percentage of ammonia until the proper result is obtained.
Water, 4 ounces or 1/4 pint (8 tablespoonfuls).

NOTE.—The tablespoon referred to is that furnished as part of the mess kit The foregoing amount is sufficient for about six rifle or machine-gun barrels.

(2) Powder the ammonium persulfate and ammonium carbonate together by placing them inside a clean cloth and grinding with a tool handle. Dissolve the powdered chemicals in the water and add the ammonia. Mix thoroughly until about 90 percent of the powder is dissolved and allow to stand for 1 hour before using. The solution should be kept in a strong bottle, closed tightly with a rubber stopper, and kept in a cool place.

e. Removal of cupro-nickel metal fouling.—To remove metal fouling proceed as follows: The bore should be free from primer and powder fouling and the barrel should be cold. Place a rubber stopper in the chamber so as to seal the bore at that point. Place a 2-inch section of rubber tube over the muzzle, so that about an inch of the tube extends above the muzzle. Pour the standard metal-fouling solution carefully into the bore from the muzzle end until it rises in the rubber tube, completely covering the muzzle. If any is spilled on the exterior of the barrel, wipe it off at once. The solution should be permitted to remain in the bore from 15 to 20 minutes, but never longer than 30 minutes under any circumstances. It should never be used in a hot barrel. Pour the solution out of the bore and remove the stopper from the chamber and the rubber tube from the muzzle. Allow any remaining solution to drain out of the muzzle and at once pump water through the bore to remove all traces of it. Dry the bore and apply oil or grease as prescribed for regular cleaning. The ammonia solution dissolves the metal fouling. When tracer ammunition has been used, it may be necessary to apply the solution three or four times to remove the large amount of metal fouling deposited. It may be necessary at times to use a wire brush in conjunction with this work. Bores should be washed out with water after each cleaning.

10. Burlap, jute.—Used over the bore sponge for cleaning the bores of cannon. It is also used for covering the breech and muzzle of cannon in storage or during stand-by condition. A cotton cloth (Osnaburg) will be used in place of burlap, jute, if the latter is not available.

11. Carbon tetrachloride.—*a. Characteristics.*—(1) Heavy colorless liquid.

(2) Volatile and incombustible.

(3) Odor similar to that of chloroform.

(4) Vapor is heavier than air.

(5) Harmful to eyes.

b. Container.—Quart bottle.

c. Method of handling.—(1) Do not keep exposed to air when not in use.

(2) If carbon tetrachloride is taken into the body by breathing its vapor, or into the digestive system through the mouth, it is quite poisonous. The symptoms of poisoning are headache, nausea, anaesthesia, followed by inflammation of the liver and kidneys, and in some cases it might lead to unconsciousness and death.

(3) In contact with the skin, this chemical may cause mild dermatitis.

(4) If carbon tetrachloride is accidentally gotten into the eyes, it causes considerable pain and produces a violent flow of tears. This effect is temporary, however. The eyes should be washed immediately with large amounts of water.

(5) Proper precautions should be taken to avoid undue exposure to carbon tetrachloride. When used openly, as in a shop, good ventilation must be provided and respiratory equipment furnished to men who work with it for a prolonged period of time.

d. Use.—(1) As a solvent for cleaning couplings and spark plug joints in tanks and combat cars. Pyrene may be used instead, if available.

(2) Used as a constituent of the liquid fill for certain types of fire extinguishers and in machine shops as a degreasing material. For ordnance purposes, however, solvent, dry-cleaning, will be used as a degreasing agent rather than carbon tetrachloride.

12. Cleaner, rifle bore.—*a. Description.*—A combination solvent and preservative which is issued for use by troops in the field for cleaning small bore arms. When cleaner, rifle bore, is not available, the bore should be cleaned with hot soap solution, soda ash solution, hot water alone, or in the absence of these, cold water. After the cleaning operation, the bore should be rinsed thoroughly with clean water, dried, and oiled. When cupro-nickel bullets are used, the bore must be cleaned with a metal swabbing solution.

b. Use.—Saturate a clean patch with cleaner, rifle bore, and push back and forth through the bore of the rifle or small arm with a cleaning rod. Repeat the operation with clean patches two or three times and then use a clean dry patch to remove all the cleaner before applying the prescribed coating of protective oil.

13. Cloths.—*a. Crocus.*—(1) *Description.*—(*a*) Fine, soft, red, or reddish-brown powder (tripoli or oxide of iron) on cloth sheets, 9 by 11 inches.

(*b*) Keeps indefinitely if stored in a fairly dry place.

(2) *Use.*—(*a*) Used for cleaning and polishing finished machine-cut surfaces, such as bolts of rifles and automatic rifles, pistols, breechblocks, parts of breech mechanisms, instruments, gun slides, and brass work.

(*b*) Battery (line) personnel may use cloth, crocus, for removing rust and stains from threads of breechblocks and breech recesses, gas-check seats, gas-check rings, bearing surfaces of parts of breech mechanisms, and firing mechanisms. It may be used on steel shanks of sight mounts and steel seats of range quadrants. Its use by line organizations on other sighting equipment is prohibited. No coarser abrasive should be used on gas-check seats. If cloth, crocus, is not sufficient to remove defects on surfaces specified above, notify the proper ordnance personnel.

(*c*) Ordnance personnel authorized to do such work may use cloth, crocus, for polishing unlacquered rifle-sight leaves, rifle or machine-gun bolts, the sight-adjusting collars of telescopic tank sights, and the polished piston heads and piston rods of hydropneumatic recoil mechanisms.

(*d*) Lacquered parts, such as the scales of aiming circles, telescope mounts, range quadrants, and panoramic sights, must not be polished except when necessary for relacquering. In this case the old lacquer should be removed with remover, paint and varnish, and the instrument polished only in the event of visible corrosion after removal of the old lacquer. Removing the old lacquer, polishing, and relacquering should be carried out only by ordnance personnel authorized to do so. Strong alkalies such as lye or soda ash or strong acids must never be used to remove lacquer and corrosion products from fire-control equipment.

b. Emery.—(1) *Description.*—Natural emery or artificial aluminum oxide abrasive on cotton drill or jean sheets (9 by 11 inches). Grain is printed on each sheet. (Grain 00, 0, ½, 1, 3. No. 00 is finest, No. 3 coarsest.)

(2) *Use of No. 00.*—(*a*) Used for polishing, cleaning, and removing rust from finished iron and steel surfaces in ordinary machine repair work. Ordnance personnel authorized to do such work may use No. 00 for the removal of burs from threads of breechblocks and breech recesses, gas-check split rings and gas-check seats, steel shanks of sight mountings, and bearing sleeves of range finder and battery commander's telescope tripods. No abrasive coarser than No. 00 will be permitted for work on breech mechanisms. To prevent unnecessary wear, cloth, crocus, should be used on these mechanisms.

(*b*) The use of No. 00 cloth, emery, on soft bearing metals—such as brass, bronze, and babbitt, is prohibited, as such bearing surfaces become charged with the abrasive, which then laps away the contacting metal. If there is reason to suspect that emery has entered any bearing, the mechanism will be disassembled and cleaned thoroughly.

(*c*) Emery, however fine, must not be used where particles of the abrasive may enter bores of small arms, bearings, or breech mechanisms of any kind.

(*d*) In no event will emery be used to polish or burnish commutators of generators since emery dust will cause "shorts" and bring about untimely destruction of the units. Sandpaper of the correct grade (fine) may be used for this purpose, provided the commutator is not too deeply ridged or worn.

(3) *Use of No. 0.*—Used for cleaning finished iron and steel surfaces other than those specified above, for surfaces where light deterioration has occurred, and for removing burs and scratches. It may be used on ground and antiaircraft machine guns, and on gun carriages and artillery accompanying infantry. No. 0 may also be used for polishing bayonet blades and other nonbearing finished surfaces where a slight removal of metal does not affect a proper fitting.

(4) *Use of No. ½.*—Used for cleaning iron and steel surfaces where reasonably heavy deterioration has occurred; also for removing burs and scratches.

(5) *Use of No. 1 (medium).*—Used for removing rust, burs, and other defects from unfinished iron and steel surfaces of light tanks, tractors, antiaircraft, railway, and seacoast artillery, and for preparing them for painting. Its use on finished surfaces is forbidden.

(6) *Use of No. 2 (coarse).*—Used for removing rust, burs, and other defects from unfinished surfaces of iron and steel and for preparing them for painting. Its use on finished surfaces is prohibited.

c. Wiping, cotton, mixed, sterilized (for machinery).—(1) *Description.*—This is an ordinary grade of wiping material.

(2) *Use.*—(*a*) Used as a substitute for cotton waste in shops and in lieu of sponges for washing vehicles.

(*b*) Cloths are preferable to cotton waste in all operations where deposits of lint are apt to plug oil lines or create stoppages that would lead to trouble. Cloths should always be used in washing operations where strong soap, lye, soda ash, or other alkaline agents are used. Sponges will deteriorate rapidly in such solutions.

(*c*) A finer grade of new cloth is required in shops authorized to disassemble recoil mechanisms, fire-control instruments, and other precision machines.

14. Paper, flint.—*a. Description.*—(1) Crushed flint rock glued to heavy paper sheets size 9 by 11 inches. This is a common variety of sandpaper.

(2) Grain sizes are No. 00, ½, 1, 1½, 2, and 2½.

b. Use of No. 00.—(1) No. 00 will be used for preparing the surfaces of wooden elements, such as sponge and rammer staves or plotting boards, for varnishing. Use this number for the finest wood finish.

(2) This grade may also be used for sanding the commutators of generators by the proper ordnance personnel. No attempt must be made, however, to condition deeply ridged or badly worn commutators by this method.

c. Use of No. ½.—(1) No. ½ is used principally for rubbing preliminary coats of paint to secure a very fine finish in the final coat. It is also used in rubbing down the stocks of small arms for refinishing and is the coarsest grain allowed for this purpose.

(2) When especially desired, the grain size of No. ½ may be reduced to a very fine paper by rubbing two pieces of No. ½ together.

d. Use of No. 1.—No. 1 is used for rubbing preliminary coats of paint to a smoother finish. Nos. 1 and 1½ are used to prepare surfaces to be painted which are in fair condition and only marred in spots.

e. Use of Nos. 2 and 2½.—Nos. 2 and 2½ are used when the surfaces are in bad condition. They are also used for removing paint.

15. Wastes.—*a. Cotton.*—(1) *Description.*—Waste is issued in two grades, colored and white.

(2) *Use of waste, cotton, colored.*—(*a*) General cleaning purposes on the exteriors of ordnance matériel such as gun carriages and automotive vehicles.

(*b*) Caulking for cracks from which it is desired to exclude dust and dirt.

(3) *Use of waste, cotton, white.*—(*a*) For general cleaning purposes on finished surfaces of ordnance matériel where a better grade than the colored cotton waste is required.

(*b*) In lieu of white cotton waste for certain tank, artillery, and ordnance organizations, an equivalent amount of clean rags may be issued.

b. Wool, colored.—Used for packing the journal boxes of railway artillery and similar heavy bearing boxes. Only the best grade of

extra long fiber woolen waste is to be used for this purpose. Waste used in journal boxes must be soaked for at least 48 hours in journal bearing oil at a temperature of not less than 70° F., before being packed into journal boxes.

16. Compounds.—*a. Cleaning, trisodium phosphate.*—(1) *Characteristics.*—(*a*) White compound usually in the form of small needle-like crystals.

(*b*) Soluble in water.

(*c*) Irritating if in prolonged contact with the hands.

(2) *Method of handling.*—(*a*) Keep in an airtight container.

(*b*) Do not allow the powder or solutions to come in contact with the hands or clothing.

(*c*) Rubber gloves should be worn by personnel using solutions of this compound.

(*d*) Do not allow the compound or solutions to come in contact with optical glass.

(*e*) Solutions must never be left in contact with painted surfaces, paint brushes, sponges, and like materials for more than a very few minutes.

(3) *Use.*—(*a*) For washing glassware or for washing painted surfaces, use a solution of about half a cup of compound, cleaning, trisodium phosphate, per gallon of clean water. Painted surfaces should be cleaned by washing only a small space at a time (approximately 2 sq. ft.), rinsing this as soon as the surface is cleaned, and drying the surface immediately with a clean rag. Failure to follow this procedure will result in stripping an excessive amount of paint from the surface. Rubber gloves should be worn by personnel doing the washing since prolonged exposure to the washing solution will cause reddening and roughening of the hands and will attack the fingernails.

(*b*) As a rinse for glassware or windows, clean water with about two tablespoonfuls of compound, cleaning, trisodium phosphate, added per gallon of water is excellent and its use usually makes wiping of glassware unnecessary.

b. Valve grinding.—(1) *Characteristics.*—(*a*) Heavy abrasive paste.

(*b*) Issued in a coarse and medium grade.

(2) *Container.*—Each grade is issued in a 4-ounce and an 8-ounce can.

(3) *Use.*—(*a*) These compounds are used in grinding valves of gasoline engines and in similar types of work.

(*b*) The coarse grade should be used for rapid, rough grinding, and the medium grade for finishing.

17. Lime, hydrated.—*a. Characteristics.*—(1) This lime has been slaked and powdered.

(2) It is only slightly soluble in water.

b. Container.—10-pound and 25-pound containers.

c. Use.—As part of the lime and lye paint remover for use on metal parts. This is described in paragraph 18.

18. Soda, caustic (lye).—*a. Characteristics.*—(1) A strongly alkaline substance.

(2) Absorbs moisture and carbon dioxide from the air, consolidating into a solid mass.

(3) Readily dissolves in water, giving off heat.

(4) Very poisonous and destructive to the body and clothing.

b. Container.—10-pound cans and 50-pound iron drums.

c. Method of handling.—(1) Handle carefully and use only the amounts called for.

(2) Dissolve into water slowly in small portions, since heat is generated during this operation.

(3) Burns caused by caustic soda on the skin or in the eyes should be treated at once by washing the injured parts with water, then with a 5 percent solution of boric acid or a 5 percent solution of either acetic acid or vinegar. Dress with vaseline, cottonseed oil, or olive oil, and bandage. If sodium hydroxide splashes into the eyes, flood immediately with a large amount of water. Call a medical officer.

(4) In case a solution of lye is swallowed, give vinegar or lemon juice (preferably vinegar) in large doses, followed by butter, olive oil, or cottonseed oil. Assist vomiting by draughts of tepid water. Call a medical officer.

(5) Lye will destroy woolen clothing and corrode nonferrous metals (aluminum, copper, brass, etc.), but its attack on iron or steel is not severe. Keep in a well-closed container.

(6) Lye is dangerous to use if not handled carefully. Precautions should be taken to prevent inhaling small particles of it when the dry material is handled. Prevent either the dust or concentrated solutions of lye from reaching the eyes.

(7) Lye solutions must not be kept in containers of nonferrous metal (copper, brass, aluminum, etc.) or in steel containers coated with nonferrous metal, such as galvanized buckets. Steel or iron is little affected by strong solutions of lye, therefore old oil drums or steel grease cans that are well cleaned make excellent containers for such solutions.

d. Use.—(1) With lime as a paint remover for metal parts.

(*a*) Lye burns and develops cracks in wood from which it is almost impossible to remove or neutralize the lye and after a time it begins to destroy the new coat of paint from underneath. For this reason lye cannot be used on wood. The lime and lye solution is considerably cheaper in first cost than remover, paint and varnish. It does not attack rubber or steel as the remover does, but corrodes nonferrous metal parts and must be handled carefully because of the danger of getting it on the clothes, the skin, or in the eyes. It must not be used where it cannot be thoroughly washed off.

(*b*) To prepare the solution for paint removing purposes dissolve 1 pound of soda, caustic (lye), in 6 pints of hot water and add enough lime to give the solution the consistency of paint.

(*c*) Use the solution freshly mixed and apply with a swab of cotton rags, or cotton waste, tied to the end of a stick. When the solution begins to dry on the surface, use a scraper to remove the old paint. Apply two or three times if necessary. Complete the cleaning by washing thoroughly with warm water to stop the action of the lye and lime.

(2). At stations equipped with a boiling tank the following instructions apply for removal of paint from metal parts only. The lye is dissolved in water in the proportions of approximately 4 pounds of lye to 15 gallons of water, and the articles are boiled in this solution until the paint is sufficiently loosened to rinse off.

(3) It is used in target paste, for which the following advantages are claimed:

(*a*) Saving in time, labor, and material, as no boiling is necessary and less flour is used than in other methods.

(*b*) Lye paste keeps indefinitely without souring or becoming lumpy.

(*c*) Targets pasted properly with lye paste stand heavy rain, and upon drying show little effect from being wet.

(*d*) Rats, roaches, etc., will not eat this paste.

(*e*) To mix target paste with lye, put into a 30-gallon iron can 1 level bucketful (3 gals.) of flour, and add slowly 9 gallons of cold water, mixing thoroughly during the addition to avoid formation of lumps. Dissolve 1½ pounds of issue lye in a 3-gallon bucket of cold water. Pour this slowly into the flour and water mixture, stirring vigorously. Continue to stir slowly while adding cold water to make up 30 gallons.

(4) Caustic soda may also be used to quicken the action of cleaning compounds.

(5) Caustic soda, for cleaning purposes, is *not* to be used in recoil mechanisms. Sodium hydroxide, CP, should be used in the preparation of solutions for recoil mechanisms.

19. Paper, lens, tissue.—*a. Characteristics.*—A white, lightweight, and delicate tissue paper.

b. Use.—For cleaning optical glass by gentle and careful rubbing of the glass.

c. Method of handling.—(1) Keep this paper in a clean place, free from dust, grit, or dirt, which might scratch an optical surface.

(2) Keep dry.

(3) Do not use more than once.

(4) Use as a wad or several layers thick.

20. Care of optical glass.—*a.* In the presence of grease, dirt, and dust which ordinarily contain acids, glass is likely to corrode. This corrosion starts as a film, ordinarily brown in color when viewed by reflected light, which may progress until the film covers the whole surface. Formation of this film interferes with the good optical qualities of an instrument. All kinds of optical glass are susceptible to corrosion, but prompt removal of moisture and dust and the keeping of glass surfaces perfectly clean and dry will prevent or greatly retard this corrosive action.

b. During storage or while in use, optical parts of instruments must be guarded from heat such as would occur if equipment were exposed to the direct rays of the sun in midsummer.

c. If water remains on the surfaces of optical elements a portion of the glass may become etched, leaving pocks or holes in the glass surface. It is, therefore, important to keep optical instruments dry and to store them in dry places.

d. No wiping materials other than paper, lens, tissue, should be used in the field on optical parts of instruments. Chamois skins are objectionable as they quickly gather grit, dirt, or dust, and are likely to scratch the surface. Waste or cloths should not be used, as they are hard, and ordinarily contain grit. Paper, lens, tissue, will be used for cleaning and wiping optical glass. In the field, the optical surfaces may first be moistened by the breath and the surface then cleaned with the paper. Avoid hard rubbing.

e. Removal of lenses and prisms from instruments for cleaning is not permitted except by trained ordnance personnel.

f. In ordnance maintenance shops soft, clean cloths may be used prior to the use of paper, lens, tissue, provided that great care is exercised to keep these cloths free from all kinds of grease, grit, and dust. When a solvent for cleaning glass is required, pure grain

alcohol, which on evaporation leaves a perfectly clean surface free from wax or gums of any kind, is best. The grain alcohol should be used sparingly and should not be allowed to run between the lens and lens mountings. Never use a water solution containing alkali for cleaning optical glass since the alkali will attack and rapidly etch the glass.

g. Lenses and prisms that are extremely dirty may be brushed with a clean camel's-hair brush. The brush should be free from dust and grit and should not be applied to the optical surface more than is necessary to remove the dirt. This brush, which can also be used to apply grain alcohol to the lens, should be kept in a clean, dry place and used only for cleaning optical glass.

h. Exposed optical parts of instruments coated with a film of chemicals during gas attacks should be wiped clean with clean, dry, paper, lens, tissue. Moisten with the breath and repeat the operation several times if necessary, but rub gently. If the film is difficult to remove, moisten slightly with alcohol, ethyl, and again rub gently with paper, lens, tissue. If this does not clean the optics properly, it will be necessary to return the equipment to the ordnance shop for overhaul and repair.

21. Patches, cut (canton flannel).—*a. Description.*—Patches are pieces of flannel 2½ inches square. One side of the patch is soft and fleecy and the other side is coarse.

b. Use.—Used in cleaning and polishing the bores of pistols, revolvers, rifles, and machine guns. For removing dirt, grease, or rust from a rifle barrel the patch is so assembled to the cleaning rod that the harder side is on the outside; but for drying and polishing, the soft (fleecy) side should be out. Only those cleaning rods issued by the Ordnance Department for the purpose may be used.

22. Polish, metal, paste.—*a. Description.*—(1) Contains iron oxide base.

(2) It is a material so fine it hardly acts as an abrasive.

b. Use.—(1) Used in the field for cleaning and polishing brass, bronze, German silver, aluminum, and other bright (unlacquered) parts to supplement the work of cloth, crocus.

(2) Polishing is prohibited on instruments, sights, scales, and surfaces which are painted, varnished, lacquered, or given such special finishes as browning or parkerizing, except as required in refinishing in ordnance shops.

23. Soap, castile.—*a. Description.*—(1) A neutral soda soap made with vegetable oils only.

(2) Bars shrink in storage due to evaporation of moisture.

b. Use.—(1) Used in the preparation of solution, sponging.

(2) Soap should be used as a lubricant, if necessary, to facilitate the mounting of rubber tires on wheel rims. Either liquid soap applied to the beads or a bar of soap rubbed on the beads will serve this purpose.

24. Soap, saddle.—This soap will be used for cleaning leather equipment.

25. Paraffin (grade 117–120).—Paraffin is used for—

a. Preparation of remover, paint and varnish.

b. Protective medium for ends of gun slings to which metal parts are attached when stored.

c. The ends of the gun slings are to be dipped so that the paraffin will extend to a distance of about ⅛ inch beyond juncture of the metal parts.

d. The strap and entire gun slings are placed in bundles and packed in paper-lined wooden cases.

26. Oil, neat's-foot.—*a. Characteristics.*—A pale yellow oil.

b. Use.—(1) Preservation of holsters, gun slings, and other leather equipment furnished by the Ordnance Department.

(2) Apply with a small sponge or rag, after first cleaning the leather with a sponge dampened in lukewarm water and castile soap. Either natural sponges or cellulose sponges may be used. Rub the oil well into the leather.

(3) In cold weather heat the oil until lukewarm but never hot, and after application hang the article in a warm place.

(4) If a polish is desired after the leather is thoroughly dry, use a perfectly clean sponge and apply a little dressing, russet leather.

(5) Not to be used on harness.

27. Dressing, russet leather.—*a. Characteristics.*—(1) Sometimes erroneously referred to as an equipment dressing.

(2) A preparation of beeswax and turpentine, composed of 67 percent yellow beeswax and 33 percent turpentine.

b. Use.—(1) Used as a polish for leather equipment, especially holsters and gun slings.

(2) After cleaning and the application of oil, neat's-foot, the leather is rubbed until the oil is nearly removed from the grain side of the leather. Dressing, russet leather, is then applied sparingly and rubbed to a polish.

(3) Scars, cuts, or abrasions of the leather may be improved in appearance, though not obliterated, by such use of dressing, russet leather.

28. Care of leather equipment.—*a.* The action of soap depends upon certain physical properties which help in bringing about the mechanical removal of dirt and grease. The soapy water in combination with the grease and dirt forms an emulsion which is easily washed off. Only a small amount of the oil in the leather is removed by the soap as there is little or no chemical action. However, repeated washings will probably necessitate replacement of oil to prevent the leather from becoming harsh and brittle, since some oil is removed each time the piece is washed.

b. Nearly all ordnance leather equipment is now russet or fair leather, and when these articles become soiled they should be cleaned by carefully removing all hardened grease with a sliver of wood (not glass or knife), and washed with a sponge saturated with a heavy lather of soap, saddle, and clean, tepid water. Do not use hot water nor allow the leather to soak. Rinse thoroughly and rub vigorously with a dry cloth until the leather is dry. Straps and other articles of unvarnished leather which become dry and brittle should be cleaned as described, and while the leather is still moist, be given an exceedingly light coat of oil, neat's-foot, by rubbing with a soft cloth moistened (not saturated) with the oil. Wipe off any oil the leather does not absorb. In cold weather the oil may be heated lukewarm (never hot) before using, and the article hung in a warm place after being oiled. Shellacked sole-leather cases do not require oiling.

c. Leather equipment must never be washed with strong cleaning solution containing alkali, since alkali has a deteriorating effect on leather goods.

d. Russet leather, as manufactured, is stuffed with a dubbing of codliver oil and tallow. Enough of this is absorbed to improve the quality and prolong the life of the leather, but not enough oil remains on the surface to soil the clothing if the equipment is properly cared for. It should be noted that if more than a light coat of oil is given in the washing and oiling described above, the leather will be greatly darkened and will quickly soil the clothing. No method of cleaning can then restore the original light color of the leather or remove stains from it.

e. Articles of black leather may be cleaned with soap, saddle, and rinsed. When nearly dry they should be lightly sponged with a mixture of 1 teaspoonful of lampblack in 1 pint of oil, neat's-foot, the mixture having first been stirred until it has a glossy black appearance. The mixture should then be well rubbed into the leather.

f. Leather equipment which has become wet should be dried in the shade. Wet leather exposed to the sun or to too hot a stove or radiator becomes hard and brittle.

29. Soda ash.—*a. Characteristics.*—(1) White odorless powder.

(2) Soluble in water but not in alcohol.

(3) Alkaline in nature.

(4) Also known as sodium carbonate.

b. Container.—100-pound box.

c. Method of handling.—(1) No special precautions need be taken when handling soda ash except to prevent it from coming in contact with the eyes and prolonged contact with the body or clothing.

(2) Empty oil or grease cans, wiped clean, should be used to mix and store the cleaning solution during the using period. Solutions containing this compound will attack nonferrous metal (copper, brass, bronze, aluminum) containers and will remove the galvanizing from galvanized pails.

d. Use.—(1) Always used in a cleaning solution consisting of ½ to 1 pound (depending upon the strength desired) of soda ash in 1 gallon of boiling water.

(2) The solution is used for—

(*a*) Cleaning bores and breech mechanisms of small arms and cannon.

(*b*) Removing grease and dirt from all types of ordnance matériel preparatory to painting.

(*c*) Wherever a general cleaning solution may be required.

30. Sponges.—*a. Types.*—Either sponge, natural, or sponge, cellulose, may be issued.

b. Method of handling.—(1) Use with very mild cleaning solutions only.

(2) Sponges will be used, for the most part, with soap and water only.

(3) Solutions containing trisodium phosfate, soda ash, or lye will ruin sponges of either type, so rags should be used with such solutions.

c. Use.—(1) Sponges will be used for general maintenance work such as cleaning windows, walls, automobiles, and weapons.

(2) Cellulose sponges will be restricted for the most part to cleaning of leather cavalry equipment and like materials.

31. Solution, sponging.—*a. Types.*—Two kinds of sponging solutions can be made, depending upon the use to which they will be put: a soap sponging solution and a sponging solution for saluting guns.

b. Soap sponging solution.—(1) *Uses.*—(*a*) Sponging liquid for use in extinguishing burning residue in chamber of cannon.

(*b*) If the soap solution is not available, only water will be used as a substitute.

(2) *Preparation.*—(*a*) This solution is prepared by dissolving 1 pound of soap, castile, in 4 gallons of water. Yellow soaps should not be used, as they are likely to leave a gummy deposit in the breech recess.

(*b*) The soap should be shaved from the bar to facilitate dissolving. It should then be added to the water and the water heated until the soap is dissolved. The water should be stirred as quietly as possible to prevent foaming.

(*c*) To avoid the necessity of handling large receptacles, as much soap as is required for all the water to be used can be dissolved in one pail of water. This concentrated soap solution can then be added to water in other receptacles to make up the prescribed proportions.

c. Sponging solution for saluting guns.—This is made by dissolving 1 pound of soda ash in 1 gallon of boiling water.

d. Antifreeze sponging solutions.—(1) When the temperature is below 32° F., glycerin, grade A, U. S. P., will be added to each of the sponging solutions described above, as indicated in the following table, to prevent freezing of the solution:

Minimum temperature ° F.	*Parts by volume*	
	Solution	*Glycerin*
18	80	20
12	70	30
0	60	40
—14	50	50
—40	40	60

(2) This antifreeze solution may be prepared with sufficient accuracy by employing the present issue canteen cup as a measure. This cup holds almost ⅞ quart—approximately 5 cups to the gallon. To make 1 gallon of the antifreeze solution, the cup may be used as a measure as follows:

Minimum temperature °F.	*Cups*	
	Solution	*Glycerin*
18	4	1
12	3½	1½
0	3	2
—14	2½	2½
—40	2	3

(3) It will be quite satisfactory to use as an antifreeze sponging solution for cold weather the drainings from recoil mechanisms for which the glycerin-water solution mentioned in paragraph 80 has been specified. If such drainings are available, it will be necessary only to add ½ pound of soda ash or ¼ pound of soap, castile, per

gallon to have the equivalent of the 50–50 solution listed above, which is good for −40° F.

32. Solvent, dry-cleaning.—*a. Characteristics.*—(1) Colorless and inflammable liquid distilled from petroleum.

(2) Evaporates without leaving a corrosion-inducing film on machines and polished metal surfaces.

(3) Explosive and inflammable characteristics are similar to that of kerosene.

b. Container.—Gallon can.

c. Method of handling.—(1) Care is required in handling and storing solvent, dry-cleaning, because of the fire hazard. In no case should it be poured or allowed to stand in open containers around or near an open fire.

(2) Smoking is prohibited in the vicinity of or while handling the solvent.

(3) Though not quite as dangerous from the standpoint of fire hazard, the same precautions in storage and handling should be followed as those outlined in AR 850–20 for handling gasoline.

(4) Its continual use without gloves dries the skin and produces cracks. In some cases a mild dermatitis may result from its prolonged contact with the skin.

(5) Solvent, dry-cleaning, shall be handled and used in well-ventilated places.

d. Use.—(1) Used principally as a grease-removing liquid.

(2) Solvent, dry-cleaning, is used for cleaning all metal surfaces of material preparatory to application of rust-preventive compound. It is generally applied with rags to large parts and as a bath for small parts.

(3) It is used with a wire brush to loosen newly formed rust when cleaning bores of rifles.

(4) Removal of excess solvent from the material being cleaned is generally done by wiping with light-colored cloth until no staining of the cloth occurs.

(5) To avoid leaving finger marks, which are ordinarily acid and induce corrosion, gloves should be worn by persons handling parts after such cleaning.

(6) Solvent, dry-cleaning, like most petroleum products, will attack and discolor rubber. It is noncorrosive to metal, but for the most careful work and protection of highly machined surfaces against corrosion, it will be necessary to apply corrosion-preventive compound or lacquer, as the case may be, immediately after cleaning the material with solvent.

(7) Solvent may contain traces of water, in which case corrosion will be accelerated. For this reason corrosion-preventive measures must be taken immediately after its use.

(8) Gasoline should not be used for the above-mentioned cleaning purposes. The increased fire hazard occasioned by its use, together with the toxic nature and corrosion-accelerating properties of gasoline-containing leaded compounds, make its use undesirable.

33. Decontamination.—*a. Protective measures against contamination.*—(1) For matériel in constant danger of gas attacks, whether from chemical clouds, chemical shells, or chemical spray, care should be taken to keep all unpainted metal parts of the engines, instruments, guns, mountings, and accessories well-coated with oil.

(2) Ordinary fabrics of wool or cotton offer practically no protection against vesicants (lewisite, mustard gas, and ethyldichlorasine). Rubber and oilcloth will be penetrated by vesicants within a short time. The longer the period during which they are exposed, the greater the danger in wearing these articles. Rubber boots worn in an area shelled heavily with lewisite or mustard gas may be a grave danger to men who wear them several days after the bombardment. Impervious cloth, such as is used in the manufacture of impermeable clothing, will resist penetration by liquid vesicants for over an hour, but soon after this time the clothing becomes dangerous. Fabrics which are lightly contaminated may be decontaminated, but if the articles are heavily covered with mustard, they should be destroyed by burying or burning in areas where the fumes from the fire will not affect personnel or animals.

(3) Metal parts of all instruments should be covered with oil and protected with covers when not in actual use, care being taken that the oil does not come in contact with any glass or find its way into the interior of the instruments.

(4) Ammunition should be kept in sealed containers. If exposed to gases, corrosion is likely to occur, particularly on brass parts.

b. Cleaning.—(1) All unpainted metal parts of the vehicle and engine, together with all accessories and spare parts exposed to any gas except mustard or lewisite, must be cleaned with solvent, dry-cleaning, or alcohol, denatured, and wiped dry as soon as possible after the attack, and in any case within 24 hours, after which they should again be thoroughly coated with oil.

(2) Exposed ammunition should be cleaned with agent, decontaminating, noncorrosive, or, if this is not available, with strong soap and cool water. Corroded ammunition should either be cleaned thoroughly or discarded. Ammunition containers should be cleaned

in the same manner. *Do not use dry, powdered agent, decontaminating (chloride of lime), on or near ammunition supplies* as flaming occurs through the use of the chloride of lime on liquid mustard thereby causing high concentration of mustard vapors.

c. Personal care.—(1) The following measures should be taken when removing liquid vesicants (mustard, lewisite) from various materials and equipment (guns, ammunition, web, leather equipment, wood, metals, rope, etc.), which have come in contact with these liquid chemicals.

(2) For all of the decontamination operations indicated, a complete suit of impermeable clothing and a service gas mask must be worn. Removal of protective clothing should be performed with the assistance of other persons equipped with gas masks and rubber gloves, so as to minimize the danger of getting mustard on the skin. Immediately after the removal of the suit, a thorough bath with soap and water (preferably hot) must be taken.

(3) Should any skin areas have come in contact with mustard, liquid, cleanse with solvent, dry-cleaning, any oil, alcohol, carbon tetrachloride, or pyrene prior to taking the soap and water bath. If the face has been exposed to the vapor, or if even a very small drop of mustard gets into an eye, immediate care must be given to prevent serious injury. The eyes should be flooded with water or solution of boric acid. The insides of the lids and the eyeball must both be thoroughly washed. An eye cup, syringe, or dropper will help in this process. Repeat the washing *hourly*. If vapor has been breathed, treat and handle as a lung irritant casualty (complete rest and nonalcoholic stimulants). Symptoms arising from contact with mustard appear 2 to 4 hours after exposure. Thorough cleaning, as outlined above, will minimize or completely prevent all symptoms, *if done within 20 or 30 minutes after exposure.*

(4) Do not attempt to wear the protective suit again until it has been decontaminated. If exposed to vapor only, these garments may be cleaned satisfactorily by hanging in the open air, preferably sunlight, for several days. Permeable protective clothing exposed to vapor may also be decontaminated by steaming for 2 hours. Various kinds of steaming devices can be improvised from materials available in the field. The simplest is merely a large GI can provided with a false bottom which serves to hold the clothing about a foot from the true bottom. Six or 8 inches of water is poured into the bottom of the can, the false bottom inserted, and the garments piled in. The can is then placed over a fire, the top covered but not so tightly as to prevent the escape of steam. Steam the clothes for at least 2 hours

after steam first appears from around the lid. If the clothing has been splashed with liquid mustard, steaming for 6 to 8 hours will be required. Add water to the GI can from time to time to prevent all the water boiling out.

d. Decontamination of matériel.—(1) Commence by freeing the objects of dirt, lumps of earth, and liquid with woolen spatulas, rags, etc., which will be burned or buried immediately after this operation. Care must be taken to protect personnel against vapors arising from burning rags.

(2) Vesicant-contaminated metal surfaces that are greased or oiled must first be cleaned with solvent, dry-cleaning, or other available solvents for oil, and swabbed with rags attached to the ends of sticks. Burn all used rags and sticks. Such cleaning removes most of the mustard gas, but a thin film remains, which must be neutralized. This is done with a bleaching solution made by mixing 1 part agent, decontaminating (chloride of lime), with 1 part water, which should be swabbed over all surfaces. To prevent serious corrosion, do not allow bleaching solution to remain in contact with metal surfaces longer than 1 hour. Remove the bleaching solution by washing with water. After drying, polish and oil all surfaces. The use of agent, decontaminating (chloride of lime), in the dry powder form is not recommended, as it reacts violently with liquid mustard gas, causing flaming and the formation of a high concentration of mustard gas vapor.

(3) Exposed surfaces of all instruments and unpainted metal working parts (such as breechblocks, traversing screws, etc.) exposed to mustard gas or lewisite must be cleaned with one of the following:

(*a*) Warm water and soap.

(*b*) Alcohol, denatured.

(*c*) Solvent, dry-cleaning.

(*d*) Agent, decontaminating, noncorrosive, mixed 1 part solid to 15 parts solvent (acetylene tetrachloride) by weight.

(4) Remove all traces of agent or solvent by wiping with clean, dry rags. Bleaching solution must not be used because of its corrosive action.

(5) Clean instrument lenses as per directions given in paragraph 20. All leather and canvas parts should be thoroughly scrubbed with bleaching solution, or discarded. At the earliest opportunity, coat all metal surfaces with light machine oil. In the event mustard has penetrated into joints of the instrument, the instrument should be replaced at the earliest opportunity and returned to ordnance personnel for disassembly and thorough cleaning.

(6) Gun bores should be swabbed out with strong soap and water, dried thoroughly, then oiled with oil, engine, SAE 10.

(7) In the event that agent, decontaminating (chloride of lime), is not available, large volumes of hot water and soap may be used to decontaminate matériel. Scrubbing with hot water will wash mustard onto the ground, where it will lie at the bottom of pools and puddles. Therefore, all equipment should be removed from the contaminated area before protective clothing, and particularly the service gas mask, is removed. Such areas should be plainly marked with warning signs before abandonment. After washing equipment in the above manner, it will be necessary to protect all personnel continually against the danger of slow vaporization of mustard from areas not reached by the scrubbing, or from leather, canvas web, etc., particularly during the heat of the day. Thorough decontamination with bleaching solution should be performed at the first opportunity on all parts not accessible by scrubbing and on all porous materials.

(8) Scrubbing metal surfaces with cold water will remove and partially decompose lewisite to an extremely toxic toxoid. Prolonged contact with water tends to reduce its vesicant properties to a considerable extent. As the ultimate decomposition product of lewisite is a vesicant, arsenic compound, whether chloride of lime or water is used in decontaminating, water supplies which drain from a lewisite-contaminated area are poisoned and are unfit for consumption by men or animals. Rain falling on equipment formerly contaminated with lewisite and cleaned in the field will wash sufficient arsenic into the puddles to make them dangerous for consumption by horses.

e. Transportation of matériel contaminated by chemicals.—The removal will be effected by automotive units whenever possible. If horse transport must be used, the route will be carefully reconnoitered in order to avoid contaminated ground. The matériel will be decontaminated as thoroughly as possible before its removal.

f. Special precautions for automotive matériel.—(1) When vehicles have been subjected to clouds of gas with the engine running, it will be necessary to service the air cleaner by removing old oil, flushing with solvent, dry-cleaning, and refilling with engine oil of the proper grade.

(2) Instrument panels should be cleansed as outlined in *d*(3) above. Seat cushions that have been sprayed with mustard should be discarded. Washing the compartments thoroughly with bleaching solution is the most that can be done in the field. Driving personnel should be on the alert constantly for slow vaporization of

mustard gas, particularly when the equipment gets warm. Contaminated harness should be cleaned carefully before use.

(3) Exterior surfaces of vehicles should be decontaminated with bleaching solution. Repainting may be necessary after this operation.

g. For additional information with respect to decontamination see FM 21–40 and TM 3–215 and 3–220.

SECTION III

PRESERVATIVES

34. Rust.—*a. General.*—Rust is a compound formed by the oxidation of iron in the presence of water. There are two kinds, ordinarily known as red rust and black rust. Black rust does not progress under ordinary conditions. Red rust progresses as an infection, thus it is obvious that all red rust must be completely removed from the surface of iron or steel to assure stoppage of rusting. It can be removed by mechanical rubbing or polishing, by sandblasting, or by chemical means. The application of paint or of corrosion-preventive compound will greatly retard the progress of rusting. However, the propagation of rust can take place beneath these coatings. If rust has been removed by chemical means, it is most essential that the chemical be neutralized and completely removed after the work of rust removal is finished. The article should then be thoroughly dried before the rust-preventive compound or paint is applied. Sandblasting can be used only where there is no possibility of the abrasive getting into moving parts during or after the blasting operation. Bearings, bearing surfaces, or finely machined parts must never be sandblasted.

b. Rust pits.—In its earliest stages rust or corrosion may appear as an almost invisible discoloration. This discoloration gradually darkens in color to a yellowish or reddish tinge and progresses until

pits are formed. Pits a thousandth of an inch in depth are plainly visible to the naked eye. Once pits are formed, rusting progresses rapidly around the whole cavity of the pit, and soon a caked mass of iron oxide is projected beyond the surface of the metal. It is highly desirable that rusting be arrested in the early stages and that protective measures be taken.

35. Corrosion.—*a. Rate of corrosion.*—(1) The rate of corrosion varies with the condition of metal surfaces, highly polished surfaces being much more resistant to corrosion than ordinary machined or rough surfaces. The rate also depends on temperature, pressure, atmospheric conditions, action of chemicals, chemical composition of the metal, and many other factors. Metals ordinarily employed in construction of ordinance matériel are universally subjected to corrosion unless protected. In some cases corrosive action is increased under special conditions.

(2) In gun barrels, primer fouling collects moisture from the atmosphere. Corrosion is propagated by the salt solution thus formed.

(3) The packing in the case of recoil mechanisms contains free sulfur and small quantities of other corrosive compounds. The gradual breakdown of rubber compounds apparently results in the formation of acids which attack steel. These processes may not be true corrosion but rather the dissolving of metal by acids, or other chemicals, but they are generally included as corrosive problems because of the similarity.

b. Greases, lubricants, and corrosion preventives are not all stable compounds. In time they decompose, especially if in contact with the atmosphere. Subsequent formations of acids attack metal. In some cases the preservatives absorb water. In either case corrosion takes place under the coating material.

c. Climatic conditions affect "atmospheric corrosion" considerably. Thus corrosion is slight in dry, arid sections even with high temperature. The rate is very high in the humid sections, especially in warm regions. High humidity is thus considered to be the most important single factor in the development of rust.

d. Exclusion of air from metal surfaces does not guarantee freedom from corrosion. Both water and oxygen are almost universally present dissolved in liquids, greases, etc., in sufficient quantities to rust ferrous metals.

e. Corrosion or the formation of rust is often accelerated by the action between the base metal and minute particles of impurities in or on the base metal. This is due to the setting up of a system

known as an electrolytic cell, consisting of the base metal, the impurities, and a liquid, the latter being as a rule condensed water vapor made slightly acid by absorbed carbon dioxide. It is for this reason that moisture must be kept from coming in contact with unprotected metals insofar as it is possible to do so. Due to the electrolytic cells set up between dissimilar metals, it is necessary to take unusual precautions to prevent corrosion when two different metals are in contact. Thus when aluminum-alloy pistons are in cylinders and separated from steel surfaces by only a small clearance, corrosion may take place even though the metal is separated by oil or grease. Many oils and greases have a tendency to oxidize and form acids, and acids also form in the crankcases of cars from sulfur compounds originating in the gasoline. These decomposition products aid and accelerate corrosion. The particularly aggressive corrosive action of leaded gasoline, formation of acids from lubricants and fuels, and electrolytic action associated with contact of dissimilar metals or impurities in metals make it obvious that the problem of properly protecting automotive or aircraft-type engines is most difficult.

f. Corrosion difficulties may be experienced where wood, packings, etc., are in contact with metal, as these materials may contain water. Crated parts in packing boxes containing wood shavings and like material should be stored in a dry and protected place. If it is necessary that the material remain packed and in the packing boxes, the boxes should then be raised above the floor level at least 1 inch by inserting wood blocks, short lengths of pipe, or similar material under them.

36. Inspection for corrosion.—*a.* For prevention of rust it is highly essential that the methods of examination of metal surfaces be such as to detect rusting in the initial stages. A plain metal surface after thorough cleaning can be best examined under a strong light so reflected to the eye that details of the surface are well defined. Slight discoloration or minute isolated particles of rust are difficult to detect. If discoloration is noted, the presence of minute rust particles can best be determined by a good magnifying glass.

b. For examining bores a mirror with magnification of about two, mounted on a rod at an angle of about 45°, will be found to be excellent. A light should be provided adjacent to the mirror to illuminate the surface of the bore under examination. The light should be hidden from the eye of the observer.

c. Surfaces of recuperator bores or those of piston rods of hydropneumatic recuperators must be kept free of corrosion. Formation

of pits may result in condemnation of the parts. It is, therefore, important that examination and treatment of such surfaces be conducted with the greatest possible care.

d. In the preparation of a surface for examination the rust-preventive material should be dissolved with solvent, dry-cleaning, then solvent and dissolved material wiped off with a clean cloth. Use of leaded gasoline is prohibited since it would induce corrosion, it is toxic, and all gasoline is dangerous to handle from the standpoint of fire hazard. Abrasive or polishing material may remove evidence of corrosion and therefore will not be used prior to the examination.

37. Preparation of metal surfaces for slushing.—*a. Precautions.*—(1) Preparation of the metal surface prior to the application of the rust preventive is most important. Probably a very large percentage of corrosion is due to improper cleaning of the metal surfaces before the rust preventive is applied.

(2) The metal surface should be clean, dry, and free of all traces of corrosion.

(3) In cleaning metal and in handling clean metal surfaces, gloves should be worn to protect the metal from acid stains and corrosion resulting from body perspiration.

(4) Preparation of metal surfaces for slushing in heated rooms is excellent practice.

b. Cleaning of metal surfaces.—(1) Grease and dirt may be removed by wiping with rags soaked in solvent, dry-cleaning. Special precautions should be taken before use to see that the solvent is free of water. The cleaned surface should be wiped dry.

(2) Usually the removal of surface rust is best conducted by the use of abrasives or by other mechanical means. If rust has progressed to such an extent that pits are formed, polishing by abrasives, grinding, lapping, or buffing might not remove the rust from the pit.

(3) It is possible to dissolve iron rust in acids or specially prepared compounds. This method of chemically cleaning steel surfaces is not ordinarily employed on highly machined or highly polished surfaces, but may be justified under some conditions. Acids and similar material ordinarily dissolve not only the iron rust but also attack the metal and are therefore objectionable. In case chemicals are used, the greatest care must be taken to remove every trace of acid from the surface of the metal, otherwise later corrosive action may be accelerated beneath the rust preventive. The use of acids or other chemicals to remove rust should not be attempted unless special permission has been obtained.

(4) Removal of surface rust may be satisfactorily accomplished by sandblasting in many instances. Sandblasting must never be resorted to, however, with matériel so constructed that sand, emery, or other abrasives might get into bearings, gear cases, or other vulnerable spots. Special permission should be obtained before sandblasting matériel. Soft bearing metals should never be sandblasted, as part of the abrasive is retained by the metal and will later cut and destroy the working parts with which it comes in contact.

38. Rust preventives.—*a. General.*—(1) Oils and greases do not always act as rust preventives.

(2) The materials described below are prepared and issued for preventing rust and corrosion on metal surfaces in storage.

(3) Rust preventives function by excluding moisture, air, and dust from the surfaces covered.

(4) Rust preventives are not to be used as lubricants.

(5) Rust preventives removed from material being cleaned should not be used again as they probably will be contaminated with dirt and foreign matter.

b. Rust preventive compounds (previously known as slushing oils, slushing grease, cosmic, or cosmolene).—(1) Compound, rust-preventive, heavy.

(2) Compound, rust-preventive, light.

(3) Compound, corrosion-preventive, aircraft engine.

c. Storage.—(1) Items should be stored in their original containers and kept tightly covered.

(2) Items should not be contaminated by dirt, water, or foreign substances of any nature.

(3) Avoid storage under strong light or in ventilated places.

39. Compounds.—*a. Rust-preventive.*—(1) *Heavy.*—(*a*) *Characteristics.*

1. A viscous petroleum product.

2. Inflammable, so precautions must be taken to avoid overheating.

(*b*) *Container.*—5-pound and 25-pound cans.

(*c*) *Use.*

1. Used for protection of finished surfaces during dead storage.

2. May be heated in a suitable tank so articles can be coated by dipping.

3. Temperatures up to 300° F. are safe but not practical.

4. For protection of matériel for long time storage, the heavy compound should never be thinned by the light compound or by oil.

(*d*) *Method of using.*

1. Compound, rust-preventive, heavy, must be made fluid prior to use. A practical method to obtain fluidity is to place the container of compound in a vessel of water, heating it to about 180° F., the exact temperature being determined by the thickness of the film desired. The higher the temperature of the compound, the thinner the film applied to the metal. The desirable thickness of the film is the maximum uniform thickness which can be retained on the metal in storage.

2. The compound should be maintained at the using temperature for about half an hour before applying. Best results will be obtained if the compound is heated slightly above this temperature and then allowed to cool to the desired consistency before using.

3. During heating, the material should be stirred slowly to eliminate bubbles of air or water vapor. Presence of water will be indicated by frothing on top of the bath.

4. See paragraph 37 for preparation of the metal surfaces preliminary to application of the compound, rust-preventive, heavy.

(2) *Light.*—(*a*) *Container.*—5-pound and 25-pound cans.

(*b*) *Use.*

1. Used primarily for short time protection of finished surfaces of all classes.

2. Not to be used on material in permanent storage, or for long time protection as it does not give as high a degree of protection against corrosion as the heavy compound.

3. Especially adapted for use by troops because of ease of application and removal.

4. May be applied by rubbing, swabbing, or dipping.

5. Heating is necessary only under very cold conditions.

6. See paragraph 37 for preparation of the metal surfaces preliminary to application of compound, rust-preventive, light.

b. Corrosion preventive, aircraft engine.—Used for spraying the interior parts of automotive engines and aircraft type tank engines as protection against corrosion during storage. (See AR 850–18.)

40. Method of applying rust-preventive compounds.—*a. Materials required.*—(1) Source of heat for heating the heavy compound.

(2) Container large enough to be used for dipping.

(3) A swab made by fastening a piece of heavy felt on the end a pole, wrapping the felt head with several layers of clean wiping

cloths free of lint. Burlap is not suitable for use on the highly finished or polished surfaces of recoil mechanisms.

(4) A good grade of cheesecloth is satisfactory. Cloths used on the interior of recoil mechanisms must be soft and free of any substances which might cause scratches.

b. Dipping.—(1) The dipping process is by far the best method. There is also much less danger of the inclusion of air bubbles in the grease film. The grease film cools after application to the metal, tightening the film. The film obtained by dipping should be smooth, silky, regular, and of uniform thickness.

(2) Preliminary heating of the material before dipping is good practice, as it drives off a portion of the moisture film adhering to the surface of the metal. The temperature of the metal when dipped should not be above the temperature of the grease. There is no objection to having the temperature of the surface of the metal at the temperature of the grease, but the body of the metal should be cooler, to set the grease film as rapidly as possible after dipping, otherwise too thin a film will be obtained. If the metal is not given a preliminary heating, it is considered good practice to allow the pieces dipped to remain in the solution for a short time to permit absorption of the water film by the grease and to heat the surface of the metal sufficiently for good adhesion.

(3) The desirable thickness of the film is the maximum which will remain on the metal at the maximum temperature to which it is subjected in storage.

(4) Pieces containing bores or cavities should be dipped in such a manner as to allow the easiest escape of air and complete covering of all surfaces.

(5) After dipping, allow the pieces to drain until cooled to room temperature. The drippings are suitable for future use and should be neither wasted nor allowed to become contaminated with water, oils, dust, or grease.

c. Swabbing.—(1) In case dipping is not practicable, swabbing is the preferred method.

(2) The grease should be heated to a slightly higher temperature than that necessary in dipping, as it cools before reaching the metal surface. In swabbing, several applications of grease are necessary, as the air must be worked out and a uniform coat of grease applied.

41. Slushing of small arms.—*a.* At arsenals the application of rust-preventive compound to small arms follows immediately after cleaning and consists in dipping the whole rifle, pistol, machine gun, or automatic rifle in a heated vat containing compound, rust-

preventive, heavy. Usually it is desirable to maintain the temperature as close as possible to 150° F. The rust-preventive compound is fluid at the correct dipping temperature and enters all parts of the bolt and magazine mechanism, leaving a thin film on every surface. As the article stands in a rack after dipping and is still hot, the excess compound runs off, leaving a film which solidifies to such an extent that it does not easily rub off.

b. At Rock Island Arsenal small arms are coated as follows: The barrel is given a coat of rust-preventive compound by means of an elevated tank which flows the rust preventive through the barrel, forming a cylindrical coating rather than a plug. It was found that the plug, as it became old, would contract and leave the barrel exposed.

42. Inspection of corrosion-preventive film.—*a.* As failure of the corrosion-preventive film may cause local corrosion, careful inspection of the film is essential. If the corrosion-preventive compound is applied at the wrong temperature, a coating either too thick or too thin will result. Optimum conditions of temperature will be determined by usage and this optimum temperature maintained in applying each specific corrosion-preventive compound. In this manner, maximum corrosion-preventive measures are carried out with a minimum of waste.

b. If the corrosion-preventive compound is raised to too high a temperature or if it is too heavy, slippage or running may result. There is also some danger of fire from overheating. Avoid, therefore, storage of matériel in hot places.

c. Some corrosion-preventive films are prone to cracking, especially after they have become old and dried out or excess solvent has been added to the film. Dust and dirt tend to accentuate this condition. Sunlight may also bring about premature destruction of the corrosion-preventive film and precautions should be taken to prevent exposure of material coated with corrosion-preventive compound to the rays of the sun. If by visual inspection it is found that cracks have appeared and the metal is exposed, the old corrosion-preventive coating must be removed and the material protected with a new coating.

d. Examination of the corrosion-preventive film is in itself insufficient for the detection of corrosion. No corrosion-preventive compound has yet been developed that will completely stop corrosion.

e. Careful periodical inspection is essential to determine the effective life of a given corrosion-preventive film.

f. If dissimilar metals are in contact, separated only by grease or oil films, corrosion must be expected to spread more rapidly than in

other cases. Inspection of metals stored under such conditions should, therefore, be made at more frequent intervals than under normal conditions.

g. In case grease is used between packing and metal surfaces, the moisture or acids which may be contained in the packing may cause failure of the grease film in a comparatively short time. Certain greases decompose in service due to oxidation, with subsequent formation of corrosive substances. Experience will indicate where such conditions are apt to occur, and more frequent inspections should be made accordingly.

43. Storage conditions.—*a.* (1) Storage conditions must be regulated to eliminate every possible source of moisture which might gain access to metal surfaces.

(2) In the protection of interior parts against corrosion, every attempt should be made to seal them against access of air. The strength or elasticity of the seal should be sufficient to withstand the slight increases in interior pressure which may take place under change of atmospheric conditions. It is important that interior surfaces be kept free from change in atmospheric conditions in order to avoid deposition of moisture. Wherever practicable, the temperature conditions should be kept constant.

(3) In some cases penetration of moisture may be delayed by wrapping the greased article in oiled paper. This method of protection is especially valuable in the case of small articles in tropical climates.

b. If metal surfaces to be protected against corrosion are in direct contact with wooden surfaces, care should be taken to grease the wooden surfaces so as to prevent as much as possible the transmission of moisture from the wood to the metal surface. Green lumber should be avoided. Where wood remains in intimate contact with metal it is a wise precaution to dry the wood thoroughly and then soak it in oil so as to prevent access of moisture into the wood; but even in these cases there should be a grease seal formed between the wood and the metal surface.

c. The storage of matériel in tight boxes is good practice as such boxes keep a large amount of moisture away from the matériel to be protected. Protection afforded by boxes is dependent on proper storage. Storage of boxes should be in weatherproof buildings, with stored boxes separated from the flooring at least 1 inch so as to prevent the possibility of water or solutions from broken containers entering neighboring boxes of material. The separating medium may be short layers of waste pipe, bricks, or short pieces of wood. The latter is not

very satisfactory as it will permit some moisture to be transferred to the packing cases or boxes.

d. More frequent inspection and treatments will be necessary in a damp, tropical climate than in temperate zones.

44. Method of slushing recoil, counterrecoil, and buffer mechanisms.—*a. Mechanisms filled with a glycerin-water solution.*—(1) For long-time storage where the matériel is not to be kept in stand-by condition, ordnance personnel authorized to do so will drain the mechanism, thoroughly clean and dry it, and then treat it with compound, rust-preventive, heavy.

(2) Mechanisms in which water solutions are used should be drained and flushed with a solution made up of ½ pound of soda ash per gallon of water. After thoroughly drying, compound, rust-preventive, heavy, will be applied.

b. Mechanisms filled with oil.—Recoil mechanisms filled with a recoil oil should be kept filled, and no attempt should be made to apply corrosion-preventive compound to the interior of the mechanism.

c. Preparation of equipment for reuse.—Corrosion-preventive compound will be initially rubbed off with rags or waste and finally removed with solvent, dry-cleaning, prior to placing units or matériel in service again.

45. Corrosion-preventive measures for guns in service.—*a. Small arms.*—(1) Clean with cleaner, rifle bore.

(2) For stand-by condition, apply compound, rust-preventive, light, after cleaning as above.

(3) If the gun is not to remain in service, treat it after proper preparation and cleaning, as follows: Insert the muzzle in melted compound, rust-preventive, heavy, and fill the bore by pumping with a thong brush attached to a cleaning rod. Then coat all other exposed metal surfaces by dipping or brushing.

b. Large-bore guns.—(1) In stand-by condition, clean after firing with soda ash solution, dry thoroughly, and then apply compound, rust-preventive, light. Be sure the bore is coated uniformly and completely.

(2) If available, cleaner, rifle bore, can be used in place of soda ash solution.

46. Lead, white, basic carbonate, paste, and lead, white, basic sulfate.—*a. Characteristics.*—Issued as a white basic carbonate or sulfate paste.

b. Container.—A 5-pound can.

c. Use.—(1) Used chiefly as a heavy rust-preventive coating on exposed iron or steel surfaces.

(2) The white lead coating might be used for preservation of material stored in stand-by condition or for permanent storage, as it is more adhesive under extremes of temperature than present rust-preventive compounds.

(3) White lead paste is also used to lubricate the threads and bodies of bolts of seacoast carriages, base plugs of empty projectiles, and other threaded parts which remain assembled for long periods of time and are apt to rust together or seize.

(4) Its use is prohibited on working surfaces where it cannot be readily removed without damaging those surfaces or without unnecessary labor or use of solvents.

(5) For the most part, use of white lead will be restricted to plugs and threaded joints, as present corrosion-preventive compounds will protect matériel sufficiently in most climates.

(6) It is desirable as a rule to use basic carbonate rather than basic sulfate since for most purposes the carbonate is more satisfactory, is generally carried in stock, and can be supplied more promptly.

d. Method of application.—(1) Materials used to reduce stiff lead paste to a more workable material will depend on whether a hard-drying or a nondrying covering is desired.

(2) For the former, heavy grade rust-preventive compound will give a semi-dried surface while for the latter, lubricating oil is used.

(3) Melted tallow may also be used as a working medium with the sulfate or carbonate.

47. Naphthalene, flake.—*a. Characteristics.*—(1) White flakes.

(2) Strong odor similar to moth balls.

(3) Vaporizes and forms a gas which is heavier than air. Confine its use, therefore, to airtight receptacles in order to obtain a concentrated naphthalene vapor.

b. Container.—5-pound and 50-pound containers.

c. Use.—(1) This chemical is used to prevent damage by moths to linings of helmets, felt wads, felt packings of instrument chests, carpets, gun sponges, and paint and varnish brushes.

(2) Flakes should be sprinkled thickly on the articles, which should then, if possible, be wrapped in paper covers and tightly boxed.

(3) The recommended concentration is about 1 pound of naphthalene per 100 cubic feet of storage space. If used in insufficient quantities, these materials are not effective, and may as well not be used at all.

(4) The mere odor is not sufficient to kill or repel unless the vapors are present in sufficient quantities.

(5) Naphthalene odor is distasteful to moths, preventing them from laying the eggs which later hatch into the destroying larvae. After the eggs are once laid, the naphthalene is of little use.

(6) The material should be thoroughly brushed and aired before packing with naphthalene and should be inspected at least once a year. If moths are prevalent more frequent inspections are necessary, especially during the moth season. If there are any signs of devastation by the moth larvae, the articles must be unpacked, cleaned, and recharged with naphthalene. Moth eggs are very small (almost microscopic); the larvae are about the diameter of the head of a common pin and $\frac{3}{16}$ to $\frac{1}{4}$ inch long.

SECTION IV

PAINTS AND RELATED MATERIALS

48. General.—*a.* Paint is the material upon which chief dependence for protection against corrosion and deterioration of metals and woods must be placed. Many different paints are listed in SNL K–1 and inasmuch as the principles of their application are much the same, details as to the use and application of all of them will not be given here. As to color schemes to be followed in the case of such material as munitions or tanks, the equipment for the most part will be painted as issued, providing further painting is necessary.

The Technical Manuals relative to the matériel in question will in most cases give the information wanted.

b. Certain paints adhere to surfaces better than others and furnish a better protective coating. The liquids of the first or base coat should penetrate into the minute depressions or pits in the material and adhere with ufficient tenacity to form a good bond for following coats.

c. The success of a job of painting depends partly on the selection of a suitable paint, but also largely upon the care used in preparing the surface, which should be made thoroughly clean, dry, and smooth.

49. Handling.—*a.* The paints or enamels are issued mixed with liquid and ready to apply except in a few instances. Paints or enamels stored in large containers should be well stirred before transfer to smaller containers. All containers must be kept covered to prevent contact with the air or entrance of foreign matter except when the particular container is being used.

b. Varnishes and enamels work somewhat stiffer than paint. The addition of turpentine as a thinner should be done only very sparingly, because it will destroy the desired gloss. Since high gloss paints are now little used, this problem is not apt to come up. When used too thick on vertical or inclined surfaces, varnishes and enamels may sag, giving a bad appearance. When this occurs, wash off the surface immediately with turpentine before it has had opportunity to set, and thin the remaining paint or enamel with a small amount of turpentine. Removal of paint with remover, paint and varnish, will be necessary if the varnish or enamel becomes hard before turpentine can be applied.

c. Existing stocks of the standard olive-drab paint previously issued may be used up as base coats on old matériel being repainted. It is most necessary in this case to add turpentine to cut the gloss. The final coat must in all events be enamel, synthetic, olive-drab, lusterless. The exact and proper thickness of each coat can be learned only by experience. If too thin, it often cracks and dries, and if too thick it will become blistered, wrinkled, and unsightly. The first coat may, however, be much thinner than any of the succeeding coats.

50. Painting.—*a. All parts to be painted* shall be free from rust, dirt, grease, kerosene, and alkali, and they must be dry.

(1) Metal parts may be washed in a liquid solution consisting of ½ pound of soda ash in 8 quarts of warm water, then rinsed in clear water and wiped thoroughly dry.

(2) Wood parts may be treated in the same manner but the alkaline solutions must not be left on for more than a few minutes and the surfaces should be wiped dry as soon as they are washed clean.

(3) When artillery or automotive equipment is in fair condition and only marred in spots, the bad places should be touched with enamel, synthetic, olive-drab, lusterless, and permitted to dry. The whole surface will then be sandpapered with paper, flint, No. 1, and a finish coat of enamel, synthetic, olive-drab, lusterless, applied and allowed to dry thoroughly before the matériel is used.

(4) If matériel is in bad condition, all parts should be thoroughly sanded with paper, flint, No. 2, given a coat of primer, ground, synthetic, and permitted to dry for at least 16 hours. Rough spots will then be sandpapered with paper, flint, No. 00, wiped free from dust and dirt, and a final coat of enamel, synthetic, olive-drab, lusterless, applied and allowed to dry thoroughly before the matériel is used.

b. After repeated paintings the paint may become so thick as to scale off in places or present an unsightly appearance.

(1) The old paint may then be removed for repainting by the use of a lime and lye solution or remover, paint and varnish. For formula and method of application of the lime and lye solution, see paragraph 18.

(2) It is important that every trace of lye, remover, or cleaning compound be rinsed off. Special attention to this requirement is necessary in preparing wooden parts because of the porosity of the wood.

(3) Woodwork should be properly putty-stopped after the priming coat and before the second coat is applied. The putty should be pressed into the crevices or cracks in the wood with the blade of the putty knife. All excess should be scraped off and the wood sandpapered after the putty is allowed to dry.

c. Oil cups, *grease-gun fittings*, *alemite fittings*, and similar lubricating devices as well as an area ¾ inch in diameter around each oil hole will be painted red so that they may be readily located.

d. Rammer staves receive one coat of primer, one coat of varnish, shellac, orange, and one coat of varnish, spar, water resisting. The shellac coat is thoroughly sandpapered before the spar varnish is applied.

e. Target marking disk staves are given one dip in primer and, below the disk, one coat of spar varnish. The marking disks have a coat of red lead, and then disk and adjacent parts of the staff are given one coat of enamel, red, water resisting, paint, target, black, or paint, target, white, as required.

f. Target matériel generally is governed by the policy that wooden parts usually destroyed by bullets will not be painted. Timber frame supports of sliding targets are, however, given one coat of commercial red paint. The pulleys, sash cord and sash cord clamps, roller brackets, rollers, slide racks, slide irons, and hook bolts of sliding targets are not painted. All parts of the car and track of rolling targets for machine guns and all parts of sled targets, except snatch blocks, ropes, staves, and pasteboard targets, receive one coat of commercial red paint.

g. Motors of ordnance vehicles will be painted as required. However, motors received in an unpainted condition must remain in that condition. This applies particularly to radial air-cooled type engines used in tanks, in which case painting would impair the heat-transfer efficiency.

h. Fire-control instruments, panoramic sights, telescopic sights, quadrants, and fuze setters have the paint baked on at the time of manufacture and these instruments do not require any additional paint in service. If the paint on an instrument becomes marred so that the finish requires renewal, the instrument should be turned in to an arsenal.

51. Hazards.—*a. Ventilation.*—(1) Thinners used with paints, varnishes, and enamels are quite toxic. Continued breathing of fumes during or after painting operations must be avoided since they are apt to cause sickness and can cause complete disability or even death.

(2) If it is at all practicable, painting of matériel should be accomplished in the open air.

(3) If it is necessary to paint indoors, ample ventilation must be provided and personnel should not remain in rooms for long periods if fumes from painting are noticeable. Toxic fumes will persist in some cases for many days after painting operations have taken place indoors. For this reason ventilation precautions must be taken for considerable periods after the painting operation has taken place.

b. Contact with paint materials.—(1) It must also be kept in mind that very poisonous compounds are used in paints.

(2) Hands should be thoroughly washed before eating, and cuts or wounds on the hands must be kept free of such materials as paints since many of them contain basic lead sulfate, basic lead carbonate, chromium compounds, and other poisonous materials.

(3) Lead chromate is particularly poisonous and like other lead paints it may enter the system during eating or handling. Thus eating with dirty paint-covered hands or allowing paint to remain on wounds is a dangerous practice.

(4) Many of the thinners are also poisonous and can enter the system through the skin, through inhalation, or through carelessness in handling food.

c. Fire.—(1) Fire hazards due to inflammability of paint and paint materials are quite serious.

(2) If it is at all practicable, paints should be stored in a steel cabinet in a small building away from the work building. Once opened, cans containing varnish removers, thinners, paints, and similar materials should be covered tightly before being stored or put away overnight.

(3) Oily or solvent-soaked rags should be promptly disposed of after use since storage might cause fire by spontaneous combustion.

(4) Empty drums or other containers in which solvents, thinners, and similar materials have been shipped are potential killers, since they often contain enough vaporized material of an inflammable nature to cause explosions. Drums or cans should therefore never have heat or flame applied, such as in welding or soldering operations, unless they are first thoroughly steamed out, then filled with water and inspected to make sure that all traces of the odor of solvent or thinner are removed.

(5) Aside from the fact that illness or even death can result from working in confined spaces filled with fumes from solvents, paint thinners, and the like, there is the very serious danger of an explosion due to the explosive properties of such fumes when mixed with the proper amount of air.

(6) In view of the above, workmen can and should take proper precautions to protect their own health. The precautions outlined for the storage of gasoline in AR 850–20 must also be followed for paint thinners, paint removers, solvents, etc.

52. Lead, red, dry.—*a. Container.*—6 pounds in a quart can.

b. Use.—(1) Red lead is recognized as one of the best base coats for iron, steel, or wood. It possesses no particular advantage, however, as a base coat on metals other than iron and steel.

(2) Red lead paints do not keep well and must be mixed as needed according to the following formula: 20 pounds of lead, red, dry, per 3 quarts of mixture, liquid, for red lead paint. The usual method of mixing is to place a small amount of dry lead in a suitable container, work in liquid mixture until a paste is formed, and then add the rest of the liquid mixture and stir thoroughly.

(3) Red lead paint must not be used on bearing parts or other working parts.

(4) These paints have the effect of slightly etching the surface and so securing a good bond for succeeding coats.

53. Enamel, synthetic, olive-drab, lusterless.—*a. Container.*—1-gallon and 5-gallon cans.

b. Use.—(1) Ordnance matériel is painted before issue and one maintenance coat per year will be ample for protection. With but few exceptions all ordnance matériel will be painted with enamel, synthetic, olive-drab, lusterless.

(2) This enamel may be applied over old coats of long oil enamel and oil paint previously issued by the Ordance Department provided the old coat is in satisfactory condition.

c. Method of application.—(1) It may be brushed on satisfactorily when used unthinned in the original package consistency or when thinned no more than 5 percent by volume with thinner (for use with enamel, synthetic, olive-drab).

(2) The enamel will spray satisfactorily when thinned with 15 percent by volume of thinner (for use with enamel, synthetic, olive-drab).

(3) If sprayed, it dries enough for repainting within ½ hour and dries hard in 16 hours.

(4) Linseed oil must not be used as thinner since it will impart a luster not desired in this enamel.

(5) Fire-control instruments, for instance, which require a crystalline finish, will not be painted with olive-drab enamel.

(6) If the base coat on the material is in poor condition and it is desirable to strip the old paint from the material rather than use sanding and touch-up methods, it will be necessary to apply a primer coat.

54. Primers.—*a. Ground, synthetic.*—(1) *Container.*—1-gallon can.

(2) *Use.*—It should be used on wood as a base coat for synthetic enamel.

(3) *Method of application.*—(*a*) It will brush satisfactorily as received or after the addition of not more than 5 percent by volume of thinner (for use with enamel, synthetic, olive-drab).

(*b*) It will dry to touch in 30 minutes and hard in 5 to 7 hours.

(*c*) For spraying, it may be thinned with not more than 15 percent by volume of thinner (for use with enamel, synthetic, olive-drab).

(*d*) Lacquers must not be applied to primer, ground, synthetic, within less than 48 hours.

b. Synthetic, rust inhibiting, for bare metal.—(1) *Container.*—1-quart and 1-gallon cans.

(2) *Use.*—It should be used as a base coat on metal, and its use and application is similar to that outlined in *a* above.

55. Painting helmets.—*a. Preparation for painting helmets, steel, M1917 and M1917A1.*—Helmets will be clean, free from scale, rust, grease, and dirt. Sandblasting has proven to be a very satisfactory method for preparing the surface of helmets for painting.

b. Method of painting.—(1) Spray the interior of the helmet body with one coat of enamel, synthetic, olive-drab, lusterless.

(2) Spray the exterior of the helmet with one coat of enamel, synthetic, olive-drab, lusterless, which has previously been mixed with not less than 8 ounces of ground cork per gallon of enamel. The cork should be mixed in a tank by means of a power driven agitator while the spray operation is being performed. Material in the mixing tank should be under an air pressure of 8 pounds per square inch and the pressure on the spray guns should be 15 pounds per square inch. If a thinner is required, thinner (for use with enamel, synthetic, olive-drab) should be used. In no case should the amount of thinner exceed 15 percent by volume of the enamel.

56. Drier, liquid paint.—*a. Container.*—Quart can.

b. Function.—(1) Driers are used in paints to hasten the drying of linseed oil, a component of paint which otherwise dries very slowly.

(2) Driers, and in less degree turpentine, operate through their ability to absorb oxygen from the air and to transmit this oxygen to the linseed oil.

(3) Too much drier burns paint, causing it to get too hard and to scale.

(4) Ready-mixed paints have the correct amount of drier in them and no more should be added unless the paint has become so old and thick that a comparatively large volume of linseed oil is necessary to thin it.

(5) Drier should not be used to thin paints nor should more than 1 percent by volume be used in any case.

(6) A drier works by chemical action whereas most mineral spirit thinners mix physically with a paint, making it easier to spread. The thinner then evaporates, leaving the paint body in its original form.

57. Lacquer.—*a. Characteristics.*—(1) Transparent liquid.

(2) Dries rapidly, leaving a weather resistant coating.

(3) Will set to touch in a few minutes.

(4) Inflammable and dangerous to inhale.

b. Method of application.—(1) Must be thin enough to flow easily.

(2) Applied with a camel's-hair brush or, preferably, sprayed.

(3) Approved thinner is amyl acetate.

(4) Alcohol may be used in place of amyl acetate but it may be used only sparingly and only when absolutely necessary.

(5) It will be necessary to carry out precautions against fire and against inhalation of vapors.

c. Use.—(1) Used on sandblasted metal surfaces of fire-control and sighting equipment to prevent tarnishing and deterioration.

(2) Use for this purpose is restricted to ordnance personnel at maintenance shops or to personnel authorized to work on fire-control equipment.

(3) The specific applications of the various colored lacquers, with but few exceptions, will be restricted to the personnel of arsenals and ordnance maintenance shops.

58. Mixture, liquid, for red lead paint.—*a.* A mixture of raw linseed oil, pure gum spirit turpentine, and drier.

b. Used for making up red lead paint.

c. The proportions for 1 gallon of red lead paint are—

5 pints oil, linseed, raw
½ pint turpentine
½ pint drier, liquid paint

used mixed with dry red lead.

59. Oil, linseed, raw.—*a. Container.*—1-gallon can.

b. Use.—(1) A component of mixture, liquid, for red lead paint.

(2) An auxiliary thinner for ready mixed paint.

(3) The oil is applied on gun stocks with a cloth, the surplus wiped off, and the stock polished with a clean, dry cloth or the palm of the hand.

(4) Used to treat the inside packing of arm lockers and arm chests.

(5) It must not be used in connection with enamel, synthetic, olive-drab, lusterless, since this use would cause a high luster objectionable during wartime.

60. Putty (whiting).—*a. Container.*—5-pound can.

b. Method of handling.—(1) Keep the putty in a can and keep the cover tight, taking out only as much as is needed at a time.

(2) If it gets hard, add a drop or two of linseed oil to a mass as large as can be worked in one hand and knead it with the hands or with the putty knife.

(3) Too much oil makes putty too soft. When of the right consistency, it works easily under the knife and does not stick to the fingers.

(4) If lid has not been properly put on the can and the putty has dried out to the extent that it is hard and brittle, it is useless to waste time and material to work it up again. In cases such as these, large quantities of dried-out putty should be returned to the arsenal for salvage.

c. Use.—For filling holes and crevices in woodwork before painting.

61. Turpentine.—*a. Container.*—1-gallon can.

b. Use.—(1) For preparation of mixture, liquid, for red lead paint.

(2) As a thinner for paints, spar varnishes, and asphaltum varnishes.

(3) It should not be used as a thinner for enamel, synthetic, olive-drab, lusterless.

(4) Since a luster is destroyed by thinning with turpentine, its use should be curtailed where a high luster is desired.

c. Action.—Turpentine, in the process of evaporation, absorbs oxygen. It has the property of imparting the oxygen to the bodies with which it is associated, and in turn causes them to dry. This is not true of petroleum thinners, which simply evaporate.

62. Varnishes.—*a.* Varnish, shellac, orange.

b. Varnish, shellac, white.

c. Varnish, spar, water-resisting.

d. Use.—(1) The varnishes are very much alike with respect to methods of application and use.

(2) Generally speaking, the shellacs seal the grain of wood quickly but do not stand weather and are not as transparent as the spar varnish listed above.

(3) White shellac is a quick drying, transparent varnish used on plotting, range, and deflection boards as a corrosion-preventive coating.

(4) Shellacs are used on rammer staves prior to application of a coat of varnish, spar, water-resisting.

(5) Varnish, spar, water-resisting, is used on wooden parts of fire-control instruments, such as tripod legs, and as a finish coat on all wooden rammer staves.

e. Handling varnishes.—(1) Pure grain alcohol is the best thinner for shellac.

(2) White shellac is darkened considerably by contact with iron, and where color is important it should be kept in glass containers and spread with a brush bound with leather or set in rubber.

(3) Turpentine may be used sparingly as a thinner for varnish, spar, water-resisting.

63. Varnish, mixing (for aluminum paint).—*a. Container.*—1-gallon can.

b. Use.—Mixed with paint, aluminum, in the proportions of ½ pound of aluminum powder to 1 quart of varnish.

64. Paint, aluminum.—*a. Characteristics.*—Light aluminum-colored powder.

b. Container.—½-pound can.

c. Use.—(1) For use it must be mixed with varnish, mixing (for aluminum paint), in the proportions of ½ pound of aluminum powder to 1 quart of varnish.

(2) The use of this paint is restricted to the priming of *aluminum* surfaces for painting.

(3) Before applying the aluminum primer, the surface should be roughened with a stiff bristled steel wire brush.

(4) The aluminum coat may be followed with the required number of coats of standard olive-drab paint.

65. Acetone, grade B.—*a. Characteristics.*—(1) A colorless, volatile, and inflammable liquid.

(2) Characteristic sweetish odor.

(3) Soluble in water and alcohol.

b. Container.—1-gallon can.

c. Method of handling.—(1) Work with acetone or a mixture containing this compound should be carried out in open air or in a well ventilated room.

(2) Acetone is very volatile and inflammable, forming explosive mixtures with air. This, in additon to its toxic properties, will necessitate extreme caution in its handling and use.

(3) Prolonged exposure to fumes of acetone will result in nausea, headache, and eventually chronic disease.

d. Use.—Used in preparation of remover, paint and varnish.

66. Benzene (benzol) grade C.—*a. Characteristics.*—(1) A colorless, volatile, and inflammable liquid.

(2) Odor similar to gasoline.

(3) Insoluble in water, soluble in alcohol.

(4) Burns with a smoky luminous flame.

(5) Vapors of benzene are heavier than air, with which it forms explosive mixtures.

(6) Frozen benzene is almost as inflammable as liquid benzene.

b. Container.—1-gallon can.

c. Method of handling.—(1) Toxicity of benzene is as follows: It is a very poisonous substance, acting upon the nervous system and upon the blood-forming organs. It is absorbed into the body by inhaling or through the skin. Mild or acute benzene poisoning is evidenced by symptoms of excessive fatigue, headaches, and nausea.

The chronic form of benzene poisoning is characterized by symptoms of intoxication, fatigue, and anemia, followed by convulsions, paralysis, unconsciousness, and possible death.

(2) Proper precautionary measures against fire and explosive hazards and against undue exposure to fumes of benzene will be taken in view of its toxic and explosive properties.

d. Use.—Used in preparation of remover, paint and varnish.

67. Remover, paint and varnish.—*a. Characteristics.*—(1) It is a toxic and explosive liquid mixture consisting of benzene, acetone, denatured alcohol, and paraffin.

(2) This mixture is inflammable and quite volatile.

(3) It is toxic if inhaled or if it comes in contact with the body.

b. Preparation.

	Grade
1 gallon acetone	B
3 gallons benzene (benzol)	C
1 gallon alcohol (denatured or ethyl)	
1 pound paraffin (granulated or flaked)	117–120

Add paraffin to benzene and let soak 10 hours; add other ingredients; mix thoroughly and can.

c. Method of handling.—(1) This mixture is inflammable and quite volatile. The fire hazard is great, and smoking will be prohibited while it is being used and as long thereafter as the fumes persist.

(2) It is quite toxic and continued exposure to the fumes in poorly ventilated rooms will lead to headaches, nausea, and eventually to chronic ailments and even death.

(3) Contact with the hands or other portions of the body should be avoided, since these chemicals cause a stubborn rash to appear on the skin of some people.

(4) Keep paint remover out of any finished joint or bearing from which it cannot be thoroughly cleaned. It attacks rubber and should be kept away from insulated wires.

(5) It is well not to get any of the remover on the hands as most brands have poisonous qualities tending to produce a rash as well as to dry and crack the skin.

d. Use.—(1) It is used to dissolve old paint and varnish from wooden parts of matériel, and whenever else it is impracticable to use the lime-and-lye solution. As a cleaner for wood it does not check or crack the surface, and as water is not required to wash it off, the grain of the wood is not raised.

(2) Apply the remover as it comes from the can, very liberally but slowly with a 3-inch or 4-inch varnish brush, using a single or

one-way stroke only. Brushing out or over several times seems to seal the surface so that the remover does not have its best effect. Allow the remover to remain on for about 15 minutes. The paint or varnish may then be wiped or scraped off.

(3) Wash off *all* the paint and varnish remover with solvent, dry-cleaning, before applying new paint.

(4) Wash the brush with solvent, dry-cleaning, and dry it before putting it into fresh paint or varnish.

68. Care of paint brushes.—*a. Conclusion of painting.*—(1) At the conclusion of a job of painting, brushes or spraying equipment must be carefully cleaned with turpentine or solvent, dry-cleaning, and wrapped in oil paper. Camel's-hair brushes should, after thorough cleaning, be wrapped in a thin sheet of oil paper and laid flat on a shelf or other clean surface. It is important that the hair of any brush be guarded against distortion while not in use.

(2) When put in storage, brushes should be protected with naphthalene.

b. Old paint brushes.—Worn paint brushes should be retained for use in spreading rust-preventive compound and similar materials. Very old brushes may be used for applying caustic solutions and removing paint. This will result in their quick destruction, however.

c. Brushes in semi-continuous use.—Brushes in semi-continuous use may be suspended in a can of lubricating oil by means of a wire passed through holes in the brush handles. The bristles should be completely covered with the oil but the brush should not touch the bottom of the can. A brush kept in this manner is ready for immediate use with a minimum of cost in labor or material. The oil should be drained from the brush, the brush wiped fairly free of oil, and then washed in solvent, dry-cleaning, or similar material before the painting operation begins.

d. Brushes in continuous use.—If a painting operation is to extend over a period of several days or even weeks, the brushes may be protected overnight by suspending them in a container of fresh water.

SECTION V

LUBRICANTS

69. General.—*a. Care of lubricants.*—All lubricant containers must be kept closed so as to prevent the possibility of grit, dirt, lint, moisture, and other foreign materials getting into lubricants. Rapid wearing and even immediate destruction of parts may result from the use of lubricants which contain abrasives or other foreign matter. Containers should be kept closed when lubricant is not actually being removed; also, they should not be opened when sand and grit may be blown into them.

b. Safety measures.—(1) Prompt removal and disposal of oil rags and papers must be accomplished, since an accumulation of such material may cause a fire by spontaneous combustion.

(2) The use of too much lubricant must be avoided. It should be kept in mind that ball bearings should be filled about ½ full and never more than ⅔ full of the recommended grease. The use of excessive lubricant in this instance will cause overheating of the bearings and may cause the premature destruction of the matériel.

c. References.—It is strongly recommended that the exact quantities and grades of lubricants recommended in Technical Manuals, lubrication guides, manufacturer's catalogs, and like publications be rigidly followed.

70. Graphite.—*a. Flake.*—Used mixed with lubricating cup grease No. 5 in the proportion by volume of flake graphite 1 part, cup grease 5 parts, as a substitute for hard graphite lubricating grease. Its use has been restricted because of better and more modern lubricants. It will be used now only as a substitute or an emergency lubricant.

b. Powdered.—(1) *Container.*—1-pound can.

(2) *Preparation for use.*—Usually mixed with No. 3 cup grease in the proportion of 1 pound of grease to 1 ounce of graphite, powdered.

(3) *Use.*—(*a*) A thin coating is applied on liner seats in tubes of antiaircraft guns with removable liners.

(*b*) Lubrication of bearing surfaces of targets.

(*c*) Used in the compression grease cups on heavy-duty bearings, such as the trunnions of the major caliber guns comprising seacoast and railway artillery.

(*d*) It is not to be used on roller or ball bearings or on gun-roller paths since on such surfaces transparent greases are more desirable in order that rust may be detected when first formed.

71. Grease, graphite, soft (aircraft).—*a. Characteristics.*—(1) Soft, black grease.

(2) Graphite establishes on finished metal surfaces a thin film not easily washed off by rain. This grease is therefore especially valuable on bearing surfaces exposed to the weather, such as gun slides and elevating arcs of light and medium artillery.

(3) It should not be used on ball or roller bearings.

b. Container.—1-pound can.

c. Use.—Lubrication and slushing of sprocket chains, counter-recoil springs, chest-carrying springs, and similar large springs on artillery matériel.

72. Oil.—*a. Castor, inhibited.*—(1) *Characteristics.*—White, transparent, sluggish oil.

(2) *Container.*—1-pint and 1-quart containers.

(3) *Use.*—Lubrication of the rubber or synthetic rubber (dermatine or neoprene) packings of hydropneumatic recoil mechanisms, including those of 155-mm and 240-mm howitzers, M1918.

b. Clock.—(1) *Grade 1.*—(*a*) *Characteristics.*

1. Fish oil with characteristic fishy odor.

2. Slightly yellowish in color and very fluid.

3. Good lubricating qualities and a particular freedom from evaporation and gumming.

(*b*) *Handling.*

1. Keep in a cool place.

2. Keep container covered.

3. Apply with a dropper or wire.

(*c*) *Use.*

1. Desirable for use on small pivot bearings in clocks and fine instruments which receive lubricating attention only once or twice a year.

2. Its use should be restricted almost entirely to clocks and other very fine instruments inasmuch as it is quite expensive and perishable in storage.

(2) *Grade 2.*—Grade No. 2 clock oil is a compounded oil of very thin consistency which is especially adaptable where it is desired that a nongumming lubricant be spread over a considerable surface. Its use has been almost entirely supplanted by oil, lubricating, for aircraft instruments and machine guns, which is less expensive, more stable, and is a better all around lubricant than oil, clock, No. 2.

c. Engine (SAE 10, 30, 50).—(1) *Containers.*—1-pint, 1-quart, and 1-gallon containers.

(2) *Use.*—(*a*) General lubricating purposes.

(*b*) Oil, engine, SAE 10, should be used to protect bores of cannon in stand-by condition. The gun should be cleaned after each firing period and the bore swabbed with this oil.

(*c*) Oil, engine, should be used in the gear cases of heavy artillery. Oil, engine, SAE 30, should be used if the prevailing temperatures are above 32° F. For temperatures below 32° F., oil, engine, SAE 10, should be used. This will apply in general to all gear cases on heavy artillery for which oil is specified.

(*d*) For very low or arctic temperatures it may be necessary to replace SAE 10 with oil, lubricating, for aircraft instruments and machine guns. Frequent checks for leakage or loss of lubricant from the gear cases must be made.

(*e*) Lubrication charts furnished with matériel will give specific information as to the correct grade of oil and where it should be used.

(*f*) Ordinarily, oil in artillery gear cases should be changed twice a year. In tropical climates once a year will be sufficient, as only one grade will be required throughout the year.

(*g*) This oil is used as the lubricant in crankcases of automotive engines.

d. Hydraulic variable speed gears.—Used for hydraulic variable speed gears such as gear cases on the maneuvering mechanisms of certain seacoast artillery, large tanks, and antiaircraft remote control systems.

e. Lard.—Used for lubricating taps and dies in certain machine operations. Taps and dies are flushed from a hand oiler. It is most necessary to use lard oil when cutting threads on ferrous metals. Damage to the tap or dye and a poorly cut thread may result if it is not used. Nonferrous metals do not require the use of lard oil. Used for small individual machine operations.

f. Mineral lard.—(1) *Function.*—(*a*) General term covering a class of compounded cutting oils.

(*b*) Sulfurized mineral or sulfurized mineral lard oil is generally used to produce a surface of a high degree of smoothness on finished steel.

(*c*) Water or soluble oil is generally used to obtain a better finish with a spring tool on a lathe.

(*d*) The function of the cutting fluid in metal cutting operations is to cool the tool, cool the work, improve the quality of the surface produced, lubricate the surfaces in contact, clean the tool and work, flush away the chips, and reduce the pressure of the chip on the tool.

(*e*) To cool tool and work, and flush away chips, a thin soluble oil solution of approximately 40 parts water to 1 part oil, or a solution of soda ash or borax in water serves the purpose best, since the

quantity of fluid is most important. As a rule, water solutions are more satisfactory as coolants than pure oil-cutting fluids.

(*f*) Oil containing a large percentage of sulfur reduces the tendency of steel chips to stick to the tool and helps produce a higher quality machine finish.

(*g*) In lieu of oil, mineral lard, water solutions of soda ash or borax may be used. For use on small lathes and cutting tools on ordnance maintenance vehicles, oil is preferred to other cutting fluids because it does not tend to corrode equipment and material as rapidly as water solutions. Soda ash and borax solutions are made from clean water to which one of these chemicals is added. The amount to be added is 1½ percent of the weight of the water.

(2) *Method of use.*—When used for cooling and lubricating metal cutting parts of machine tools, the oil or water solution is pumped over the cutting edge of the tool.

g. Lubricating.—(1) *For aircraft instruments and machine guns.*—

(*a*) *Characteristics.*

1. Very fluid, pure petroleum oil.

2. Has little rust-preventive properties.

(*b*) *Container.*—1-ounce bottle; 1-pint, and 1-quart cans.

(*c*) *Use.*

1. For lubrication of small arms over a wide temperature range.

2. For lubrication of fire-control and sighting equipment.

3. Satisfactory lubrication is possible at very low temperatures, if applied properly.

4. Used in buffer mechanisms of machine guns.

5. Used in artillery gear cases below 0° F.

6. Oil, sperm, or oil, engine, grades 10 or 30, are used in place of oil, lubricating, for aircraft instruments and machine guns when corrosion-preventive properties are required for short intervals of time.

7. Used as a fluid for hydraulic jacks.

(2) *Car and locomotive engine.*—(*a*) This is a very fluid oil used in journal boxes of railway artillery.

(*b*) The oil is used with wool waste supplied for this purpose; the waste being soaked in the oil prior to use.

(*c*) Avoid loose ends and lumpiness in packing. Maintain proper oil level in the journal, but avoid a "flooded" condition.

(3) *Steam cylinder, mineral.*—Use is restricted to arsenal and maintenance shops for use on steam engines having automatic lubricating devices, etc.

(4) *Chain and wire rope.*—(*a*) *Characteristics.*—Very heavy lubricating oil having the consistency of grease at ordinary temperatures.

(*b*) *Use.*—Used to lubricate and protect gears, chains, and wire ropes as on the loading apparatus of the 14-inch railroad mount, M1920, and similar equipment. It should be warmed to the temperature of boiling water to facilitate its application.

h. Sperm.—(1) *Use.*—(*a*) Lubricant and corrosion preventive on small arms.

(*b*) Should be used to protect weapons from corrosion if they are left unused for more than a few hours, and less than several days.

(*c*) In lieu of oil, sperm, oil, lubricating, for aircraft instruments and machine guns, will be used as a protection against corrosion.

(*d*) It must be understood, however, that oil, lubricating, for aircraft instruments and machine guns, will not afford adequate protection against corrosion for more than a few hours under severe weather conditions, while oil, sperm, will protect weapons for 2 or 3 days under similar circumstances.

(*e*) For periods in excess of several days and less than temporary storage conditions, oil, engine, will be used as a preservative.

73. Petrolatum.—Will be used to some extent in ordnance maintenance shops. However, its use on worm gears of fire-control and sighting instruments has been superseded by grease, special, low temperature.

74. Grease, special, low temperature.—*a.* Used in lubrication of worm gears and sliding surfaces of fire-control and sighting instruments, mainly in ordnance maintenance shops.

b. Functions as a rust-preventive material for fire-control and sighting equipment.

c. Must be applied carefully and in thin films only.

75. General maintenance instructions for small arms and machine guns.—*a. General.*—Exact instructions are to be found in the Field Manuals and Technical Manuals pertaining to the weapons. The following will serve as general instructions when the specific manuals are not available:

b. Preparation for firing.—(1) When weapons are received from storage, they should be cleaned thoroughly of all rust-preventive compound or old oil with solvent, dry-cleaning, and immediately oiled, as outlined below.

(2) For all weapons fired on the ground at atmospheric temperatures above 45°F., use oil, sperm. If this oil is not available, oil, engine, SAE 10, or any light grade machine oil may be used in an emergency. Oil working parts sparingly. Apply lubricant to exposed surfaces with an oily rag; to the bore with a cleaning rod and cloth patch, inserted from the breech end.

(3) For all small arms at temperatures between 0° F. and 45° F., use oil, lubricating, for aircraft instruments and machine guns. The lubricant is best applied with a slightly oiled cloth.

(4) For the pistol, automatic, caliber .45, M1911 and M1911A1, at temperatures below 0° F., all oil should be removed with solvent, dry-cleaning, and the weapon used without oil.

(5) The rifle, U. S., caliber .30, M1, and the rifle, automatic, Browning, caliber .30, M1918 and M1918A2, at temperatures below 0° F., are oiled with oil, lubricating, for aircraft instruments and machine guns, only on the parts which show signs of wear.

(6) Aircraft machine guns, when fired in the air, should be lubricated with oil, lubricating, for aircraft instruments and machine guns, regardless of the atmospheric temperature near the ground.

(7) Oil, lubricating, for aircraft instruments and machine guns, will be used in the buffer mechanism of the gun, machine, Browning, caliber .50, M2, water-cooled, fixed, and the gun, machine, Browning, caliber .50, M2, water-cooled, flexible.

c. Cleaning.—(1) The bores of all small weapons should be cleaned thoroughly after use with cleaner, rifle bore, and immediately reoiled to prevent rust. In the event that cleaner, rifle bore, is not available, hot soapy water or a hot water solution of soda ash (1½ spoonfuls per pint of water), or even plain hot water may be used.

Caution: Oil, lubricating, for aircraft instruments and machine guns, is not a rust preventive. Oil, sperm, or oil, engine, SAE 10, should be used for protecting weapons if they are to be left more than 48 hours without firing. For prolonged storage, the weapon should be protected with compound, rust-preventive, light, or heavy, depending upon the length of storage.

(2) In cold climates, weapons should be cleaned thoroughly and oiled immediately upon bringing indoors. This prevents rusting caused by the moisture in a warm room condensing on the cold metal. After the weapons reach room temperature, they should be wiped free of condensed water vapor and oiled again.

76. General lubrication instructions for artillery.—*a. General.*—When the following information on care and preservation of artillery conflicts with that given in Field or Technical Manuals, the specific information given in Field Manuals or Technical Manuals for the particular piece of matériel should be followed.

b. Lubrication.—(1) Oil, lubricating, chain and wire rope, will be used to lubricate and protect gears, chains, and wire ropes on loading mechanisms and similar equipment.

(2) Grease, graphite, soft (aircraft), will be used for lubricating and flushing sprocket chains, counterrecoil springs, chest-carrying springs, and similar large springs on heavy seacoast artillery matériel. In climates where the prevailing temperatures are below zero it will be necessary to thin the above lubricant by slushing equipment with oil, engine, SAE 10, after application of the grease, or in the event of arctic temperatures the grease should be cleaned from the equipment and oil, engine, SAE 10, used to replace the graphite grease as a lubricant.

(3) Heavy antifriction bearings will be packed with grease, O. D., No. 0. In tropical climates grease, O. D., No. 1, should be used.

(4) All sealed gear cases will be cleaned and filled with oil, engine, SAE 10, if the prevailing temperatures are between 0° F. and 32° F. Above this temperature, oil, engine, SAE 30, will be used, and below 0° F. use oil, lubricating, for aircraft instruments and machine guns. In tropical climates oil, engine, SAE 30, should be used during all seasons. Frequent checks for leakage or loss of lubricant from the gear case must be made.

(5) In the case of hydraulic variable-speed gears, oil, for hydraulic variable-speed gears, will be used.

(6) Detailed information as to the lubrication of wheel bearings and similar parts of mobile artillery units is given in the Technical Manuals covering each type of gun. (See TM 4–245.)

c. Exercise of equipment.—It is necessary to exercise the equipment frequently. This means the working and operation of all moving parts without actually firing the gun. Operation of the equipment should occur at least once a week in ordinary climates and more frequently when lower temperatures prevail.

77. General lubrication instructions for fire-control instruments.—*a. Lubricants required.*—(1) Grease, special, low temperature.

(2) Oil, lubricating, for aircraft instruments and machine guns.

(3) Solvent, dry-cleaning.

b. Antiaircraft directors.—Lubrication instructions for antiaircraft directors will be found in OFSB 6–F–167.

c. Fire-control instruments.—(1) All ball and journal bearings, gears, cam surfaces, and other moving parts requiring grease will be coated with a thin film of grease, special, low-temperature. This should be done after cleaning the parts to be lubricated carefully with solvent, dry-cleaning, and applying the grease immediately after the solvent has evaporated to dryness. Care should be taken not to touch ungreased moving parts with the bare hands as the natural body acids may cause corrosion after the grease is applied.

(2) Ball bearings should be filled ½ to ⅔ full of grease but never more.

(3) All parts requiring oil will be lubricated with oil, lubricating, for aircraft instruments and machine guns.

(4) In general, fire-control instruments are lubricated after a general overhaul, and normally need not be lubricated in the field.

SECTION VI

FLUIDS FOR RECOIL MECHANISMS AND HYDRAULIC JACKS

78. Sodium hydroxide, CP(NaOH), pellets.—*a. Characteristics.*—(1) Small white pellets.

(2) Readily absorbs and retains moisture.

(3) Strongly alkaline.

(4) Soluble in water, alcohol, and glycerin.

b. Method of handling.—(1) Keep the container tightly covered at all times except when removing the material.

(2) Do not handle it with the fingers.

(3) Do not allow it to come in contact with the body or clothing.

(4) Dissolve it in water slowly, using small quantities at a time, since much heat is generated during this operation.

(5) Do not allow sodium hydroxide to come in contact with wood, painted, or cloth surfaces.

(6) The action of sodium hydroxide can be neutralized and stopped by washing with vinegar or a dilute acid, and then clean water.

c. Use.—(1) In preparation of glycerin-water recoil fluid.

(2) Its purpose is to make the recoil fluid alkaline, thus reducing the tendency of the solution to corrode the mechanism.

(3) Paper, litmus, paragraph 126, will be used to test for alkalinity.

(4) Instructions for the use of sodium hydroxide as outlined in paragraph 80 will be followed closely.

79. Glycerin, grade A, U. S. P.—*a. Characteristics.*—(1) Heavy colorless liquid.

(2) Mixes readily with water.

b. Container.—1-gallon can.

c. Method of handling.—(1) Keep the container tightly closed when not removing material.

(2) Do not pour any material into the container used for glycerin, grade A, U. S. P.

d. Use.—As a component of the glycerin-water recoil fluid.

80. Glycerin-water recoil fluids.—*a. Preparation.*—Glycerin-water recoil fluids are made up as follows:

(1) 60 parts by volume glycerin, grade A, U. S. P.
40 parts by volume distilled water.

To each 3 gallons of the mixture, add 1 ounce of sodium hydroxide, CP (NaOH) pellets (1 pound sodium hydroxide to 48 gallons). Caustic soda (lye) must *not* be used. The liquid should be strained through a clean piece of linen or muslin before using.

(2) 50 parts by volume glycerin, grade A, U. S. P.
50 parts by volume distilled water.

To each 3 gallons of the mixture, add 1 ounce of sodium hydroxide, CP (NaOH) pellets (1 pound sodium hydroxide to 48 gallons). Caustic soda (lye) must *not* be used. The liquid should be strained through a clean piece of linen or muslin before using.

b. Application.—(1) The glycerin-water recoil fluid described in *a*(1) above (60-40 fluid) will be used in the recoil and counterrecoil mechanisms of all carriages in the chart, paragraph 81, that require a glycerin-water recoil fluid. These carriages are:

40-mm gun carriage M1.
40-mm gun carriage M2.
155-mm howitzer carriage M1917 (Schneider).
155-mm howitzer carriage M1917A1.
155-mm howitzer carriage M1917A2.
155-mm howitzer carriage M1917A3.
155-mm howitzer carriage M1917A4.
155-mm howitzer carriage M1918.
155-mm howitzer carriage M1918A1.
155-mm howitzer carriage M1918A3.
240-mm howitzer carriage M1918.
240-mm howitzer carriage M1918A1.

(2) The glycerin-water recoil fluid described in *a*(2) above (50-50 fluid) will be used in the recoil and counterrecoil mechanisms of all carriages requiring the glycerin-water fluid that are *not* listed on the chart of paragraph 81.

(3) These recoil fluids will not function properly at arctic temperatures. However, no attempt must be made to change the formula for any reason. The raising or lowering of the glycerin content will

change the characteristics of the solution considerably. Several 155-mm howitzers have been fired successfully at −30° F. with the 60-40 fluid. Where arctic temperatures prevail, the temperature of the recoil mechanism should be maintained at a temperature above +10° F., if practicable, in order to avoid injury to matériel or personnel during firing.

(4) Increase of sodium hydroxide content above that specified in the formula will destroy leather or other packings. Glycerin-water recoil fluids should be replaced with fresh liquid whenever it is found necessary to drain cylinders. Extreme care must be taken to see that the proper recoil fluid is used when refilling cylinders.

(5) Drainings will be conserved for use in preparing a sponging solution for cold weather, but because of the alkali content it must not be used as an antifreeze coolant in car or truck radiators. Its use as a coolant would result in quick destruction of the radiator.

(6) In cases of emergency the old liquid may be strained and used for refilling of the recoil mechanism.

81. Recoil oils.—*a. Types.*—(1) Oil, recoil, light.

(2) Oil, recoil, heavy.

b. Characteristics.—(1) Recoil oils are carefully selected for their physical and chemical properties. The clearances of the recoil mechanisms are fixed according to the characteristics of the oil.

(2) The greatest care must be taken not to use any oil in a recoil mechanism except the grade and kind prescribed for it. The specific recoil oil to be used with a given weapon will be specified in the chart at the end of this paragraph and in the Technical Manual published for the matériel in question. Only the oils prescribed for a given unit may be used in that unit.

c. Use.—The following "Modification War Department Recoil Fluid Guide" (Chek-chart No. 19) will be used to determine the recoil oil required for any specific weapon:

LIGHT AND MEDIUM ARTILLERY

Caliber	Carriage		Recoil mechanism		Cannon	Recoil oil	
	Model	Class	Model	Capacity (pints)	Model	Type	Specification
37-mm	M1916	1–19B	M1916	2¾	M1916	Heavy	USA 2–96A.
	M1916A1	1–19B	M1916	2¾	M1916	Heavy	USA 2–96A.
	M4 (AT)	1–105	M4 (carriage).	5	M3	Heavy (see note G)	USA 2–96A.
	M19 (T)	D37152	M19	4¼	M5	Heavy	USA 2–96A.
	M20 (T)	D–37316	M20	4¼	M5	Heavy	USA 2–96A.
	M21 (T)	D37863	M21	2½	M5	Heavy	USA 2–96A.
	M22 (T)	D37864	M22	2½	M5	Heavy	USA 2–96A.
	M23 (T)	D48064	M23	2½	M6	Heavy	USA 2–96A.
	M24 (T)	D–47373	M24	2½	M5 or M6	Heavy	USA 2–96A.
	M3 (AA)	1–106	M1A2	3½	M1A1	Light	USA 2–36D.
	M3 (AA)	1–106	M1A2	3½	M1A2	Light	USA 2–36D.
	M3A1 (AA)	1–108	M1A2	3½	M1A2	Light	USA 2–36D.
	Air corps	(51–92 gun)	M4 (gun)	42¾ fl. oz	M4	Light	USA 2–36D.
40-mm	M1	1–110	M1	1.32	M1	Glycerin-water	(See note A).
	M2	1–118	M1	1.32	M1	Glycerin-water	(See note A).
75-mm	M1897	2–94	M1897A3	3½	M1897	Heavy	USA 2–96A.
	M1897A2	2–94					
	M1897M1	2–94	M1897A6	3½	M1897A1 M1897A2 M1897A3 M1897A4	Heavy	USA 2–96A.
	M1897M1A2	2–94					
	M1897A4	2–262					

75-mm	M1916	2-66	M1916	9	M1916, M1916MI, M1916MII, M1916MII½, M1916MIII, M1916MIII½	Heavy	USA 2-96A.
	M1916A1	2-183					
	M1916MI	2-106	M1916-MIAI	9	M1916MIAI, M1916MIIIAI, M1916MIII½A1	Heavy	USA 2-96A.
	M1916MIAI	2-284					
	M1917	2-75	M1917	5½+2.3 for Grav. Tank	M1917	Heavy	USA 2-96A.
	M1917A1	2-266					
	M2A1	2-274	M2(Mod.)	3½	M1897A2, M1897A3, M1897A4	Heavy	USA 2-96A.
	M2A2	2-274	M1897A5				
	M2A3	2-301	M2, M1897A7				
	M1 (tank)	D47305	M1	16	M2 and M3	Heavy (see note G)	USA 2-96A.
Pack. how	M1	2-229	M1	3	M1, M1A1	Heavy	USA 2-96A.
How	M2A1	2-265	M2				
How	M3	2-277	M3				
How	M3A1	2-277	M3A1				
3-in. AA, mobile	M2	2-245	M2	7**buffer 3¼	M3	Heavy (see notes B & D).	USA 2-96A.
	M2A1	2-245	M2	7**buffer 3¼	M3	Heavy (see notes B & D).	USA 2-96A.
	M2A2	2-287	M2	7**buffer 3¼	M3	Heavy (see notes B & D).	USA 2-96A.
	T4	2-276	T4	10¾**buffer 3¼	T9	Heavy (see note C).	USA 2-96A.

**Add 1 pint reserve.

LIGHT AND MEDIUM ARTILLERY—Continued

Caliber	Carriage		Recoil mechanism		Cannon	Recoil oil	
	Model	Class	Model	Capacity (pints)	Model	Type	Specification
3-in. A A, mobile	M1918	31–15	M1918	13	M1918 and M1918M1.	Light	USA 2–36D.
Fixed	M3	5–36	M3	16	M4	Light	USA 2–36D.
	M1917	5–26	M1917	6½	M1917A2 M1917A3 M1917M1A2 M1917M1A3	Light	USA 2–36D.
	M1917M1	5–31	M1917M1	16	M1917MII M2	Light	USA 2–36D.
	M1917MII	5–37	M1917-MII.	6½	M1917A2 M1917A3 M1917M1A2 M1917M1A3	Light	USA 2–36D.
	M3A1	5–36	M3A1	16	M4	Light	USA 2–36D.
90-mm AA	M1	2–299	M1	13**buffer 3¼	M1	Heavy (see note B).	USA 2–96A.
	M1A1	2–306	M1	13**buffer 3¼	M1	Heavy (see note B).	USA 2–96A.
105-mm	(How.) M1A1	2–241	(How.) M1.	9⅛	M2	Heavy	USA 2–96A.
	(How.) M2	2–298	(How.) M2.	9⅛	M2A1	Heavy	USA 2–96A.
105-mm AA	M1	6–16	M1	15	M3	Heavy (see note C).	USA 2–96A.
4.5-in.	M1	3–200	M5	48	M1	Heavy	USA 2–96A
155-mm	M1	3–185	M3	120*	M1 M1A1	Heavy	USA 2–96A.
	M1A1	3–185	M3	120*	M1	Heavy	USA 2–96A.

	M2 M3	3–197 3–198	M1917 M1918	120* 120*	M1917 M1917A1 M1918M1	Heavy	USA 2–96A.
	M1917	3–55	M1917	120*	M1917 M1918	Heavy	USA 2–96A.
	M1917A1	3–45	M1917	120*	M1917A3	Heavy	USA 2–96A.
	M1918	3–56	M1918	120*	M1917 M1918M1	Heavy	USA 2–96A.
	M1918A1	3–184	M1918	120*	M1918M1	Heavy	USA 2–96A.
How	M1	3–201	M6	48	M1	Heavy	USA 2–96A.
How	M1917	3–28	M1917 M1917A1 M1917A2 M1917A3	72	M1917 M1918	Glycerin-water	(See note A.)
How How	M1917A1 M1917A2	3–40 3–40	M1917 M1917A1 M1917A2 M1917A3	72	M1917A1	Glycerin-water	
How	M1917A3	3–40	M1917 M1917A1 M1917A2 M1917A3	72	M1917 M1917A1	Glycerin-water	(See note A.)
How	M1917A4	3–195	M1918A2	72	M1917A4	Glycerin-water	
How	M1918	3–41	M1918	72	M1917 M1918	Glycerin-water	
How	M1918A1	3–181	M1918	72	M1918	Glycerin-water	
How	M1918A3	3–196	M1918A2	72	M1918	Glycerin-water	

*Add 1 quart reserve.
** Add 1 pint reserve.

LIGHT AND MEDIUM ARTILLERY—Continued

Caliber	Carriage		Recoil mechanism		Cannon	Recoil oil	
	Model	Class	Model	Capacity (pints)	Model	Type	Specification
240-mm How	M1918	3–77	M1918	282	M1918	Glycerin-water	(See note A.
240-mm How	M1918A1	3–77	M1918	282	M1918A1	Glycerin-water	(See note A.
					M1918M1	Glycerin-water	(See note A.
					M1918M1A1	Glycerin-water	(See note A.

NOTES

A—60 parts by volume glycerin, grade A, U. S. P. 40 parts by volume distilled water. To each 3 gallons of the mixture, add 1 oz. of sodium hydroxide, CP (NaOH) pellets (1 lb. sodium hydroxide to 48 gals.). Caustic soda (lye) must not be used.

B—Where material is used in a climate where existing temperatures average around 40° F., or below, OIL, recoil, light, meeting the requirements of specification USA 2-36D will be used.

C—Until further instructions are issued, only OIL, recoil, heavy, meeting specification USA 2-96A will be used.

D—The 3-inch AA gun recoil mechanism M2 valve setting should be $1\frac{13}{16}$ turns open from the closed position when OIL, recoil, light, specification USA 2-36D requirements is used. Adjustment of the recoil valve may be undertaken only by competent Ordnance Personnel.

E—Wherever OIL, recoil, heavy, meeting the requirements of specification USA 2-96A is specified, only OIL, recoil, heavy, meeting this specification, or subsequent revisions of this specification will be used.

F—Wherever OIL, recoil, light, meeting the requirements of specification USA 2-36D is specified, only OIL, recoil, light, meeting this specification, or subsequent revisions of this specification, will be used.

G—OIL, recoil, heavy, meeting the requirements of U. S. Army specification 2-96A may be used satisfactorily for temperatures down to +15° F. For temperatures not exceeding +32° F., OIL, recoil, light, meeting requirements of U. S. Army specification 2-36D will be used.

d. Care.—(1) *Foreign matter.*—(*a*) Recoil oil should not be transferred from one container to another one unless it is properly marked with the exact name of the oil as listed in SNL K–1. Great care must be taken to maintain correct labels on all oil containers so that the oils will be put to their proper use.

(*b*) Recoil oils should never be left in open containers.

(*c*) Recoil oils must not be subjected to excessive heat.

(*d*) The greatest care must be taken with recoil oils to exclude moisture and dirt.

(*e*) Test recoil oils for moisture, and strain through clean cloth before inserting in any recoil mechanism.

(*f*) Do not mix a recoil oil with another recoil oil or any other type of oil.

(2) *Water or moisture.*—(*a*) It is important that no water be introduced into recoil mechanisms that use recoil oil, as the water greatly increases the rate of corrosion and may result in pitting of the finished surfaces, interfering with the functions of the recuperator, and reducing its normal, serviceable life.

(*b*) Unfortunately, in spite of the great care taken in preparation and shipping the medium and heavy recoil oils, water is often found in them. Exposure in an open can, even if the top is covered with a cloth, will result in accumulation of moisture from the air. Condensation in a container partly filled with oil, or pouring from one container to another which has moisture on its inner walls, results in moisture being carried along with the oil into recoil mechanisms.

(*c*) It is advisable that organization commanders test the recoil oil on hand for water content. If a clean, dry glass bottle of about 1 pint capacity is filled with the recoil oil, capped, and allowed to settle, the water, being heavier than the oil, will sink to the bottom and, with the bottle slightly tilted, will form drops or bubbles of water in the lower corner of the bottle. If the bottle is then inverted with this corner uppermost and the bottle held to the light, such drops or bubbles may be seen slowly sinking in the oil. If the oil has a cloudy appearance when looked through against a light, the cloudiness may be ascribed to minute particles of water in suspension. If a shallow pan of the oil is heated over a gas jet to the temperature of boiling water, any water in the oil will appear on the surface as minute bubbles. This test will disclose the presence of water which the settling test will not detect.

(*d*) Should any of the tests show water in the oil, all oil that was handled the same as the test portion should be turned in for exchange, as there is no practical way of extracting the water or dehydrating

the oil except at a depot equipped with special machinery for the purpose. Most large electrical plants have equipment for dehydrating transformer oil and will usually undertake to dry recoil oils (in quantities exceeding 5 gallons) for a small charge. The process consists in forcing the oil under a pressure of 80 to 100 pounds per square inch through specially prepared blotter paper which retains the moisture. Another suggested method of removing water from oil is by means of a centrifuge.

(*e*) Settling alone is insufficient to remove water, and boiling affects the characteristics of the oil.

82. Alcohol, denatured.—*a. Characteristics.*—A clear liquid with inflammable and poisonous characteristics.

b. Container.—1-gallon can.

c. Use.—(1) It was formerly used in some hydraulic jacks as follows: A mixture of 2 parts alcohol, denatured, and 3 parts clean water. For very low temperatures (below −40° F.) the alcohol-water ratio should be 3 parts denatured alcohol to 2 parts water. Grain alcohol may still be used and the concentrations listed above will apply. However, the use of alcohol in hydraulic jacks should be restricted for the most part to emergency only.

(2) The liquid now prescribed for filling hydraulic jacks is oil, lubricating, for aircraft instruments and machine guns, with but one exception, namely: Raritan Arsenal will issue grain alcohol until the supply on hand is exhausted. All other depots will issue oil, lubricating, for aircraft instruments and machine guns. Under no circumstances should liquids other than oil, lubricating, for aircraft instruments and machine guns, or the alcohol issued by Raritan Arsenal, be used.

(3) Denatured alcohol may be used in preparation of remover, paint and varnish.

SECTION VII

WELDING AND BRAZING MATERIALS

83. Fluxes and welding compounds.—These materials serve the purpose of cleaning the surface and preventing excessive oxidation during the fusion of metals. With the possible exception of soldering operations their use will be restricted to highly trained ordnance personnel.

84. Acid, muriatic (commercial hydrochloric acid).—*a. Characteristics.*—(1) A clear or light yellow fuming solution.

(2) Sharp choking odor.

(3) Poisonous and dangerous to get on clothing or the body.

(4) Corrosive to most metals.

b. Method of handling.—(1) Use only as directed.

(2) Keep bottle tightly covered with a glass or rubber stopper.

(3) Do not keep in warm place or near metal tools since the vapors are highly corrosive.

(4) If it should come in contact with the eyes, wash immediately with large amounts of water.

(5) If it should come in contact with the clothes or body, wash with soap solution, or sodium carbonate or bicarbonate solutions and then large amounts of water.

c. Use.—Used mainly in the preparation of zinc chloride flux for welding and soldering.

85. Zinc chloride flux.—*a. Preparation.*—(1) Pieces of zinc, mossy, commercial, are dropped into a small quantity of the acid and are dissolved by it. When action between the liquid and the zinc ceases, the solution is ready for use. Excess zinc is allowed to remain in the solution. The flux thus prepared is actually a solution of zinc chloride.

(2) Metallic zinc scraps, wire, sheet, cast or rolled, will be satisfactory if it is definitely known that the scrap metal is zinc. However, if there is any doubt, mossy zinc should be used in the preparation of soldering flux.

b. Characteristics.—(1) More poisonous and dangerous to handle than acid, muriatic.

(2) Destructive to the body and clothes.

c. Method of handling.—Follow instructions for acid, muriatic.

d. Use.—(1) As a flux when soldering iron and steel.

(2) All excess acid and flux should be removed after soldering to prevent corrosion at the joint.

(3) Removal is best accomplished by washing with ammonia or soda ash and then large amounts of water.

(4) Do not allow the flux to run over parts of the work not to be soldered as corrosion is very likely to occur.

86. Paste, soldering.—An acid-free flux in paste form used in soldering.

87. Rosin.—A flux used to keep surfaces free of oxidation products while soldering.

88. Salt, soldering.—*a. Characteristics.*—Nonacid flux with the consistency of table salt.

b. Method of handling.—Dissolve one part of salt, soldering, in three parts of clean water. This will be applied with a brush. The above solution will be used as a flux to clean tin or tin plated articles, such as tin ammunition boxes, preparatory to applying the solder.

89. Sal ammoniac (ammonium chloride).—Used to clean soldering iron preparatory to tinning the iron.

90. Calcium carbide.—*a. Characteristics.*—Dull, grayish colored pieces of various sizes and slight characteristic odor. Calcium carbide is very reactive with water and must therefore be kept in a tightly closed can away from moisture.

b. Use.—(1) Calcium carbide is used mainly for the preparation of acetylene.

(2) There are two types of acetylene generators. One of these types is so arranged that calcium carbide is added to a large volume of water and the other type adds small quantities of water to a large volume of calcium carbide.

(3) Acetylene generators of the calcium carbide to water type are available for use as fixed installations for welding in base shops or plants; they are available in portable types for use in the field, as in pipeline welding.

(4) The water to calcium carbide types of generators are small and are so arranged that water drops slowly on the carbide, resulting in a generation and release of acetylene gas. This type of generator has a limited field of application, being used principally for lighting purposes, such as for miner's lamps, some air field lights, and other similar uses.

91. Acetylene.—*a. Characteristics.*—(1) Colorless, highly combustible gas.

(2) Has a distinctive odor that is easily detected.

(3) It forms explosive mixtures when mixed with oxygen or air. The explosive range with air may vary between 2.6 percent to 80 percent acetylene by volume. Care should therefore be taken to avoid accumulations of acetylene in confined spaces so as to eliminate the explosion hazard.

(4) Acetylene will explode spontaneously if stored in gaseous form in containers other than the special acetylene cylinders authorized by law.

(5) In the free state acetylene decomposes under pressure and therefore the safe limit for use of acetylene in welding apparatus has been established at 15 pounds per square inch.

b. Method of handling.—Acetylene will be used in the field only by specially trained and authorized personnel. Such personnel will bear in mind constantly the need for safety and fire hazards associated with the handling of acetylene and equipment associated with it.

92. Compressed air.—Compressed air is used by ordnance personnel for operating pneumatic tools, such as rivet sets, chipping chisels, paint sprays, and air hammers. Also, where proper equipment is available, it can be used in lieu of nitrogen in an emergency for recharging hydropneumatic recoil mechanisms which take the glycerin-water fluid.

93. Hydrogen, compressed.—Used for filling balloons used in antiaircraft target practice. The balloons are filled directly from the hydrogen cylinder.

94. Nitrogen, 99.5 percent.—*a. Characteristics.*—A colorless and odorless inert gas.

b. Container.—Compressed gas cylinders, 2,000-pound, M1, or compressed gas cylinders, 2,500-pound, M2.

c. Method of handling.—(1) Used by authorized personnel only to recharge hydropneumatic recoil mechanisms using recoil oil.

(2) When filling the recoil mechanisms, great care must be taken to insure dryness of the mechanism and gas lines from the nitrogen cylinder to the recoil mechanism.

(3) Thus, in reassembling hydropneumatic mechanisms, such as the Puteaux, nitrogen is introduced into the mechanism (at about 200 pounds pressure) and allowed to stand a few hours, after which the pipe or filling tube is disconnected at the shipping container and the pressure of 200 pounds allowed to blow out before final filling. These precautions are not necessary when filling either the 155-mm or 240-mm howitzer recoil mechanisms, in which the glycerin-water solution is used.

95. Oxygen, compressed.—Used in connection with acetylene welding, cutting, and brazing. Its use is restricted to ordnance maintenance shops and authorized personnel.

96. Gas cylinders.—*a. Care of cylinders.*—(1) Keep in upright position at all times.

(2) Cylinders will be wired or fastened in position so as not to bump against each other during transit.

(3) Cylinders must not be subjected to extremes of temperature. They will not be heated in order to expel remaining gases since the rise in temperature may be sufficient to cause the cylinders to explode. Rise in temperature of a gas cylinder causes the pressure to rise and at sufficiently high temperatures excessive pressures will be developed which might cause the cylinder to explode. This applies to all gases regardless of whether they are inert or not.

(4) Never drop cylinders nor permit them to strike each other violently.

(5) Never use a lifting magnet or a sling (rope or chain) when handling cylinders. A crane may be used when a safe cradle or platform is provided to hold the cylinders.

(6) When returning empty cylinders, remove the lower portion of the shipping tag attached to the cylinder. The bill of lading should specify the number of cylinders, the cylinder serial number, the consignee, and the fact that the cylinders are empty. A copy of the bill of lading should be sent to the consignee. Close valve before shipment. See that protective caps for cylinders and nuts for valve outlets are replaced before shipping empties.

(7) Only cylinders approved for use in interstate commerce should be used for the transportation of compressed gases.

b. Storage of cylinders.—(1) Cylinders will be stored where no excessive rises of temperature will occur.

(2) They may be stored in the open but in such cases should be protected against extremes of weather.

(3) During winter, cylinders stored in the open should be protected against accumulation of ice and snow.

(4) In summer, cylinders stored in the open should be screened against direct rays of the sun.

(5) Never store cylinders near highly inflammable substances such as oil, gasoline, waste, etc.

(6) Cylinders should not be exposed to continuous dampness.

(7) Store full and empty cylinders in separate places and mark the latter "M. T." with chalk and also mark the tag attached to the cylinder "M. T."

(8) Cylinders should be used in the order received. Avoid as far as possible keeping reserve cylinders in stock a long time. This will eliminate unnecessary cylinder rental charges and reduce the possibility of loss of gas by leakage.

(9) Cylinders must be returned as soon as empty and orders should be placed for quantities necessary for the user's immediate requirements. The user is held responsible for the safe return of all cylinders within 30 days.

(10) Do not store full cylinders near elevations or gangways or in locations where heavy moving objects may strike or fall on them.

(11) All electrical wiring, switches, lamps, and other electrical equipment present in storage shelters should be adequately protected to give spark proof construction.

c. Precautions when using compressed gas cylinders.—(1) *Cylinder caps.*—Where caps are provided for valve protection, such caps should be kept on cylinders except when cylinders are in use.

(2) *Filling cylinders.*—Cylinders must not be filled except by or with consent of the owner and then only in accordance with the regulations of the Interstate Commerce Commission. Never attempt to mix gases in a cylinder.

(3) *Illegal to change marks.*—It is illegal to remove or change the number or marks stamped on cylinders without written authority from the Bureau of Explosives, New York City.

(4) *Do not use as support.*—Never use cylinders for rollers, supports, or for any purpose other than to carry gas.

(5) *Do not disturb safety devices.*—Never tamper with the safety devices in valves or cylinders.

(6) *Open slowly, without wrench.*—Open cylinder valves slowly. Never use wrenches or tools except those provided or approved by the gas manufacturer.

(7) *Threads must match.*—Make sure that the threads on regulators or other unions are the same as those on cylinder valve outlets. Never force connections that do not fit.

(8) *Do not interchange regulators.*—Regulators and pressure gages provided for use with a particular gas must not be used on cylinders containing different gases.

(9) *Do not repair.*—Never attempt to repair or alter cylinders or valves.

(10) *Do not repair a leaky cylinder.*—Should a leak occur in a cylinder, take the cylinder into the open air and exhaust the gas slowly, keeping well away from fires or open lights. When empty, close the valve and replace the cap. Notify the manufacturer imme-

diately, giving serial number of cylinder and particulars of defect as far as known, and await shipping instructions.

(*d*) *General instructions when using compressed gas cylinders.*—(1) *Storage.*—Do not mix reserve stocks. Do not store reserve stocks of cylinders containing acetylene with reserve stocks of cylinders containing oxygen. They should be separately grouped.

(2) *Use of combustible gas cylinders.*—(*a*) Keep sparks and flames away from cylinders.

(*b*) Connections to piping, regulators, and other appliances should always be kept tight to prevent leaking.

(*c*) Never use an open flame to detect combustible gas leaks. Use a soap solution as indicated in paragraph 98*q*.

(*d*) When cylinders are not in use, keep valves tightly closed.

(*e*) Never use combustible gases from cylinders without reducing the pressure through a suitable regulator attached directly to the cylinder.

(*f*) After removing a valve cap, open the valve an instant to clear opening of particles of dust or dirt.

(*g*) If valve is difficult to open, point the valve opening away from you, and use greater force. Avoid, however, the use of a wrench on valves equipped with hand wheels.

(*h*) After attaching regulator and before opening cylinder valve, see that adjusting screw of regulator is released.

(*i*) Never permit the gas to enter the regulator suddenly. Open the cylinder valve slowly.

(*j*) Before regulator is removed from a cylinder, close the cylinder valve and release all the gas from regulator.

(*k*) Manifolds for combustible gases should be used only if they are designed by qualified engineers. Gas manufacturers will furnish specifications for construction and installation of suitable manifolds.

(*l*) Never interchange combustible gas regulators, hose, or other appliances with similar equipment intended for use with other gases.

(*m*) Store all cylinders containing combustible gases in a well ventilated place.

(*n*) Do not store reserve stocks of cylinders containing combustible gases with cylinders containing oxygen. They should be grouped separately.

97. Use of oxygen cylinders.—*a. Avoid oil and grease.*—Never permit oil or grease to come in contact with oxygen cylinders, valves, regulators, gages, or fittings. Do not handle oxygen cylinders or apparatus with oily hands or gloves.

b. Always use a regulator.—Never use oxygen from a cylinder without reducing the pressure through a suitable regulator intended for that purpose.

c. Blow out dirt.—After removing the valve cap, open the valve an instant to clear the opening of particles of dust or dirt.

d. Opening valve.—If valve is difficult to open, point the valve opening away from you and use greater force. Avoid, however, the use of a wrench on valves equipped with hand wheels.

e. Attaching regulator.—After attaching regulator and before cylinder valve is opened, see that the adjusting screw of the regulator is released.

f. Open valve slowly.—Never permit oxygen to enter the regulator suddenly. Open cylinder valve slowly.

g. Pressure varies with temperature.—Increase in temperature of a cylinder of gas will result in a corresponding increase in pressure. For this reason cylinders should always be protected from direct rays of the sun or from other sources of heat.

h. Before removing regulator.—Before regulator is removed from a cylinder, close the cylinder valve and release all gas from regulator.

i. Keep sparks and flame away.—Avoid sparks or flame from welding or cutting torch from coming in contact with oxygen cylinders as well as all other cylinders.

j. Never interchange equipment.—Never interchange oxygen regulators, hose, or other appliances with similar equipment intended for use with other gases.

k. Manifolding oxygen cylinders—danger in using improperly designed manifolds.—Where oxygen cylinders are connected to manifolds or headers, such manifolds must be of proper design and equipped with one or more pressure regulators. The experience of industry has conclusively proved that the consumer of oxygen does not know how to design and construct proper manifolds and service pipe lines. Unless such pipe lines are properly designed and constructed, the State and municipal bureaus, as well as the constituted safety bureaus and insurance companies, will not accept their use. Serious accidents which have occurred in the past make necessary this supervision and approval by the above authorities. Oxygen manufacturers will be glad to furnish specifications for construction and installation of proper oxygen manifolds and pipe lines. Cylinders having widely varying pressures should not be manifolded together as this condition causes intercylinder gas surges and internal heating.

l. Do not handle fittings with greasy hands.—Where oxygen manifolds and cylinders are located, care should be taken to avoid handling

the manifold fittings, connections, and oxygen cylinder valves with greasy or dirty hands.

m. Open valve wide.—Fully open the cylinder valve when cylinder is in use.

n. Do not mix gases.—Never attempt to mix gases in any oxygen cylinder.

o. Do not use oxygen as compressed air.—Never use oxygen as a substitute for compressed air. It is dangerous to use oxygen for pneumatic tools, to start Diesel engines, for creating pressure in oil reservoirs, for paint spraying, for blowing out pipe lines, etc.

p. Do not store near inflammables.—Do not store cylinders near inflammable material, especially oil, grease, or any substance likely to cause or accelerate fire. Oxygen is not inflammable, but greatly aids the combustion of other materials.

q. Do not mix reserve stocks.—Do not store reserve stocks of cylinders containing combustible gases. They should be separately grouped.

98. Use of acetylene cylinders.—*a. Keep upright.*—Acetylene cylinders should be used and stored in an upright position to avoid possibility of drawing out acetone.

b. Do not exceed 15 pounds per square inch.—Acetylene should never be used at a pressure exceeding 15 pounds per square inch.

c. Protect from sparks and flame.—Keep sparks and flame away from acetylene cylinders. Never use an open flame near cylinders for any purpose whatsoever. If it is necessary to carry a lighted torch to the cylinder for readjustment of the regulators, hold the torch with one hand as far away from the cylinders as possible, pointing the flame away.

d. Always use regulator.—Never use acetylene from cylinders through blowpipes or other devices equipped with shut-off valves on the acetylene supply connections without reducing the pressure through a suitable regulator to the cylinder valve.

e. Blow out dirt.—After removing valve cap, open valve an instant to clear opening of particles of dust or dirt.

f. Attaching regulator.—After attaching regulator and before cylinder valve is opened, see that adjusting screw of the regulator is released.

g. Point valve outlet away.—Turn the acetylene cylinder so that its valve outlet will point away from the oxygen cylinder.

h. Open cylinder valve one half turn.—If not sufficient, open further but not more than one full turn.

i. Before removing regulator.—Before regulator is removed from a cylinder, close the cylinder valve and release all gas from regulator.

j. Never interchange equipment.—Never interchange acetylene regulators, hose, or other appliances with similar equipment intended for use with other gases.

k. Do not transfer gases.—Never attempt to transfer acetylene from one cylinder to another or to mix any other gas with it in the cylinder.

l. Manifolds.—Never use manifolds for acetylene cylinders unless constructed upon the advice of a qualified acetylene engineer.

m. Keep wrench in valve when using.—The wrench used for opening the cylinder valve should always be kept on the valve spindle when cylinder is in use.

n. Close valves.—When returning empty cylinders, see that valves are closed to prevent evaporation of acetone.

o. Do not refill.—Never, under any circumstances, attempt to refill acetylene cylinder.

p. Contents by weight.—The pressure in an acetylene cylinder does not indicate accurately the amount of gas contained therein. The amount is determined by weight.

q. Testing for leaks.—Never test for acetylene leaks with an open flame. Apply a soap solution to the parts that might be leaking. The formation of bubbles indicates a leak.

r. Fire.—If an acetylene cylinder should catch fire, it can usually be extinguished with a wet blanket or burlap bag. If this fails, spray a stream of water on it to keep it cool. Remove the cylinder to a safe distance away from all buildings and equipment and consult a qualified person as to its further disposition. A burlap bag wet with calcium chloride should be kept handy for such an emergency.

99. Welding.—Detailed instructions for electric and oxyacetylene welding are to be found in OFSB 5-2. Tests for identifying metals, general information on welding and cutting equipment and operations involving their use, specific information on welding of metals used in ordnance construction, and general precautions to be observed in welding, are thoroughly covered. TM 1-430 also gives detailed information with respect to welding. The welding of a large number of different alloys is covered in this manual.

100. Oil, quenching.—*a. Characteristics.*—A black heavy oil with high flash point.

b. Use.—As a bath in which to heat articles for low temperature drawing heat treatment.

SECTION VIII

CARBON DIOXIDE FIRE EXTINGUISHERS

101. General.—*a.* Carbon dioxide portable type fire extinguishers are available in sizes ranging from 2 to 150 pounds. Instructions will be general and might apply to all sizes of fire extinguishers.

b. The principles of operation and of recharging are the same for all sizes, except that it is not practicable to recharge an extinguisher of larger than 20-pounds capacity by the cooling method.

c. Permanently installed system.—In addition to carrying portable type fire extinguishers, the light tanks and combat cars of the Army are equipped with a permanently installed fire extinguishing system in the engine compartment.

d. Regulations and instructions.—Interstate Commerce Commission regulations cover the manufacture and testing of cylinders, and the labeling, etc., for transportation.

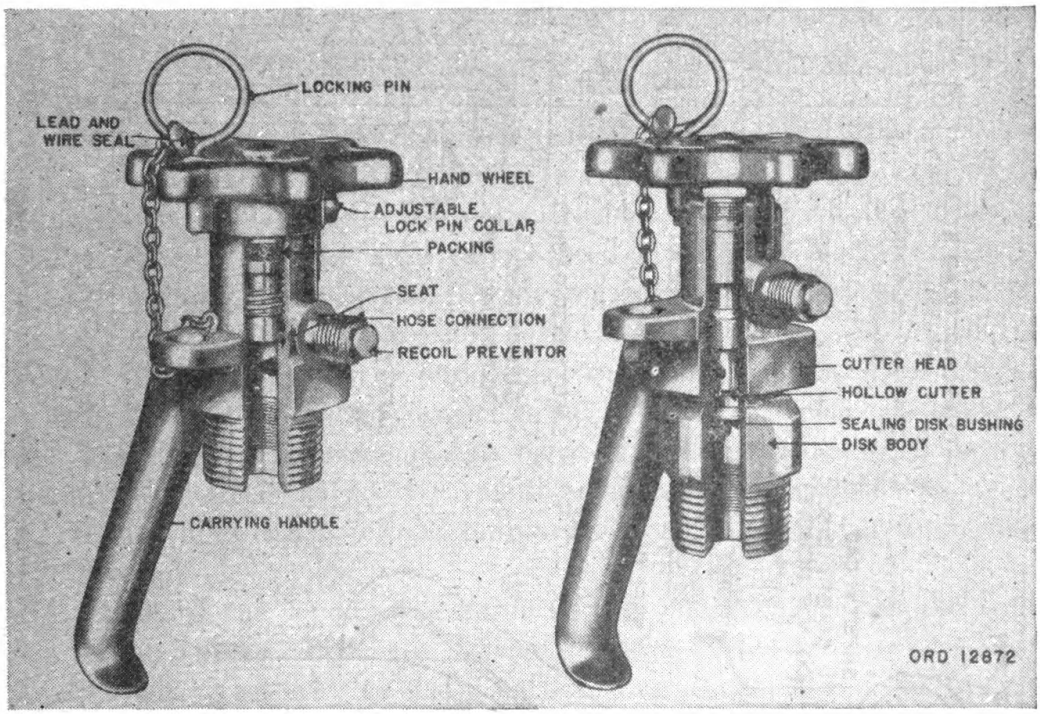
102. Description.—*a.* The carbon dioxide fire extinguisher is composed of a high pressure cylinder with a valve assembly, discharge nozzle, and hose. All valve assemblies are fitted with a recoil preventer in the hose connection (fig. 1①), to neutralize the force of discharge when the hose is disconnected. A safety disk (fig. 2①), is also provided to relieve the cylinder of any abnormal pressure that may be developed.

b. The valves used on these extinguishers are of two types, the seat or permanent shut-off type, and the disk or penetrating seat type. The former type of valve (figs. 1① and 2①) may be identified by the valve body, which is screwed directly into the cylinder, while the latter, or disk type (figs. 1② and 2②) has an intermediate piece, the disk body, between the valve body and the cylinder.

c. A permanent fire extinguishing system is installed in the engine compartments of light tanks and combat cars. It consists of a seat valve 7½ pound carbon dioxide fire extinguisher connected to a system of perforated copper tubes which distribute carbon dioxide gas spray throughout the engine compartment when the extinguisher valve is opened.

103. Characteristics of carbon dioxide.—*a.* Carbon dioxide is a clean, dry, noncorrosive, inert, and harmless gas. It is considered a fast and efficient fire extinguishing agent.

b. Carbon dioxide is stored in the extinguisher as a liquid, and discharges under its own pressure, without pumping. The pressure in



① Seat type. ② Disk type.

FIGURE 1.—Extinguisher valves.

a fully charged extinguisher is approximately 1,000 pounds per square inch at 80° F. and 2,000 pounds per square inch at 120° F.

c. In appearance, carbon dioxide gas, when discharged, closely resembles a cloud of steam. It will not damage or injure machinery, equipment, woodwork, fabrics, or anything with which it may come in contact. It should not, however, be allowed to come in contact with the bare skin. It is a nonconductor of electricity and may therefore be spread over a fire on any type of electrical equipment or installation without danger of shock being transmitted to the operator.

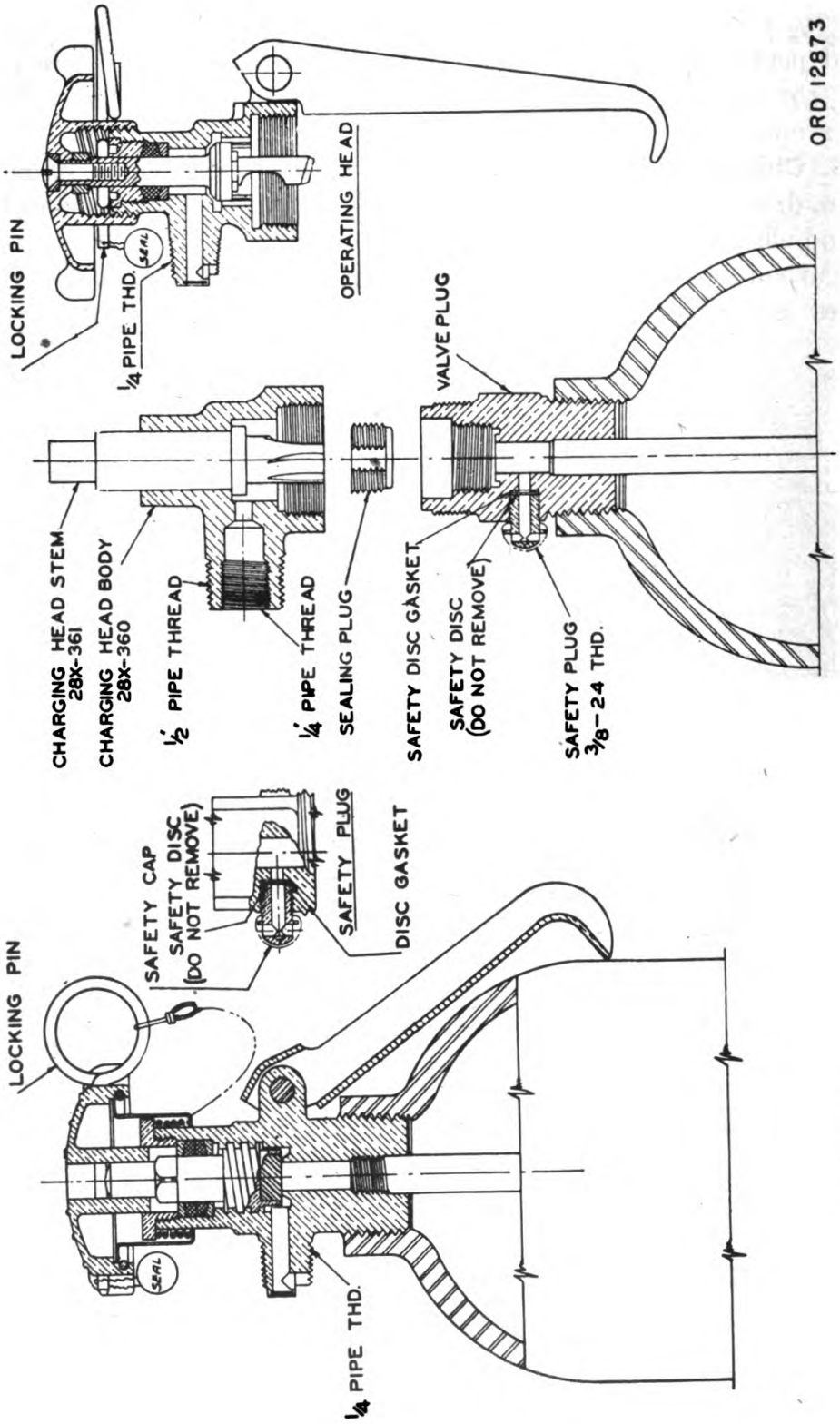


FIGURE 2.—Alfite extinguisher valves.

d. One of the most valuable properties of carbon dioxide is its high ratio of expansion, 450 to 1. When liberated, the gas is discharged by the force of its own expansion and penetrates every nook and corner, even seeking out cracks and crevices in out-of-the-way places where fire might lurk.

e. Carbon dioxide extinguishes fire by—

(1) Diluting the oxygen content of the surrounding air to a point where it will not support combustion.

(2) Cooling the burning area. The temperature of the gas is approximately 100° F. below zero at the nozzle.

f. Carbon dioxide does not deteriorate. Irrespective of how long the extinguisher remains unused after being charged, the gas is said to be just as effective as the day the cylinder was charged, provided the valves are kept tightly shut. The gas is equally effective indoors or outdoors.

104. Operation.—*a.* To operate an extinguisher with the seat type of valve, the locking pin is withdrawn and the valve is opened by turning the valve handwheel counterclockwise. With this type of valve the extinguisher may be operated and the valve permanently closed without leakage when maneuvering around a fire.

b. To operate an extinguisher with the disk type valve, the locking pin is withdrawn and the handwheel turned counterclockwise, which forces the hollow cutter down through the disk, releasing the gas. After the disk has been cut, the valve cannot again be closed permanently without leakage. By turning the handwheel clockwise, however, the valve can be closed temporarily while maneuvering around the fire.

c. Most of the 4-pound portable extinguishers carried in the light tanks and combat cars are of the disk type.

d. The correct way to use a carbon dioxide portable type fire extinguisher is shown in figure 5.

(1) The extinguisher is carried to the fire before opening the valve. If the valve is opened before reaching the fire, the gas discharged on the way is wasted. Upon reaching the fire pull the locking pin, break the seal, and open the valve by turning the valve handwheel.

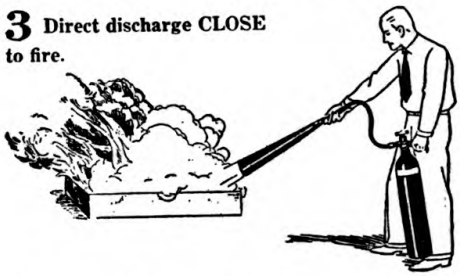
(2) Carry the extinguisher with the left hand; hold the nozzle by the rubber grip with the other hand. The extinguisher should not be allowed to stand on the ground, as this will retard maneuvering around the fire. Likewise, the nozzle should not be held near the discharge end as this keeps the discharge end too far from the fire for maximum efficiency.

The Right Way

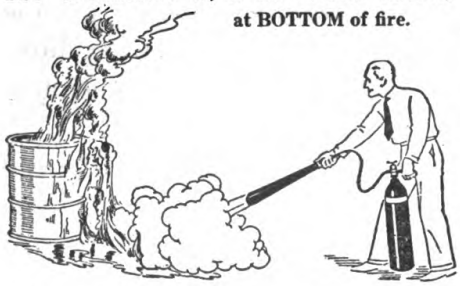
1 Carry extinguisher to fire THEN OPEN VALVE.

2 CARRY extinguisher with left hand. Hold Nozzle at HOSE END of HANDLE with other hand.

3 Direct discharge CLOSE to fire.



4 Direct discharge FIRST at EDGE NEAREST OPERATOR or, if on vertical surface, at BOTTOM of fire.



5 SLOWLY AND DELIBERATELY advance discharge as flame is extinguished. Be sure all flame is OUT in part of fire tackled before advancing.

6 Continue discharge after flames are out so as to COAT HOT MATERIAL WITH SNOW.

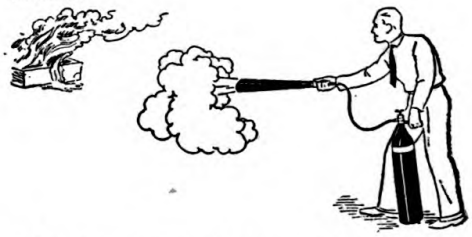
7 Have extinguisher RECHARGED AS SOON AS POSSIBLE.

The Wrong Way

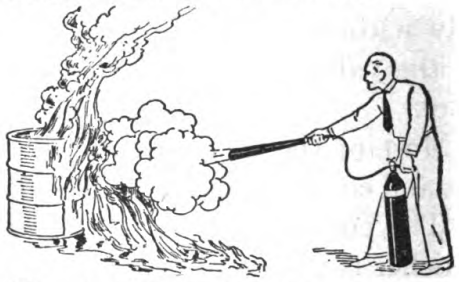
1 DON'T OPEN VALVE, BEFORE carrying extinguisher to fire.

2 DON'T stand extinguisher on the ground. DON'T hold Nozzle near Discharge End.

3 DON'T direct discharge at fire FROM FAR AWAY.



4 DON'T direct dicharge at CENTER of fire and then attempt to work to the edge.



5 DON'T HAPHAZARDLY direct discharge over various sections of fire.

Put out one portion of fire completely before attacking other parts.

6 DON'T shut off extinguisher AS SOON AS flame is put out.

7 DON'T put used extinguisher aside and FORGET about it.

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FIGURE 3.—Using portable type carbon dioxide fire extinguisher.

(3) Direct the discharge close to the fire. If discharged from far away, the carbon dioxide gas is dissipated without affecting the air immediately around the fire.

(4) Direct the discharge first at the edge of the fire nearest the operator; or, if on a vertical surface, at the bottom of the fire. Do not direct the discharge at the center of the fire and then attempt to work to the edge.

(5) Advance the discharge slowly and deliberately as the flame is extinguished, making sure that all flame is out in the part of the fire tackled before advancing. Do not direct the discharge haphazardly over various sections of the fire.

(6) Continue the discharge after the flame is out so as to coat the burned material with the carbon dioxide snow. Do not shut off the extinguisher as soon as the flame is out, as the heat may cause the fire to flame up again.

(7) A partially or fully discharged extinguisher should be replaced by a fully charged one.

e. Installation in a tank.—(1) In case of fire in the engine compartment, break the seal wire, pull out the locking pin in the handwheel of the extinguisher, and turn the handwheel to the left. This opens the valve and releases the carbon dioxide gas through the perforated tube. The system will function with the engine operating up to 1,200 rpm. It is thus possible when in action to extinguish a fire without stopping the vehicle and thereby making a fixed target for enemy fire. The vehicle should be slowed down, however, so engine speed does not exceed 1,200 rpm. If conditions will permit, the vehicle may be stopped when the fire extinguisher valve is opened.

(2) After partially or wholly discharging the extinguisher, it should be replaced as soon as possible by one fully charged.

105. Precautions.—The following precautions should be taken in handling fire extinguishers under the conditions stated:

a. All carbon dioxide fire extinguishers in service will be weighed every 4 months or whenever the seal is found broken. Personnel are warned concerning the necessity for frequent inspection of the flexible hose used with the portable carbon dioxide hand extinguisher to discover deformation and remedy leaks at the point where the hose connects to the extinguisher. Escaping gas at this connection may cause serious injury to personnel operating the extinguisher.

b. All tank and combat car personnel and those responsible for the care and maintenance of these vehicles should become accustomed to observing the extinguishers. If the seal is found broken, the extinguisher should be weighed.

c. If the weight of the charge of a cylinder is less than 3½ pounds for a 4-pound extinguisher, or 6½ pounds for a 7½-pound extinguisher, the extinguisher should be exchanged for a fully charged one. All fire extinguishers will be weighed upon receipt from the manufacturer or issuing establishment, and also upon issue to troops to insure full charges in service installations.

d. At the time of the 100-hour engine inspection of automotive equipment, or whenever the engine is removed from a vehicle, the discharge orifices in the fire extinguisher tubing thus made accessible for inspection will be blown out with compressed air to eliminate accumulated foreign matter. The necessary action also will be taken to insure the serviceable condition of the entire carbon dioxide distribution system.

106. Storage.—*a.* Charged extinguishers will preferably be stored in a cool, dry place. They may be stored in the open, but under such conditions should be protected from the extremes of weather. In winter, cylinders should be protected against accumulations of snow and ice, and in summer protected from direct rays of the sun.

b. Carbon dioxide extinguishers must never be left near furnaces, heaters, stoves, radiators, or any source of heat, as an increase in temperature causes a corresponding increase in the pressure within the cylinder which may reach dangerous proportions.

c. Temperature of extinguishers should never exceed 130° F.

d. Charged extinguishers should not be stored near gangways, elevators, or where they are in danger of being struck by moving objects.

e. If a large number of extinguishers are to be stored, the building should be well ventilated to prevent the possibility of dangerous concentrations of carbon dioxide being built up from leaky extinguishers.

f. When storing charged extinguishers, a check must be made to see that the valves are all tightened securely and the locking pins are in place and sealed.

g. Valves on empty extinguishers should be kept closed to prevent moisture or foreign material from getting into the cylinders.

h. Extinguishers in storage should be weighed once every 6 months to make certain the valves are tight and the carbon dioxide has not leaked out. If an extinguisher is found with the seal broken, it should be weighed at once. If found to be fully charged, the seal should be replaced; if not, the extinguisher should be recharged.

107. Shipment.—*a.* Before shipping carbon dioxide extinguishers, they must be packed securely in such manner that they will not be knocked over and the valves damaged.

b. If extinguishers are charged, they must be labeled with a green tag as prescribed in regulations of the Interstate Commerce Commission.

108. Recharging.—*a. Preliminary examination.*—(1) Examine all parts of the fire extinguishers and the fit of all threads for proper functioning.

(2) Check the discharging valve to see that it functions properly when the valve handle is turned.

(3) Examine the relief disk in the valve to see that it is not broken, loose, or marred in any manner. If this disk might allow the escape of gas, the disk will have to be replaced.

(4) Examine all parts of the connecting tubes and pipes of the recharging apparatus to see that they fit properly and contain no leaks.

(5) When using the pump method of recharging, examine the pump to see that it is properly lubricated.

(6) According to the Interstate Commerce Commission regulations all extinguisher cylinders must be given a 3,000-pound hydraulic test, when empty, every 5 years. Before recharging, the date of the last test, which is stamped just below the neck of the cylinder, should be checked. The month and year only are shown, for example, 8-38 would mean August 1938. If more than 5 years have elapsed since the last test, the extinguisher should be shipped to Rock Island Arsenal for test before being recharged.

b. Procedure.—(1) Carbon dioxide fire extinguishers may be recharged by the "flow" or "cooling" method. This method consists of first introducing a small charge of the carbon dioxide into the extinguisher from a 50-pound supply cylinder. This small charge is then allowed to escape into the atmosphere, thus cooling the extinguisher. After the pre-cooling operation the full charge is introduced by simple flow due to the difference of pressure and temperature.

(2) A second method of recharging carbon dioxide cylinders is pumping carbon dioxide from a main supply cylinder into the service cylinders. This method consists of attaching a motor-driven pump to the carbon dioxide supply source and to the fire extinguisher and then pumping the carbon dioxide into the service cylinder from the source of supply. This method conserves carbon dioxide and might be carried out quicker and more efficiently than the first method.

c. Pump method.—(1) *General.*—The recharging pump assembly consists of the following: a pump to transfer carbon dioxide from a commercial cylinder (50-lb. cylinder) into an extinguisher, a ¾ hp,

110-volt, 60-cycle, single-phase, a-c, motor equipped with a multi-breaker safety switch, 25 feet of electrical cord, and all necessary adapters, hose, etc., for filling commercial, syphon, and Navy type cylinders. In conjunction with the recharger pump, a warehouse type scale of 100-pound capacity graduated in ¼-pound divisions and equipped with a chain is needed to weigh the cylinders while they are being charged.

(2) *Preparation.*—(*a*) *Setting up the recharger pump.*

1. Examine the pump carefully for cracks or broken parts.

2. Turn the master gear attached to the crankshaft of the pump to be sure the mechanism turns freely. Make certain the cross head clears the packing nut.

3. Fill all oil cups with oil, engine, SAE 30. The location of these cups is indicated by numbers 1, 2, 3, 4, and 5, figure 4.

4. Be sure the available current is the same as designated on the name plate of the motor.

5. Throw the switch on and allow the pump to run 5 minutes to allow oil to lubricate the bearings.

6. The inlet and outlet of the pump are clearly marked. Attach the hose, couplings, and valves as shown in figure 5. Tighten all joints securely and do not twist the flexible hose.

7. Do not make up the coupling nut on the strainer adapter until the supply cylinder has been connected as directed in (*b*) below. The strainer adapter (6496 or 6909, fig. 5) is inserted into the inlet line to the pump to prevent dirt and foreign material from blowing into the pump and impairing the action of the valves.

(*b*) *Connecting supply cylinder to recharge pump.*

1. General.

(a) The Lux supply cylinders have a syphon tube extending to the base of the cylinder (unless otherwise specified on the cylinder) and should be used in the upright position (maximum inclination is 60° from the vertical) with the cylinder valve on top.

(b) Commercial supply cylinders without the syphon tube must be inverted so that the cylinder valve is at the bottom of the cylinder.

(c) A wooden tilt rack (fig. 6) may be used to support the inverted supply cylinder.

(d) To obtain the best results keep the supply cylinder cool and do not use a long hose between the supply cylinder and the recharger pump.

2. To connect to recharger pump.

(a) Attach the strainer adapter (6496 or 6909, fig. 9) to the supply cylinder.

(b) Attach coupling adapter (4109) by means of the coupling adapter nut (6071), making sure that the copper asbestos gasket (6139) is between the strainer adapter and the adapter pipe.

(c) Attach the ¼-inch brass nipple (6649) to the inlet of the recharger pump.

(d) Attach the ¼-inch pipe (4109) to the brass nipple by means of a flexible hose (18377).

(e) Make sure that all connections are *tight.* The flexible hose (18377) is used to facilitate easy assembling of the connections.

(*c*) *Precautions.*

1. It must be remembered that the operator is dealing with high pressure gas and before any attempt is made to recharge an extinguisher, it is imperative that the operator become familiar with the recharging method given. *Be sure that all connections are tight at all times.*

2. Do not introduce any oil or grease into the cylinder of the pump unit, nor into any of the adapters of hose connections used to convey carbon dioxide.

(*d*) *Weighing cylinders.*—A scale must be used to check the contents of the cylinder to be charged. The weight of a fully charged extinguisher may be obtained by adding the rated carbon dioxide capacity of the extinguisher to the tare weight of cylinder, valve, hose, and horn.

109. Recharging seat type cylinders by "flow" or "cooling" method.—*a.* Obtain a supply cylinder of 50-pounds capacity. Care must be exercised to insure that the dry type of carbon dioxide is used, as the presence of moisture is likely to cause freezing and consequent malfunctioning of the extinguisher. The supply cylinder should be at a temperature of at least 60° F. to obtain sufficient difference in pressure to prevent the discharge hose from freezing.

b. Determine carefully the exact weight of gas with which the extinguisher is to be filled. The weight of the empty extinguisher, and its capacity in pounds of carbon dioxide, are stamped on the side of the cylinder valve and shown on a name plate and also on a tag attached to the extinguisher.

c. Extinguishers with seat type valves, partially filled, will be recharged without first completely discharging.

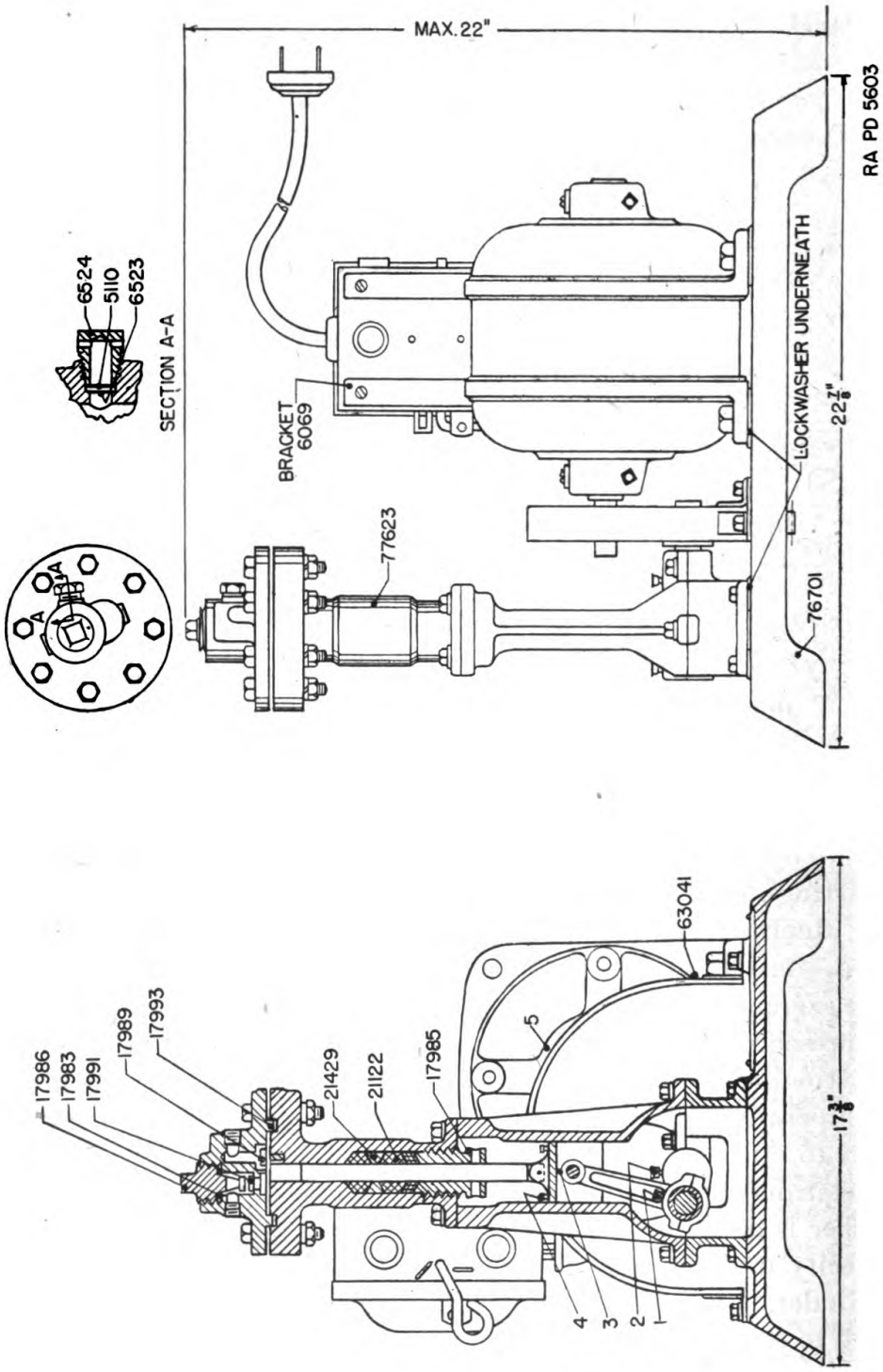

FIGURE 4.—Carbon dioxide recharging pump.

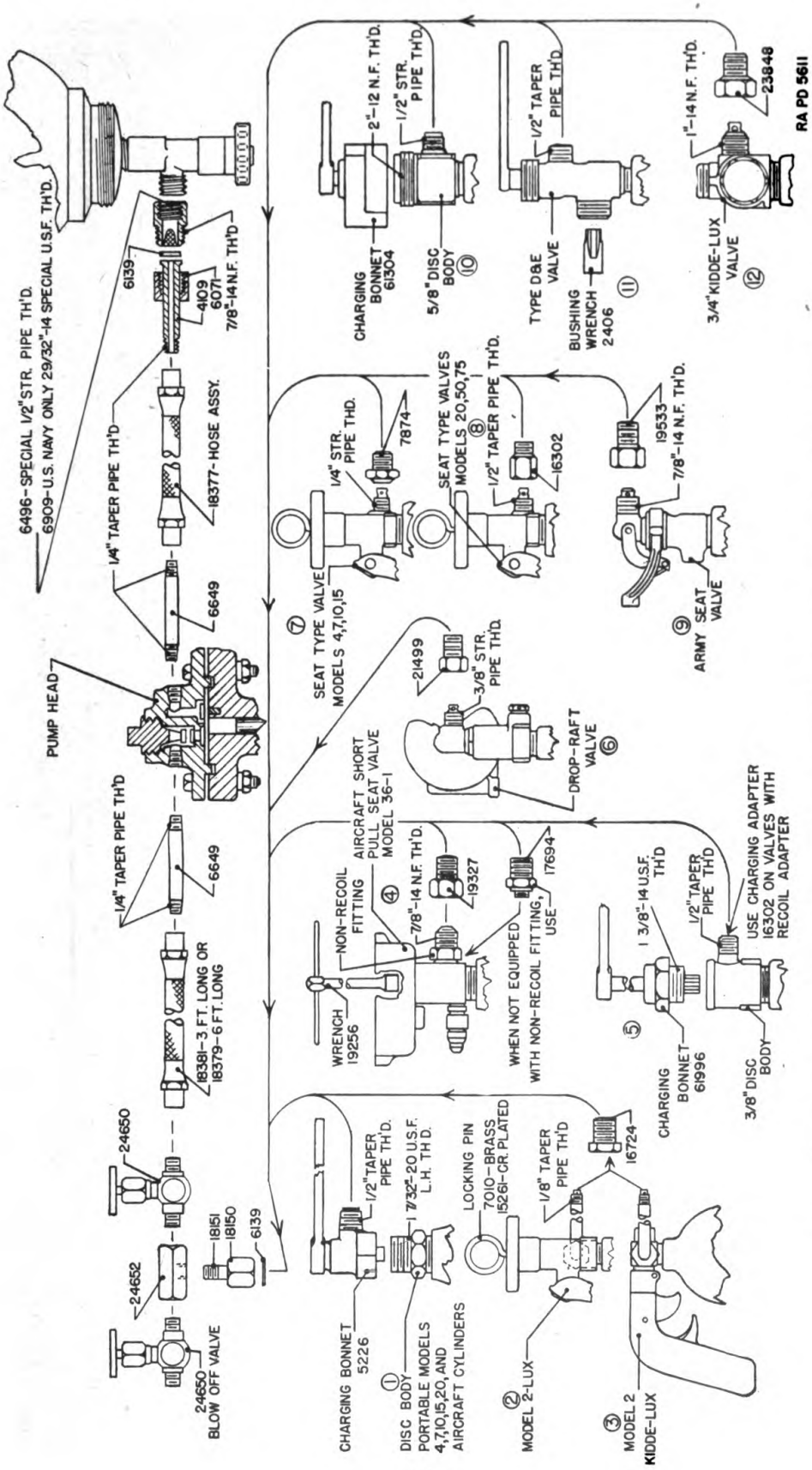

FIGURE 5.—Assembly for various types of extinguisher valves when recharging by pump method.

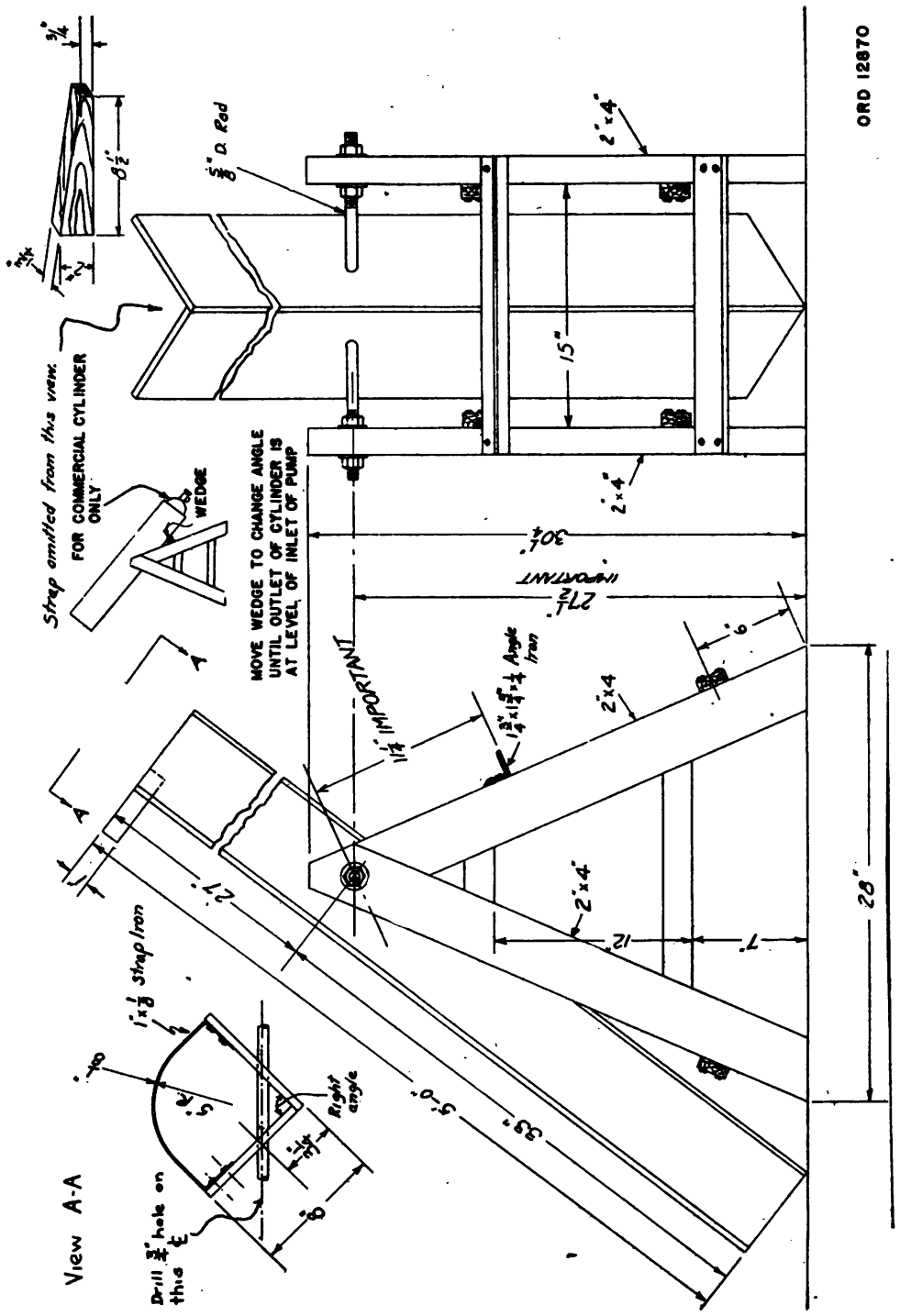

FIGURE 6.—Tilt rack.

NOTE.—Commercial supply cylinder to be inverted in tilt rack; extinguisher to be laid on scale platform with bottom end raised about 4 inches.

d. Remove the hose and nozzle from the extinguisher and attach recharging hose.

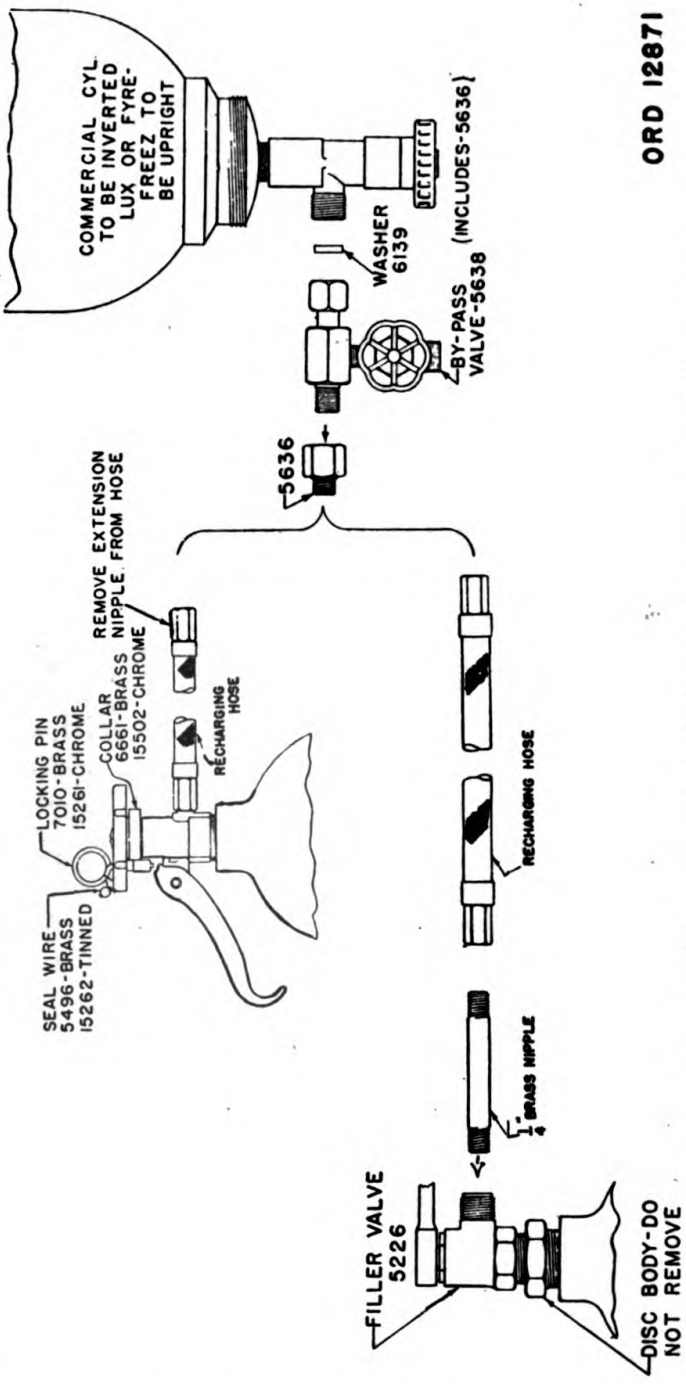

FIGURE 7.—Connections for recharging extinguishers by "flow" or "cooling" method.

e. With the supply cylinder mounted in a tilt rack (fig. 6) mount the bypass valve on the cylinder valve, care being taken to see that the packing washer is inserted, and connect the recharging hose to it as shown in figure 7.

f. Lay the extinguisher on the scales and elevate the end opposite the valve with a 4-inch block. The hose should be free so that the scales will register accurately the weight of the extinguisher.

g. Close the bypass valve and open the extinguisher valve. The valve on the supply cylinder is then opened, allowing the gas to flow into the empty extinguisher until the scales show no further increase in weight.

h. Next close the supply cylinder valve and open the bypass valve, thus allowing gas to escape into the air until the extinguisher being charged becomes coated with frost. This will amount, in weight, to about ¼ of the total charge required.

i. Close the bypass valve and open the supply cylinder valve until the extinguisher being charged contains its net rated weight of gas. If the flow is not sufficient, repeat the operations in *h* above.

Caution: During recharging, when there is pressure on the recharging hose, no one should be allowed to stand close to the hose, because if it breaks it will whip and may cause injury.

j. Close the valves on the recharged extinguisher and supply cylinder. Open the bypass valve to relieve the pressure in the hose. Close the extinguisher valve tightly but do not disconnect the charging hose until the locking pin and seal are in place.

k. Lux and C-O-Two extinguishers.—After recharging, loosen the set screw in the collar under the handwheel. Insert the locking pin and turn the collar to put tension on the handwheel locking pin. This holds the valve tightly closed. If the set screw slips back in the old recess so that tension is not placed on the locking pin, remove the handwheel from the stem and place in a new position, a quarter turn in either direction. The collar must also be turned for a new set screw location. Replace the lead seal through the locking pin to prevent tampering. The recharging hose is then removed.

l. Alfite extinguishers.—After recharging, and after the valve is tightened securely, lift the handwheel and replace the locking pin and lead seal through the hole in the locking pin. The recharging hose is then removed.

m. Check for leakage as directed in paragraph 113.

110. Recharging disk type cylinders by "flow" or "cooling" method.—To recharge a disk type extinguisher by the flow method, proceed as follows:

a. See paragraph 109*a* and *b* for the beginning of this process.

b. Open the extinguisher valve by turning the handwheel counterclockwise as far as possible to discharge any remaining gas.

c. Remove the hose and nozzle from the extinguisher valve by using the wrench on the hexagon coupling on the hose.

d. Remove the cutter head, or operating head, from the extinguisher valves (figs. 1② and 2②). Hold the extinguisher and turn the head clockwise (left hand thread). Care must be taken to use the wrench that fits the flats on the cutter head.

e. On Lux extinguishers only—remove cut-out sections of sealing disk from the cutter. If cutting edge has become dull or is damaged, the cutter must be replaced, not sharpened.

Caution: On Lux extinguishers only, be sure the sealing disk is removed, because if left in it may become wedged in the valve mechanism in such a manner as to prevent the descending cutter from striking the sealing disk a blow hard enough to cut it.

f. Inspect the safety or relief disk. If damaged, it must be replaced. This disk is inside the cutter stem of the Lux and on the side of the disk valve body on the C-O-Two and Alfite extinguishers.

g. Fit stem of filling valve or charging head in disk bushing and remove it by turning counterclockwise.

h. Insert new disk bushing and screw into disk body until it touches the valve seat.

i. Screw filling valve or charging head in disk body, making certain that the filler stem fits into the disk bushing. Raise the disk bushing from the valve seat by turning the stem counterclockwise as far as possible.

j. With the 50-pound supply cylinder mounted on the tilt rack, mount the bypass valve on the supply cylinder valve, being sure the packing washer is inserted, and connect the extinguisher to it, using the recharging hose. (See fig. 7.)

k. Fill as directed in paragraph 109 *f* to *j*, inclusive.

l. When recharged, tighten down the disk bushing very securely with wrench on the stem of the charging head.

m. Test for leakage as directed in paragraph 113.

n. After the leakage test, remove the filler valve or charging head. Before replacing the cutter head, turn the handwheel clockwise as far as possible to cause the cutter to recede. With the cutter in this position insert the locking pin. Attach the seal to the locking pin. (On Lux and C-O-Two extinguishers, the seal wire is passed through the locking pin and the hole in the handwheel. On Alfite extinguishers the seal wire is passed through the end of the locking pin only.) The cutter head is then screwed on the disk body.

o. Reassemble the hose and nozzle on the extinguisher.

p. Enter the date and the weight of extinguisher on the record card.

111. Operating recharging pump.—*a. Connecting extinguisher to the recharger pump.*—(1) Insert the ¼-inch brass nipple (6649) in the discharge outlet of the charge pump.

(2) Connect the flexible hose (18381 or 18379) to the brass nipple (6649).

(3) Connect the shut-off valve (24650) to the flexible hose.

(4) Connect the connector (24652) to the shut-off valve.

(5) Connect the blow-off valve (24650) to the connector.

(6) To the connector (24652) attach the coupling (18151) to which the fire extinguisher will be attached.

b. To assemble extinguisher fitted with disk type cutter valve to pump (valve No. 1, fig. 5).

(1) Open valve on extinguisher fully to discharge residual contents. It is desirable to have hose and horn attached while doing this.

(2) Remove hose and horn.

(3) Remove valve bonnet. Examine cutter to be sure it is not damaged. If cutter is damaged, do not attempt to repair it—replace it. Remove piece of old cut sealing disk which has lodged in cutter tubing.

(4) Fit recharging bonnet No. 5226 into disk bushing and remove bushing by turning recharging bonnet stem.

(5) Insert new disk bushing assembly and screw bushing down on seat *loosely*.

(6) Replace recharging bonnet stem in recharging bonnet.

(7) Assemble recharging bonnet on cylinder valve body, first being sure that the flutes of the recharging bonnet stem fit into the corresponding recesses of disk bushing assembly. The thread on the bonnet is left hand. Tighten recharging bonnet securely on cylinder.

(8) Make up coupling nut (18150) on outlet of recharging bonnet.

(9) Back off the disk bushing assembly from the seat two full turns by turning the stem of the recharging bonnet with the wrench provided. *Make certain blow-off valve is in its closed position.*

c. To assemble extinguisher fitted with seat type valve (valves Nos. 2, 4, or 9, fig. 5) to the pump.

(1) The seat type cylinder may be empty or partially charged. *It is not necessary to discharge the residual contents of these cylinders.*

(2) Remove hose and horn.

(3) Make up proper adapter onto seat type valve as shown in figure 5.

(4) Make up coupling nut (18150) to the other thread of the adapter used in (3) above. Use washer (6139) between these two items.

(5) Remove valve locking pin from valve handwheel and open valve fully.

(6) Make certain blow-off valve is in its closed position.

d. Operation of pump.—(1) *Make certain the blow-off valve is in its closed position and that shut-off valve and valve at cylinder to be recharged are open.*

(2) Start the recharging pump.

(3) Open valve on supply cylinder as wide as possible. Keep constant check on weight of cylinder being recharged.

(4) When weight has been reached at which cylinder is fully charged, stop the motor by means of the switch.

(5) Close shut-off valve tightly.

(6) Close valve (seat type valve) or tighten down disk bushing (disk type valve) on cylinder which has been recharged.

(7) If it is desired to recharge other cylinders, the valve on the supply cylinder may be left open.

(8) When unit is not in use, the valve on the supply cylinder should be closed.

(9) The pressure in the recharging pump and connections may be relieved by opening the shut-off valve.

NOTE.—The cooler the supply cylinder is at the start, the easier it is to transfer. If the supply cylinder contains a low percentage of its rated capacity, it may be found difficult to recharge a cylinder completely from it. In this case a fully charged supply cylinder should be used to put the last few pounds into the cylinder to be recharged, and the slightly charged supply cylinder should be used in starting the recharging of a cylinder which is empty. In this way, little gas is lost in the recharging process. If, during the recharging process, the extinguisher cylinder ceases to gain in weight, there may be one of two things wrong:

(*a*) The supply cylinder may contain less than 10 pounds of carbon dioxide. In this case a fully charged supply cylinder should be used, and the partially charged cylinder reserved to start the recharging of an empty cylinder.

(*b*) The connecting lines may have become stopped up with carbon dioxide snow. In this case the motor should be shut down, the disk assembly (disk type valve) or the extinguisher valve (seat type valve) should be securely closed, and the supply cylinder valve shut off. The hose connections should be "broken" and these connections cleared of the carbon dioxide snow. After these lines are clear, the cylinders may be reconnected and the charging process continued. The causes of this stoppage are water in the supply cylinder or too small a valve passage (less than ⅛-inch) in the supply cylinder.

112. After extinguisher has been charged by pump method.—*a. Disk type valve extinguishers.*—(1) Place the extinguishers in a pipe vise and tighten disk bushing securely, using stem and wrench of recharging bonnet. Use a firm, steady pull on wrench. *Do not* jerk on it or hit it with a hammer.

(2) Remove recharging bonnet.

(3) If any leaks develop, tighten down on disk bushing more securely. Test for leakage as outlined in paragraph 113.

(4) Do not permit any cylinder to be issued until a careful test shows no leaks.

(5) Turn handwheel clockwise as far as possible, so as to draw cutter into bonnet assembly. When assembling, be sure *not* to rotate handwheel in direction of arrow on handwheel, as this will cause the release of gas. Reinstall bonnet assembly, using a 10-inch wrench and pulling *hard*.

(6) To prevent tampering with the handwheel, pass standard lead seal wire through hole in handwheel and hole in lug opposite hose connection. Secure with lead seal. Be sure to use copper wire no heavier than standard lead seal wire.

(7) Reassemble extension handle on extension nipple and then horn on extension nipple.

(8) Reattach hose and horn to safety plug outlet of bonnet assembly.

(9) Record weight of extinguisher on cylinder record card.

b. Seat type valve extinguishers.—(1) Close valve on recharged seat type cylinder as tightly as possible.

(2) Insert valve locking pin through hole in handwheel and valve yoke. If hole in yoke does not correspond exactly with one in handwheel, loosen set screw in valve yoke and rotate yoke until holes match; then tighten set screw and insert valve locking pin.

(3) Test for leakage as outlined in paragraph 113. If any leaks develop, close valve more securely, at the same time resetting valve locking pin and yoke; then retest.

(4) Do not permit any cylinder to be issued until careful tests show no leakage.

(5) Tie valve locking pin to handwheel, using lead seal wire.

(6) Reinstall horn and hose on to seat type valve and tighten securely.

(7) Put date and cylinder weight on cylinder record card.

113. Test for leaks.—After recharging, test the fire extinguishers as follows:

a. Submerge the extinguisher valve in water. During the test no hose or charging apparatus should be attached to the valve.

b. Allow the extinguisher to stand for 5 minutes and look for bubbles caused by escaping gas.

c. If leaks develop, tighten the valve as described in preceding paragraphs.

d. No extinguishers should be stored nor issued until careful tests show there are no leaks.

e. Allow all water to drain from valves.

114. Maintenance of recharger pump.—*a. Lubrication.*—The recharging pump should be oiled regularly, depending upon the use given the unit. The location of lubricating points are shown by numbers 1, 2, 3, 4, and 5, figure 4. Use oil, engine, SAE 30, at all points. The plunger packing requires *no oil.*

b. Plunger packing.—If a leak should develop at the lower end of plunger, tighten up on plunger guide (17985) with the rod supplied (3/8 inch by 6 inches, approximately). Do not bind plunger by pulling up too snugly. When it is no longer possible to pull up on plunger guide, new packing should be inserted as follows:

(1) Remove the compressor body from the frame by unscrewing the four bolts which hold the compressor body to the cross head guide, and remove pin which holds plunger to cross head.

(2) Place the compressor body in a vise, remove plunger guide (17985) and old packing. Insert only the two large pieces of packing and the spacer (21429). Then insert the plunger guide and turn down as far as possible to compress and form the packing around plunger. This operation will undoubtedly cause the plunger to bind, but it can be easily freed by turning and working plunger up and down a few times.

(3) Remove the plunger guide and insert the small ring of packing. Install so that the bevel fits the plunger guide and the packing already in place. Replace the plunger guide and pull up until the maximum dimension between the body and end of plunger guide is 1 3/16 inches; otherwise the cross head will strike the plunger guide. The plunger should be freed by working back and forth several times.

(4) Replace the compressor body on the cross head guide, lining it up with the plunger before tightening bolts securely. Turn master gear several revolutions by hand to be sure the cross head does not strike plunger guide.

c. Cleaning.—(1) The connections to the recharging pump should be kept free from foreign matter at all times.

(2) If a decrease is noted in the amount of carbon dioxide transferred (should be approximately 80 percent of supply cylinder), remove the check valves in compressor head and clean them. To do this, remove the eight bolts from the top of the compressor body and lift off the discharge head; the inlet check valve (17989) is then accessible. The outlet check valve can be removed by unscrewing the plug (17986). Clean both checks and seat thoroughly. When replacing checks, use new gaskets (17983 and 17993). Tighten securely all head bolts and outlet plug.

d. Strainer.—The strainer in the inlet line should be cleaned frequently for maximum efficiency of the unit.

e. Tightening.—It is advisable to tighten all bolts on the discharge head, compressor head, and frame, which may become loose from vibration.

115. Parts and equipment.—*a.* The following parts and equipment are necessary for recharging fire extinguisher:

Description	Part number			Interchangeable
	Lux	C-O-Two	Alfite	
Equipment				
50-pound supply cylinder of carbon dioxide	-------	----------	----------	
Platform scales	-------	----------	----------	
Tilt rack	-------	----------	----------	
Recharging hose [1]	-------	----------	----------	Yes.
Bypass valve	5638	5638	----------	Yes.
Bypass valve asbestos washer	6139	6139	----------	Yes.
Filler valve or charging head [2]	5226	PFBA	28×1240	Yes.
Necessary parts for recharging				
Seat disk bushing [2]	5023	PSD	28×1337	Yes.
Wire seal	12562	PLS	28×68	Yes.
Possible replacement parts necessary				
Safety disk and washer	2048	PSNWN	28×481 2CD–576	No.
Safety cap	None	None	28×389	No.
Secondary safety disk [2]	5110	None	None	No.
Extinguisher hose	18377	PH–18	28×1309	Yes.
Locking pin	15261	PP	28×344	Lux and C-O-Two.

[1] The hose from the extinguisher may be used if necessary but this necessitates disconnecting the discharge nozzle. It is better to remove the hose and nozzle assembly intact and use a recharging hose or spare extinguisher hose for recharging.

[2] These parts used when recharging disk valve type extinguishers only.

b. Nomenclature of parts as shown in figures 4 and 5.

913 Stem wrench.
2406 Bushing wrench.
4021 Recharging bonnet stem.

4109 Coupling adapter.
5110 Safety disk and washer assembly.
5226 Charging bonnet complete—packed type.
6071 Coupling adapter nut.
6139 Copper asbestos washer.
6496 Strainer adapter.
6523 Safety disk washer.
6524 Recoil plug.
6649 ¼-inch I. P. S. nipple—X. H. brass.
6909 Special U. S. N. strainer adapter.
7010 Locking pin—brass.
7874 Adapter ¼-inch I. P. S. female, ½-inch I. P. S. male.
15261 Locking pin—chrome.
16302 Adapter—½-inch I. P. S. female, ½-inch I. P. S. male thread.
16724 Adapter—⅛-inch I. P. S. female, ½-inch I. P. S. male.
17693 Adapter—½-inch—20 N. F. and ½-inch I. P. S.—both male.
17983 Discharge valve washer.
17985 Plunger guide.
17986 Discharge valve cap (plug).
17989 Inlet valve assembly.
17991 Discharge valve assembly.
17993 Gasket—compressor head.
18150 Coupling nut.
18151 Nipple.
18379 Flexible hose—6 feet long.
18381 Flexible hose—3 feet long.
19256 Wrench—Short pull seat valve.
19327 Adapter—⅞-inch–14 N. F. female, ½-inch I. P. S. male.
19533 Adapter—⅞-inch–14 N. F. female, ½-inch I. P. S. male.
21122 Packing.
21429 Packing spacer.
21499 Adapter—⅜-inch I. P. S. female, ½-inch I. P. S. male.
23848 Adapter—1-inch–14 N. F. female, ½-inch I. P. S. male.
24650 Shut-off valve and blow-off valve.
24652 Connector.
61304 Charging bonnet—⅝-inch disk body.
61996 Charging bonnet—⅜-inch disk body.

SECTION IX

MISCELLANEOUS

116. Brush.—*a. Mottling, No. 2 (7/8 inch).*—(1) *Characteristics.*—The bristles project about 1 inch from furrule and the over-all length of brush is about 5¼ inches.

(2) *Use.*—Used for cleaning sights, position finders, and the like.

b. Artist's, camel's-hair, round, No. 1.—(1) *Characteristics.*—Small end of ferrule about 3/16 inch in diameter.

(2) *Use.*—(*a*) Cleaning and brushing the lenses of optical instruments.

(*b*) Painting around oil holes.

(*c*) Lacquering small surfaces.

(*d*) Brushes used on optical instruments must be used for that purpose only. In no event should a brush that has previously been used for painting or lacquering be used on optics.

117. Chalk.—*a. White, railroad, 1 inch by 4 inches.*—Used for general marking purposes, sight lines, etc.

b. Blue, railroad, 1 inch by 4 inches.—Used for marking purposes to distinguish from previous white chalk marking, or on surfaces on which white chalk marks are not plainly seen.

c. White marking, lump.—Used in shop to cover surfaces preparatory to laying out dimensions, and for general temporary marking purposes.

118. Compound.—*a. Antiseize, mica base.*—(1) *Container.*—1-pound and 5-pound cans.

(2) *Use.*—Used on some threaded fittings in automotive and aeronautical engine assemblies. A typical application is on spark-plug threads or radial aviation-type engines and similar units to prevent corrosion, sticking, and to facilitate disassembly.

b. Antiseize, white lead base (for threaded fittings of seacoast guns, etc.).—(1) *Container.*—1-pound can.

(2) *Use.*—(*a*) Used in same manner and for purposes similar to those outlined in *a* above.

(*b*) Lubricates threads during assembly, protects against corrosion, and tends to form an airtight and easily disassembled unit.

(*c*) It can be used to advantage on bolts and similar threaded parts of seacoast guns that are exposed to severe weathering conditions and its use is recommended on aluminum or aluminum-alloy threaded parts, threaded steel parts under considerable strain, and on threaded parts subject to frequent adjustment.

(*d*) The compound should be stirred well before being applied and should not be applied in excessive quantities. Application should be made on male fittings only.

119. Dressing, belt.—Used to increase the adhesion of a machine belt to its pulleys.

120. Ethylene glycol.—*a. Characteristics.*—(1) A heavy, oily, colorless liquid.

(2) Mixes with water and alcohol in all proportions.

b. Use.—(1) Main use is as an antifreeze in water-cooled machine guns and in radiators of automotive equipment.

(2) Solutions of water and ethylene glycol will be used in jackets of machine guns where arctic temperatures prevail. It is satisfactory for temperatures as low as −60° F. It is highly important that the proper proportions of ethylene glycol and water be maintained.

(3) The lowest temperature at which ethylene glycol water solution can be used is −62° F. The proportions to be used at this temperature are 60 percent by volume of ethylene glycol and 40 percent by volume of water. Any change in this proportion will result in raising the freezing point of the solution.

(4) In lieu of ethylene glycol it will be satisfactory, in cases of emergency only, to use oil, engine, SAE 10, or even drained crankcase oil of similar viscosity in jackets of machine guns. This latter should be strained through a piece of muslin before it is used.

(5) The use of ethylene glycol as an antifreeze agent in automotive equipment is described in Technical Manuals and OFSB's.

121. Flask, Florence.—*a. Characteristics.*—One liter capacity. A thin glass flask containing a round body and a tubular neck.

b. Use.—These flasks are used as containers of material for forming water targets used in connection with aircraft bombing practice. The flask filled with the proper material is dropped from the bomber. When it strikes the water the flask breaks, and the material spreads out over a large area, thus forming a suitable target for bombing practice.

122. Knife, putty.—Used to force putty into cracks and crevices preparatory to painting. It is also used to scrape off old paint.

123. Needle, sacking.—This is a heavy needle about 5 inches long with a wide eye for twine. The needle is used for sewing burlap on sponges during the cleaning of bores of cannon.

124. Palm, sailmaker's.—Used to protect the hand when using the needle, sacking.

125. Paint, blue marking, semi-paste.—This consists of Prussian blue pigment in oil. It is used as a marking material in the operation of fitting bearings, etc.

126. Paper, litmus.—*a. Characteristics.*—(1) This is a paper impregnated with an organic dye called litmus. The coloring matter of litmus is pink and its alkaline salts are blue.

(2) Paper, litmus, may, therefore, be pink or blue, depending upon the acidity or alkalinity of the medium surrounding it.

b. Use.—(1) Paper, litmus, is used to test solutions to note whether they are acid, alkaline, or neutral.

(2) If blue litmus paper is put into an alkaline solution the paper will remain blue; if put into a neutral solution it will remain blue; if put into an acid solution it will turn pink.

(3) If pink litmus paper is put into an acid solution it will remain pink; if put into a neutral solution it will remain pink; if put into an alkaline solution it will turn blue.

(4) Paper, litmus, will be used mainly in testing the alkalinity of glycerin-water recoil fluid used in recoil mechanisms. This solution should be alkaline if made properly, therefore, it will turn pink litmus paper to a blue color. Failure to have the glycerin-water fluid alkaline will result in extreme corrosion of the recoil mechanism. However, excessive alkalinity will result in destruction of leather or packings used in the mechanism.

127. Potassium, cyanide of.—*a. Characteristics.*—(1) A powdered, white or brown tinged powder.

(2) This substance is extremely poisonous.

(3) It is hygroscopic and may take up enough moisture to become partially liquefied if allowed to stand in open containers.

(4) This material gives off a deadly gas, hydrogen cyanide, when in contact with any acid.

b. Method of handling.—(1) Keep the container tightly covered at all times when not in use.

(2) Every precaution should be taken to keep the material clean, dry, and away from all acids or other chemicals.

(3) Extreme care will be taken when using, handling, and storing this material. It will be used only by personnel familiar with its use and authorized to use it.

c. Use.—(1) Used in the case-hardening of steel parts.

(2) The metal part is heated to a bright red and the part to be hardened immersed in or rubbed with the cyanide, which melts at contact with the hot metal. Carbon is released from the chemical and enters the iron, forming a thin layer of carbon steel on the surface which hardens when quenched in water.

(3) Parts to be treated in this manner should first be washed thoroughly to insure removal of any acid substance which might be upon them.

128. Stopper, rubber.—Used to close the chambers of small arms and machine guns during use of the metal-fouling solution.

129. Tubing, rubber, 2-inch section.—Used on the muzzle end of small arms and machine gun barrels to retain the metal-fouling solution during cleaning.

130. Twine, jute.—Used for sewing burlap covering on the sponges used for cleaning bores of cannon.

APPENDIX

LIST OF REFERENCES

1. Standard Nomenclature Lists.—*a. Cleaning and preserving.*

Cleaning, preserving, and lubricating materials	SNL K–1.
Soldering, brazing, and welding material	SNL K–2.

b. OPSI.—Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" ..... OPSI.

2. Explanatory publications.—*a. Lubrication.*

Automotive lubrication	TM 10–540.
Lubrication instructions	OFSB, 6-series.
War Department Lubrication Guides.	

b. Chemical attack.

Decontamination	TC 38, 1941.
Defense against chemical attack	FM 21–40.
Military chemistry and chemical agents	TM 3–215.

c. Maintenance.

Maintenance of matériel	OFSB, 4-series.
Motor transport	FM 25–10
Motor transport inspections	TM 10–545.
Ordnance maintenance procedure—matériel inspection and repair	TM 9–1100.
Precautions in handling gasoline	AR 850–20.
Preservation and care of seacoast defense matériel	TM 4–245.
Storage of motor vehicle equipment	AR 850–18.

d. Welding.

Electric and oxyacetylene welding	OFSB 5–2.
The blacksmith and the welder	TM 10–440.
Welding	TM 1–430.

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(For explanation of symbols see FM 21–6.)

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