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NAVAL SHIPS TECHNICAL MANUAL

CHAPTER 9930

FIRE FIGHTING — SHIP

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4. Gasoline fuel gives off copious amounts of flammable vapors from its surface at ordinary temperatures in summer and in winter. These vapors can be easily ignited by sparks or other flames and burn rapidly. If gasoline is contained in a tank with an air space above it which is suitably vented, the gasoline vapor will quickly replace the air and give a vapor-filled space which is too rich to burn; i.e., the low propertion of air to fuel vapor is not capable of combustion. However, if the contents of the gasoline tank are drained and air comes into the vapor space during the operation, it may be easily ignited and an explosion can take place.

5. Gasoline vapors (or fumes) are heavier than air and will seek a low level in which to collect. The shipboard fire fighter must be particularly careful to avoid leakage of gasoline fuel vapor into lower spaces or compartments in the ship. Thorough spark-proof ventilation is necessary if this should occur.

Jet fuels of the JP-4 type are somewhat different than gasoline but are no less dangerous. JP-4 fuel gives off flammable and explosive vapors at a slower rate than gasoline at ordinary temperatures. This property means that in a tank of JP-4 fuel the vapor space above the liquid will be almost always capable of explosion or ignition.

6. Fires in gasoline and JP-4 fuel can be extinguished only by smothering methods, either of the temporary or permanent type. If temporary smothering agents are used, the flammable vapors, which continue to evolve from these fuels at ordinary temperatures, can be easily reignited and the fire begins all over again. Permanent smothering should be utilized to avoid reignition. Since water does not mix with these fuels, nor does it stop evolution of flammable vapors, it will not extinguish these fires, and in fact, water alone usually causes flammable fuel fires to spread dangerously.

7. JP-5 jet fuel is less dangerous at ordinary temperature than gasoline or JP-4 in that it does not give off copious flammable vapors. It is very similar to kerosene in this respect. However, the fire fighter must remember that it burns very easily on the surface of absorbent materials like mattresses or cloth where a "wicking" action takes place like it does in a kerosene lantern. When JP-5 fuel gets hot, it begins to act like gasoline or JP-4 fuel and gives off copious flammable vapors which can be easily ignited.

8. Diesel fuel is very similar to JP-5 in its flammability characteristics. It is relatively safe unless it is heated or sprayed on a hot surface like a hot metal bulkhead.

9. Fires in JP-5 jet fuels and diesel fuels cannot be extinguished by cooling with fine sprays of water and they also must be smothered. However, temporary smothering agents do not cool and stop evolution of flammable vapors and the hot fuel can be quickly reignited unless a permanent smothering agent is used. Water sprays used with a temporary smothering agent, such as dry chemical, will also cool and extinguish these fires.

10. Fuel oils used for steam boilers are even less flammable than other flammable fuels aboard ship. To constitute a fire hazard they have to be heated to a high temperature and sprayed out from a nozzle or similar device. However, the fire fighter must take into account that, once they start to burn in any depth, they have a characteristic of self-heating. This means that they conduct heat from the flames on their top surface down through the unburned liquid and the whole liquid mass must be cooled with water in order to halt further evolution of flammable vapors and flames. Fires in so-called propulsion fuel oils may be extinguished and cooled with water so that they stop giving off flammable vapors or they may be extinguished by smothering with permanent smothering agents. If they are temporarily smothered without cooling, they sometimes may be reignited like gasoline.

11. Fires in electrical insulation or plastic materials in electric motors or electronic equipment are called **"Class C"** fires because of the added factor of electric current in the fire situation. They must be especially dealt with to avoid electrical shock to the fire fighter and unnecessary damage to expensive electric equipment. The fuels in such fires often consist of both Class A fuels (paper, cloth and plastic insulation) and Class B fuels (transformer oils which have become heated), but unless all electricity has been shut off and the fire has become so large that damage is no longer a factor, these fires must be extinguished with a non-conducting medium such as a flame smothering gas. For complete safety, fires in electrical equipment should be fought only after all current to the equipment has been shut off; this usually halts the flow of heat to the fuel and it can readily be extinguished.

12. Magnesium metal is a combustible **(Class D)** fuel aboard ship if it becomes heated to a high temperature. This fuel burns with a dazzling white flame of very high temperature. At this temperature it reacts chemically in the white flame area with ordinary extinguishing agents such as water, and special methods have been devised to cope with it. These will be dealt with later. In general, magnesium metal fires are extinguished only by smothering with dry sand, or by a cooling action using large amounts of water from a safe distance, or by spraying water on the unburned metal behind the flame, so that its temperature is lowered and burning can no longer continue.

9930.16 THE HEAT OR TEMPERATURE

1. Another component of the Fire Triangle which must be present in order to have fire or combustion is **HEAT**, which is closely related to **TEMPERATURE.**

2. Since all fires are chemical reactions and temperature plays and important part in all chemical reactions and the rate at which they proceed, we need to learn about this important element of fire.

3. All flames in fires consist of rapidly burning gasses and all combustible substances must be heated to a certain temperature required by that material to cause flammable gases to be evolved where they can be ignited by a spark or another flame. The temperature at which this process can begin is very important to the fire fighter because it denotes the point at which materials "catch fire" and is one measure of the hazard of a material toward fire.

4. In general, **Class A fuels** like wood, paper, rags and upholstery, have to be raised to a relatively high temperature before they can be ignited with a flame or spark. The ignition temperature for wood, for instance, is about 400^{o}F. and since most Class A fuels reach this temperature relatively slowly they are considered less hazardous than other combustible substances. The fire fighter must remember however, that if Class A fuels (or any solid fuel, for that matter) are cut up into small pieces, (like wood shavings or shredded paper) their increased surface area when exposed to a heat or flame source will bring them to

their ignition temperature very rapidly and they become a hazardous fuel.

5. **Class B flammable liquids** vary in their tendency to ignite in proportion to their vaporizing qualities. The temperature at which these fuels become a fire hazard is called their **flash point**. The flash point for gasoline and JP-4 is below ordinary room and weather temperatures; i.e., minus 40°F. Hence these fuels can be readily ignited because flammable vapors are continually being evolved from their surface. Thus we can see that flames can be ignited from the air-exposed surface of gasoline or JP-4 fuel at any temperature above minus 40°F.

6. Diesel fuel and JP-5 jet fuel must be raised above ordinary room temperatures before they give off vapors which can be ignited. Their flash points are 140°F. The fire fighter must remember that decks and adjacent storage areas often reach 130°F. to 150°F. when exposed to sunshine in the summer or in the tropics.

7. Navy Special propulsion fuel oil (or Bunker (black) fuel) begins to give off small amounts of alammable vapors at 150°F. and above this temperature it gets more and more dangerous.

8. **Class C fuels,** since they may consist of burning Class A or Class B fuels, have similar hazardous properties with the addition of heat. The heat in this case usually comes from abnormal electrical heating which brings the fuel (insulation or transformer oil etc.) to its temperature capable of ignition.

9. Magnesium metal alloy or **Class D fuel** does not ignite in air until high temperatures are reached, about 180°F. When enough heat has been supplied to this metal from the burning of gasoline, jet fuel, or a welding torch, it will ignite in air and burn with a dazzling hot flame which has a temperature of above 4000°F.

10. **Self-ignition and spontaneous ignition** in ordinary fuels takes place at much higher temperatures than the ignition temperature or the flash point, (where flame is initiated by a spark or another flame). Self-ignition of Class A fuels can occur from about 450°F, and up, depending on the material.

11. Spontaneous ignition occurs in Class A fuels such as rags or fibrous materials saturated with animal or vegetable fats and applied paint, if these materials are confined in a space with little air circulation to take away the heat they can develop while "drying" (oxidizing) in air. Such fatty (non-petroleum) materials liberate heat as they dry or oxidize to a skin-like substance. (Like linseed oil paints "dry".) Adequate ventilation or cooling can remove this possibility.

12. **Static electricity** is a source of ignition or heat which the fire fighter must guard against. When fuels (both Class A and Class B) or non-conducting materials are moved and friction is developed, static electricity is also developed. If this static charge cannot escape or "leak off" it will build up to a point where it can spark and ignite a vaporizable fuel such as gasoline or jet fuel. JP-4 jet fuel is especially notable for building up static charges within the body of the liquid when it is pumped or poured. Since this fuel also produces easily explodable mixtures, and chance of accumulation of static electrical charges should be avoided by metallic contact or grounding of all tanks and hose nozzles, etc., used with the fuel. Wire clip electrical connections to metallic parts of the ship must be used at all times with this fuel, thus grounding any aircraft, nozzles, or tanks and allowing escape of electrical charges before static sparks may develop.

13. The **transmission of heat** occurs in three ways: by radiation, by conduction, and by convection.

14. In **radiation,** heat is distributed in all directions and no medium is required. It is this radiation which causes the feeling of heat when standing before an open fire. In **conduction,** heat is transferred through a substance by direct contact. Thus, a thick steel bulkhead with a fire on one side causes heat to be given off in adjoining compartments through conduction by the steel. In **convection,** the heated air and gases rise from a fire bringing heat to all other combustible substances within reach. This process is particularly applicable to ventilation systems aboard ships which may carry the heated gases to places far removed from the fire.

15. Obviously, the removal of heat is best carried out by the use of water and water sprays, by water-containing foam, and also by ventilating to outside (cooler) areas.

9930.17 THE OXYGEN OR AIR

1. Since all combustion of fuels requires air or oxygen to proceed (except in the case of certain liquid or solid propellants, explosives and pyrotechnics) the fire fighter must know the characteristics of this component of the fire triangle in order to control and extinguish fires aboard ship.

2. Although it may sometimes be a difficult task to accomplish, the control by dilution or cutting off of the air or oxygen supply to a fire and flame is the principal method of extinguishment utilizing this element of the fire triangle.

3. Air consists of 21 percent oxygen and this is enough to cause combustible substances to burn or unite with oxygen at a rapid rate. If this amount of oxygen is increased in some manner by evaporation of nearby liquid oxygen supplies, or escape of oxygen from high pressure tanks, the rate of burning of a fire increases many-fold and more heat is evolved. If for some reason, the oxygen percentage is decreased, (slow burning of combustibles in a closed space will do this) all flames will diminish and go out. However, in the case of Class A combustibles, burning at a very slow rate—called glowing or smoldering—can continue indefinitely when only 6 percent oxygen is present in the space.

4. When air is mixed with combustible vapors or dust in the correct amounts in a closed space, it is capable of exploding if ignited with a spark or flame. Such explosions are exceedingly fast burning reactions. Combustible vapors and smokes or dusts do not require specific air-to-combustible mixtures to generate explosions. For instance, gasoline-air mixtures will explode when the vapor to air ratio reaches 1.4 percent gasoline vapor mixed with 98.6 percent air (by volume). All mixtures up to 6 percent gasoline mixed with 94 percent air will also explode. Above 6 percent gasoline, the mixture will not explode or even burn; it is then said to be "too rich to burn", (i.e., there isn't enough oxygen present to unite completely with the fuel vapor). Other ordinary fuel vapors also demonstrate this characteristic. Some smokes and dusts however, can explode with much lesser amounts of oxygen present, even if the air is diluted with an inert gas, such as carbon

NAVAL SHIPS TECHNICAL MANUAL

CHAPTER 9930 – FIRE FIGHTING – SHIP

September, 1967 Edition

CONTENTS

SECTION I FIRE, FIRE FIGHTING AGENTS AND FIRE FIGHTING EQUIPMENT

SUBSECTION A GENERAL CONSIDERATIONS

9930.1 FIRE PREVENTION

1. Many ships have been lost by fire. Experience has indicated that steel ships can become floating furnaces, fed by the combustible and flammable materials carried on board. Some ships have become blazing infernos which had to be abandoned and later sunk by our own forces because fires got out of control and prevented the effective application of damage-control actions. The prevention, as well as the fighting of fires, has proved essential in the survival of a ship in combat. Efforts must be continually made to reduce the damage resulting from fire by allowing a minimum of hazards to exist.

2. There are four basic principles which must be observed in reducing ship fire hazards:

a. Stow and protect all combustibles.

b. Make regular and frequent inspections.

c. Educate all personnel in the reductions of fire hazards.

d. Enforce fire prevention policies and practices.

3. Ship habitability and other programs must thoroughly consider all probabilities of the items creating unnecessary and unwarranted fire hazards from the use and installation of unathorized and non-approved combustible or flammable materials and coatings. The Commanding Officer must ensure that the installation or application of unauthorized or non-approved woods, plastics, fibrous materials, paints, coatings, tile and adhesives, paneling, "false" bulkheads or overheads does not occur in his ship. Any installation or application of non-regulation or unapproved materials which may have, are now, or which may be considered, must be reported or submitted to the Naval Ship Systems Command and possible approval. Otherwise, the Commanding Officer must assume the responsibility for permitting a hazardous condition to exist within his ship.

9930.2 REFERENCE LIBRARY

1. A reference library for easy access and training in fire prevention, fire-fighting techniques and equipment should be established and maintained. This reference library should consist of those publications and instructions issued by the Naval Establishment, manufacturer's instructions, and covering fire fighting equipment as in- on the specific ship, whenever possible, commercial publication on the subjects. The following is a partial list of suitable publications:

Ships Damage Control Book
Naval Ships Technical Manual
Instructions for Care and Use of Flame Safety Lamp, Mine Safety Appliance Company, Pittsburgh, Pa.
Instructions for Care and Use of Oxygen Indicator, Portable, Mine Safety Appliance Company, Pittsburgh, Pa.
Instructions for Use of Davis Vapotester, Model M-1, Davis Emergency Equipment, Newark, N.J.

Instruction Manual for Oxygen Breathing Apparatus, Navy Type A-3, NavShips 393-0573
Instruction Manual, Magazine Sprinkler System Control Valves, NavShips 348-0781
Instruction Manual, Pump, Centrifugal, Portable, Gasoline Engine Driven, Model P-250, NavShips 347-2878
Instruction Manual, Pump, Fire, Centrifugal, Portable, Gasoline Engine Driven Model P-500, NavShips 347-0001
Liquid Propellant Safety Manual, Bureau of Weapons, October 1958
Manual for Firefighting Exercises, NavPers 92175-B
NFPA Fire Protection Handbook Crosby, Fiske, and Forster, National Fire Protection Association, Boston, Mass.
NWIP 50-1 (A) CONFIDENTIAL
NWP 50(A) Shipboard Procedures
OPNAVINST 8110.16 Series
Supplementary Instructions and Information for the Operation of the M-S-A Explosimeter, Model 4,
M Mine Safety Applicance Company, Pittsburgh, Pa.
DASA Technical Letter 20-6 of 1 Jan 1962
Damage Control Manual for MSTS Ships in Service, COMSTSINST 3541.5A
Damage Controlman 1 & Chief, NavPers 10572C
Damage Controlman 3 & 2, NavPers 10571-D
Encyclopedia of Science and Technology, McGraw-Hill
Fire Fighting Guidance Nuclear Weapons AFP-92-1-1
Fire Marshal and Gas Free Engineer's Manual, 1961
Fire Service Hydraulics, Sheppart-Case-Sheppard, Mann Pub. Co. N.Y. 18, N.Y.
Foam Liquid Proportioner, 60-180 Gal. Per. Min, NavShips 393-0564
Foam Liquid Proportioner, 500-1000 Gal. Per. Min, NavShips 387-0167
Foam Liquid Proportioner, 400-1000 Gal. Per. Min, NavShips 387-0559
Foam Liquid Proportioner, 200-1000 Gal. Per. Min, NavShips 393-0627
Fog Foam Dry Type System, NavShips 250-688-5
General Specifications for Ships of the U.S. Navy, Sec. 9930-1
General Specifications for Ships of the U.S. Navy, Sec. 9480-3
Fire Protection for Chemicals, Charles W. Bahme, National Fire Protection Association
Handbook of Dangerous Material, Sax, Reinhold
Instruction Pamphlet for Wolf Flame Safety Lamp, Brooklyn 5, N.Y.
Instruction Pamphlet for Combustible Gas Indicator
Instruction Manual for Operation of Pack Type Oxy-Acetylene Emergency Cutting Outfit, NavShips 392-0003
Napalm Bombs, Ordnance Pamphlet 1361 (F. Prelem), Instruction Pamphlet OPNAV INST. 8110-16B
Standard First Aid Training Course, NavPers 10081A
Syllabus of Lesson Plans for First Aid, NavMed P-5056
Basic Hydraulics, NavPers 16193
Curriculum for the Introduction to Fire Fighting Techniques
Navy Firefighters' School Manual of Field Evolutions, Evolutions, NavPers 92175A
U.S. Navy Safety Precautions (OPNAV)
U.S. Navy Manual of Safety Equipment (NAVEXOS)
War Damage Reports (Classified), NavShips

2. The ship should also maintain a current library of other training aids including film, film strips, and transparencies which are made available on fire fighting and damage control subjects.

9930.3 QUALITY OF THE EQUIPMENT

Ships are provided with various types of fire fighting equipment. Every article of fire fighting equipment which has been properly maintained in operational condition is an effective piece of equipment which can be used with confidence.

9930.4 EARLIER EQUIPMENT

1. Ships and stations may have equipment and systems which may be of earlier types than those described in this chapter. The absence of references to this type of equipment, or installation should not be interpreted to indicate that they are no longer effective. Replacements and alterations are not to be made until their repair and maintenance is no longer economical, or as specifically directed.

2. Ships having such equipment are referred to the manufacturers operating manuals. If necessary information is not available, the Naval Ship Systems Command should be informed of the deficiencies.

9930.5 NEW DEVELOPMENTS

1. The Naval Ship Systems Command, in collaboration with other agencies of the Naval establishment and the Department of Defense, is committed to a program of research and development to improve techniques and equipment associated with fire fighting and damage control.

2. From time to time these novel techniques or equipment are subjected to test and evaluation by the operating forces. Often the introduction of such developments creates interest from commands not directly involved in the test and evaluation program. This "interest" often becomes a desire to obtain this "new" item, even before all reports have been made and evaluated.

3. New and improved methods and materials are provided to the operating commands as soon as the performance and production of such items are found to meet accepted engineering principles and provide overall benefit.

9930.6 FIRE FIGHTING DRILLS

1. The efficiency of the fire fighting organization is developed through drills. Every man in the organization must know where to go, how to get there, what may be needed, and what to do upon arriving at the scene of a fire. It is only by constant drilling that fire fighting parties can learn to function as teams. Men must be trained to act immediately and use the proper equipment and correct procedure.

2. Drills should be conducted under all material conditions of readiness in order to learn of the problems and conditions each imposes.

3. Communications must receive thorough consideration in any drill program. A firefighting organization can

be effective only when leaders at the scene are able to give clear and accurate messages to telephone talkers and telephone talkers become proficient in transmitting, receiving, and recording messages.

4. Drills uncover weaknesses and failures of personnel and material which can be eliminated or recognized as a possible source of danger should an actual fire occur in the area.

5. In the planning and conducting of a drill program, imagination, coupled with realistic situations, is extremely valuable.

6. An effective protection against fires in ships is the quantity and quality of training before a fire starts.

9930.7 READING DIAGRAMS AND DRAWINGS

1. A thorough understanding of how to read and interpret diagrams and drawings, particularly isometric and orthographic (mechanical) drawings is essential for every man in the fire fighting organization.

2. Damage Control Officers should ensure that all fire fighting personnel receive training and qualify in reading and properly interpreting damage control diagrams, blueprints, drawings, and other similar material concerned with his duties. (Also see article 9930.414, Compartment Identification System.)

SUB-SECTION B – THE ELEMENTS OF FIRE

Part 1. The Fire Triangle

9930.11 FIRE

The entire chemistry and physics of fire and burning or combustion, may be simplified into a relationship between three components; **fuel, heat** or temperature and **oxygen** or air. In order to have a fire in some combustible substance, each one of these components must be present and assisting each other. We can picture it in the form of a triangle which connects these factors as shown in figure 9930-1.

In this triangle the oxygen may go toward the fuel and react to give heat and this takes in more oxygen to give still more heat, etc.; or the heat may cause more fuel to become available (like causing gasoline to boil into vapor) which then takes up more oxygen to burn to give more heat which then gives still more fuel, etc. The burning reaction can go in many different directions, as you can see.

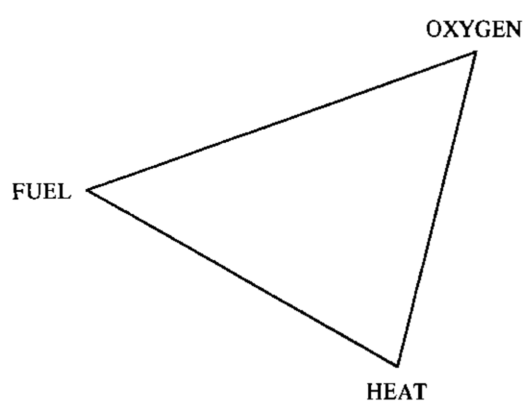


Figure 9930-1.

The modern science of fire fighting and fire extinguishment takes into account that the sides of the triangle pictured above constitute a chain reaction of burning. The three corners of the triangle are not exactly connected, but they react as though they were connected by means of a group of very active chemical particles called **free radicals** going in every direction.

An easy way to visualize this is to picture a team of three skillful jugglers, one at each corner of the triangle. These jugglers are passing indian club juggling pins back and forth to each other as shown in figure 9930-2.

Since a fire usually has a supply of everything needed to burn faster and faster, we will give each juggler a supply of juggling pins. As each juggler puts more pins into the game, it gets faster and faster, with more free radicals (pins) available for reaction (passing) as shown in figure 9930-3.

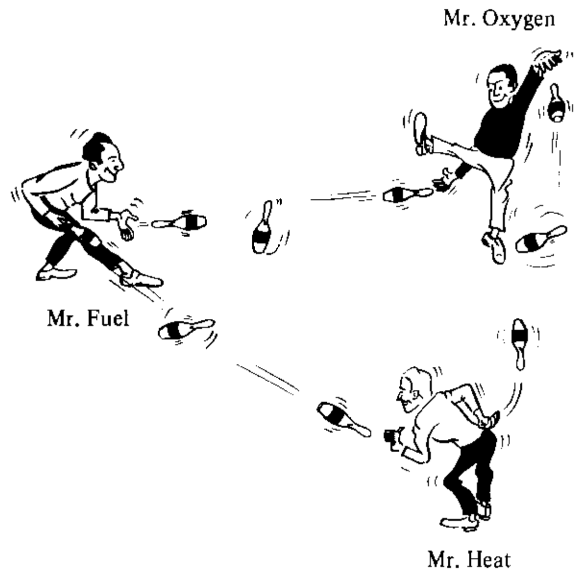


Figure 9930-2.

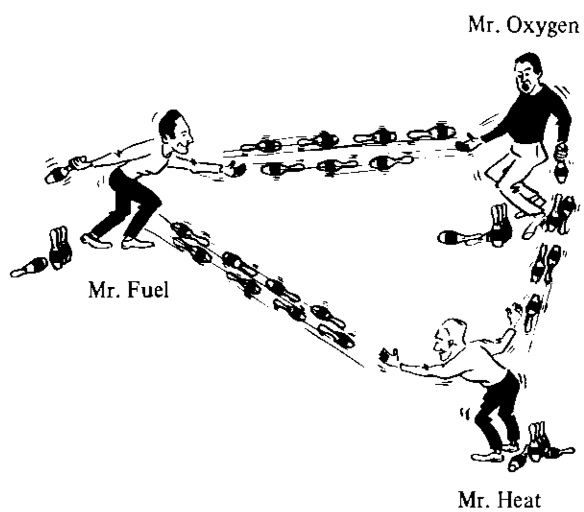


Figure 9930-3.

Now, the job of the **fire fighter** is to take these pins out of the game! If the fire fighter applies cooling water to the heat or high temperature, some juggling pins are taken out of the game so that it's slower and slower.

If enough cooling takes place, all the heat is removed and the jugglers have lost their pins and the game slows down and stops as shown in figure 9930-4.

Obviously, the fire fighter can go to work on any one or more of the components, remove them, and cause the game (and the burning) to stop. The type of fire fighting agent which the fire fighter has at his command determines which component (or components) of the triangle he is going to remove.

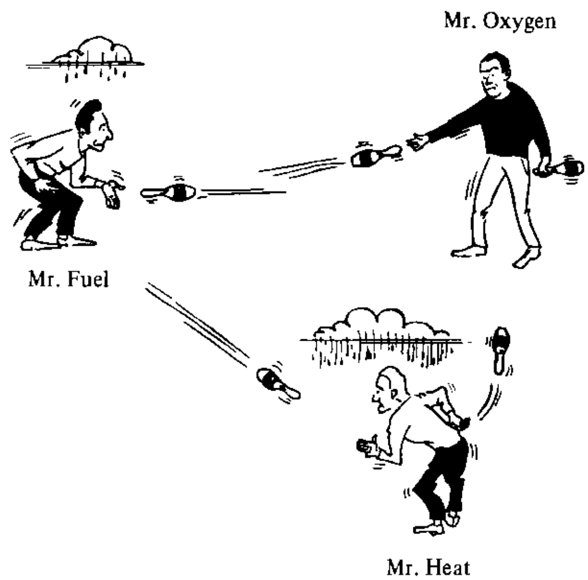


Figure 9930-4.

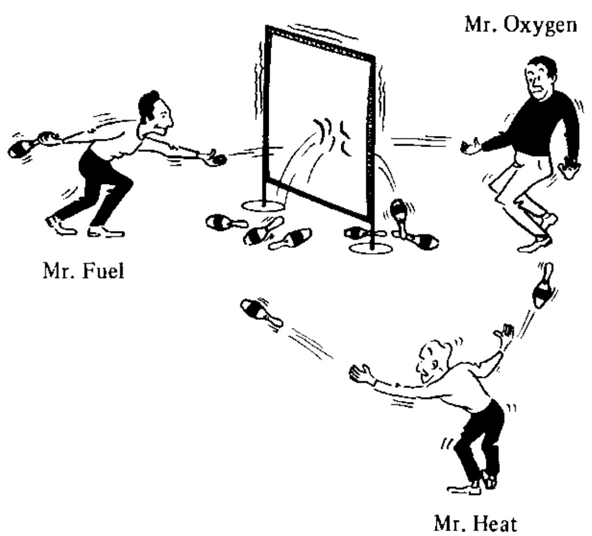


Figure 9930-5.

There is another way of stopping the game (and the combustion). This is done by putting a screen up between any two components of the triangle as shown in figure 9930-5. If the fire fighter uses an agent which puts up a temporary screen that stops the flying pins (the free radicals) and they fall to the deck without being passed on to react in the fire, then the game will stop.

This mechanism is performed by some of the agents which are available to the fire fighter which stop free radical reaction and thus extinguish the fire. Obviously, it can be seen that the fire can quickly start up again if this mechanism is used, because each of the three necessary components are still there waiting to start the game (and the fire) again!

The succeeding parts of this manual deal with fire fighting materials and equipment for extinguishing fires aboard ship using mechanisms like those pictnred above.

Part 2. Characteristics of the Factors Causing Fire

9930.15 THE FUEL

Each of the components for the fire triangle has certain properties which the fire fighter mnst know about to successfully extinguish or control fires.

1. The **FUEL** in a fire may vary considerably in its properties. Aboard ship there are many types of fuel but the three principal combustible materials encountered by the fire fighter correspond to three classes as follows:

Trash, rags, cloth, paper, upholstery, plastics, dunnage, etc. - Class A fuels

Gasoline, jet fuel, diesel oil, Navy Special fuel oil, bulk paints, thinners, etc. - Class B fuels

Electrical insulation in motors, electronic equipment, etc. - Class C situation

(For additional information, see "Fire Fighting" and "Fire Hazards" section.)

There is an additional combustible material which is also a problem to shipboard fire fighters. This is magnesium metal, which is used in aircraft construction and in certain lightweight furniture. It is called a **Class D fuel**, and requires special consideration. This will be taken up later.

2. Fires in **Class A fuels** are called "Class A" fires. This fuel burns rapidly or slowly, depending on how much heat and oxygen is supplied to it. If it is burning slowly, with little flamming, but some glowing embers are seen, it is said to be smoldering. In this stage it produces much smoke and also produces deadly poisonous carbon monoxide gass because of an insufficient supply of oxygen. If plenty of air reaches a slowly burning Class A fuel it will become hotter until it begins to flame. Fires in these types of fuel are best controlled and extinguished by removing their heat with water. They may also be halted by temporarily or permanently cutting off their access to air (smothering or coating). The various types of smothering agents will be taken up later.

3. Fires in **Class B fuels** are called "Class B" fires. This type of fuel is a liquid at ordinary temperatures and, because it is almost always giving off explosive and flammable vapors from any exposed fuel surface depending on the fuels individual physical characteristics and its temperature, the fire fighter must know about these factors in order to successfully combat fires in it.

dioxide, so that only one-half of the oxygen remains, it can still burn or explode.

5. For rough estimation purposes, the fire fighter should know that gasoline vapor concentrations of 1.4 percent (the lower explosive limit) smell very strongly even to the point of causing a stinging sensation in the nose. To fully test such atmospheres, the shipboard combustible gas indicator or explosimeter should be used.

6. To halt flames by decreasing the oxygen supply with a diluting gas, any inert gas may be used. The principal ones available to the shipboard fire fighter are carbon dioxide and inert gas from an inert gas generator. The action of these gases is to temporarily smother the fire. As soon as ventilation is started with fresh air, the fire can start up again if complete extinguishment has not been successful. This lack of holding action is particularly true with Class A fires which can smolder, as we have seen, with very little air being supplied to them. If air is again supplied with its 21 percent oxygen, flames can start up again.

7. Another method of smothering a fire is quickly available to shipboard fire fighters below decks. By merely closing off all hatches and passageways, a fire will produce its own smothering gases in the principal form of carbon dioxide. The fire fighter is cautioned, however, that the deadly gas **carbon monoxide** is also formed when such a compartment fire is closed off. This will be taken up later.

8. The use of **foam** is another method, and an excellent one, for smothering, and thus cutting off the air to a fire. Foam is a so-called **permanent smothering agent** which requires mechanical removal after the fire is out. One of its principal advantages is that foam cools as well as smothers a fire, particularly in burning oils and flammable liquids.

9. Magnesium metal fires (Class D) are the only ones which cannot be extinguished using ordinary smothering or air dilution inert gases. These fires are so hot that they react vigorously with carbon dioxide and the nitrogen from an inert gas. Foam also causes a vigorous reaction in the white fire zone of burning magnesium and increased burning and scattering of hot molten metal may occur. The only successful smothering agent for this fire is dry sand.

SUB-SECTION C – FIRE FIGHTING AGENTS AVAILABLE

Part 1. Water

9930.20 METHODS OF APPLICATION

1. Water is a cooling and diluting agent far superior to other agents and most economical to use. Cooling or the removal of heat, is the most common method of fire extinguishment. Water may be applied to a fire aboard ship in three different ways from the single piece of equipment most commonly used for water application, the **all-purpose nozzle**:

a. In the form of a straight solid stream of water with a long reach and penetrating power.

b. In the form of "high velocity" water-fog with some reach or throw of the umbrella-shaped pattern of small water particles.

c. In the form of "low velocity" water-fog (when using an applicator) with very little reach of exceedingly fine water particles in a wide umbrella-shaped "cloud" pattern. This pattern is very easily blown about by wind currents.

2. The shipboard fire fighter must remember that every gallon of water put on a fire which does not act usefully on that fire by cooling it or removing the fuel must be gotten rid of by pumping it overboard or disposing of it in some manner. For this reason the straight solid stream of water is seldom used unless the fire fighter needs its characteristic of long reach or deep penetration.

9930.21 CHARACTERISTICS OF WATER FORMS

1. Water, in the form of a **solid stream**, is used to reach into smoke-filled spaces or areas at a distance from the fire fighter which need cooling or washing down to prevent or extinguish a fire. Keeping in mind the constant problem of excess water disposal, the solid stream form, high volume water discharge, should be used as little as possible, especially in situations below decks where free water run-off to the sea cannot take place. The solid stream form of water conducts electricity back to the fire fighter and under no circumstances shall it be used on fires in electrical equipment unless **all** current is disconnected and the equipment is electrically inert. Solid stream water is used only on Class A fires. There are instances where quick cooling of magnesium alloy and fire is needed, and water can be used. This will be taken up later.

2. **Water fog** is perhaps the most useful heat removing agent available to the shipboard fire fighter. Water in the form of fog, either high or low velocity fog, is the most economical form for the use of water for fire fighting purposes. However, the fog must be applied by the fire fighter directly to the area requiring cooling if its benefits are to be realized.

3. Water-fog affords protection to the fire fighting by the formation of a screen of water droplets between himself and the fire. This fog screen protects the fire fighter from the intense heat and, as a result, his maneuverability toward the base of the fire is greatly increased. Not only does fog dilute or absorb various vapors, but to a certain extent it will also wash fumes and smoke from the atmosphere, thus contributing further to the protection of the fighter. The fire fighter can help clear smoke from his own immediate area by occasionally directing the fog pattern upward for a few seconds.

4. In compartments which are fully involved wirh fire, or nearly so, the fire fighter can greatly reduce the heat and flame before entering by liberal application of water fog through doors and air ports, into upper areas of the compartment. In early stages of such a fire, the greater part of the water fog so applied will turn to steam, thereby smothering the fire as well as reducing heat during the steam generating process. The fire fighter should stand clear of openings since there may be a violent outward rush of hot gases and air due to their being displaced by steam.

5. When water is broken up into small particles, there is little or no danger of carrying electric current under normal conditions of fire fighting if the nozzles are operated at their designed pressure to produce a fine spray. The all-purpose nozzle, or its applicator, constitutes a hazard to the fire fighter due to accidental shifting to

solid stream or to touching electrical equipment with the applicator. Even after current is shut off, particularly in electronic equipment, a dangerous potential may remain until an effective ground is established. Water fog is therefore not recommended as an extinguishing agent for electrical fires, except as a last resort. If necessary to apply water fog, the nozzle should not be advanced any nearer the power source than absolutely necessary for proper utilization of the fog pattern.

6. Because of the cooling qualities of the finely diffused water particles, fog can be used successfully on fuel oil fires. However, danger of a reflash is present until the entire bulk of the fuel is cooled below the flash point.

Part 2. Air Foam

9930.25 FOAM CHARACTERISTICS

1. Fires in flammable liquids such as gasoline require a **smothering** action for their extinguishment. Gasoline and JP-4 need a permanent smothering agent to stop evolution of flammable vapors which are evolved from these fuels at ordinary temperatures or above.

2. Air foam, or mechanical foam, as it is sometimes called because of the mechanical process of mixing air into water containing foam-forming concentrate to generate the foam, is produced by the following two principal devices on board most Naval vessels:

a. The NPU foam nozzle
b. The FFF fog-foam nozzle

3. The foam produced with these nozzles is a thick, viscous, very light and stable material which floats on almost any liquid, including water. It is non-toxic and does not damage surfaces like painted bulkheads, etc., on which it may be directed. It consists of very small bubbles of air mixed into water (which has a small amount of foam-forming liquid mixed with it) and is capable of resisting attack by flames or fire. When this foam is heated in a fire it actually becomes stronger and tougher than when first produced, and after the fuel fire is extinguished it continues to seal off vapor from the surface and remains for periods up to 24 hours. To remove it, some sweeping action or mechanical removal process, like a jet of water, may be needed.

4. The generation and production of foam from shipboard foam equipment is accomplished only by supplying a solution of foam-forming concentrate in water under pressure to the mixing area of the nozzle where air is drawn into the liquid. To do this, a suitable liquid **proportioner** must also be used to induct foam-forming concentrate liquid in the correct proportion into the water stream. There are three methods used on board ship for this liquid proportioning action:

a. The water-motor proportioner
b. The pick-up tube of the NPU foam nozzle
c. The duplex pressure proportioner

5. Each of these proportioners operates in a different way to get the proper proportion of 6 percent foam-forming concentrate into the water line leading to the foam nozzle. The water motor proportioner pumps foam out of a can or tank into the water with a small pump which is connected to a large water motor which revolves when water is passed through it. The pick-up tube attached to the body of the NPU foam nozzle is connected to a small venturi suction eductor built into the foam nozzle. A vacuum is built up in the tube and the liquid is educted into the water stream. The dual tanks of the duplex pressure proportioner are filled with foam-forming concentrate at the start and water is led into each tank successively, displacing and forcing the concentrate into the water line. The tanks must be refilled manually during operation. Details of operation of this equipment will be discussed later in this chapter.

Part 3. Carbon Dioxide Gas

9930.30 CHARACTERISTICS

1. Another method for extinguishing fires by a smothering action is the use of the inert gas, carbon dioxide to "starve" the fire by diluting or replacing its oxygen supply. If gaseous carbon dioxide is directed into a fire so that sufficient oxygen to support combustion is no longer available, the flames will subside and cease. Depending on the fuel, this action will take place when the customary 21 percent oxygen in air is diluted with carbon dioxide down to 15 percent oxygen or lower. Some Class A fuels require that it be reduced to less than 6 percent oxygen in order to extinguish glowing ember combustion. The smothering action of carbon dioxide gas is a temporary one however, and the fire fighter must remember that the fire will quickly rekindle if the oxygen is supplied again in the presence of an ignition source. The temperature of the burning substance and its surroundings must be lowered below its ignition temperature if the fire is to remain extinguished when oxygen again becomes available to it. Carbon dioxide is a dry, non-corrosive gas, which is inert when in contact with most substances, and will not damage machinery or other equipment. It is a non-conductor of electricity and can be safely used in fighting fires that would present the hazard of electrical shock. Normally encountered freezing temperatures do not affect the operation of the extinguisher. However, extinguishers exposed to arctic temperatures for prolonged periods will fail to operate. Carbon dioxide gas, whether in fixed installation or portable, is generally stored in steel cylinders at high pressure of about 850 psi at normal room temperatures. Under this pressure, about two-thirds of the volume of the carbon dioxide is in liquid form, and when discharged, it has the appearance of snow. The cooling effect of the low temperature snow (minus 110°F.) is of rather small consequence although it increases the effective dilution period. Carbon dioxide portable extinguishers consist of a forged-steel container fitted with a "squeeze-grip" and contain 15 lbs. of carbon dioxide.

2. In various spaces of certain ships there are other types of carbon dioxide equipment which may be permanently installed with hose-and-reel for getting the gas to the fire. There are also permanently installed carbon dioxide piped systems utilizing automatic or pull-cable activation methods for protecting certain enclosed spaces from fire. These will be dealt with later.

Part 4. Dry Chemical Extinguishing Agent

9930. CHARACTERISTICS

Since all fires are chemical reactions, it is not surprising that there are certain extinguishing agents that operate by a purely chemical action to quench flames. These agents are dry chemical powders which are blown onto the fire by a charge of expellant gas such as carbon dioxide, nitrogen, or high pressure air.

The chemical action and extinguishing mechanism of dry chemical agents is a very complicated one. It does not involve inerting like carbon dioxide gas, nor does it involve cooling like water fog. In general, it may be said that dry chemical agents **halt** the production of the very active **free radicals** in a fire. This action is much like putting a temporary screen between the heat and the fuel and the oxygen. In the fire triangle this halts the union of the three components just long enough for the flames to be extinguished.

The dry chemical agent used in the Navy is a purple-colored powder composed of potassium bicarbonate and is called "Purple-K-Powder" (PKP).

9930.36 APPLICATIONS

The agent is provided primarily for use on Class B fires. It is also safe and effective on Class C fires but should not be used in lieu of carbon dioxide, unless necessary due to fouling of electronic components that may result.

For internal fires in gas turbines and aircraft engines, PKP should be used only as a last resort when efforts to control the fire with CO_2 have failed. The PKP leaves a residue that, under some circumstances, cannot be completely removed without disassembly of the engine. For Class B fires external to the engines, PKP should be used immediately.

Part 5. Light Water

9930.38 CHARACTERISTICS

1. Light water is a concentrated mixture of fluorinated surfactants. The type used by the Navy is a 6 percent concentration, that is, six parts of Light Water are mixed with 94 parts of water.

2. Light Water was developed for combatting Class B fires. It is a clear, slightly amber colored liquid which has the ability of floating on the surface of hydrocarbon fuels creating a film which prevents the escape of vapors and consequently prevents ignition. The Light Water is applied to the fuel surface as a foam. As the Light Water solution drains from the foam, it forms the vapor tight film on top of the fuel.

3. Although Light Water can be used separately in much the same manner as protein foam, it is generally used in conjunction with PKP. There is absolute compatibility between PKP and Light Water and between Light Water and Protein Foam.

4. The shelf life of the concentrated Light Water or the mixed solution are both indefinite. There is no deterioration of the product with time.

5. Current plans call for replacement of protein foam with light water.

This manual will shortly be revised to reflect such changes.

SUB-SECTION D. SHIPBOARD INSTALLATIONS

Part 1. Ventilating and Dewatering Systems

9930.41 REGULATION OF VENTILATING DUCTS

An understanding of the ventilating system aboard Naval ships is a prime necessity for successful fire fighting in the Navy as it is not possible to vent fires as is common in structural fires ashore. While the system consists largely of ducts of many sizes which perform indispensable service, they can also provide the means for the spread of fire and the release of toxic gases. It is the fire fighter's duty, therefore, to see that ventilating ducts do not add to the dangers aboard his ship at the time of fire. He does so, upon orders, by closing or by opening ventilation dampers or valves, stopping or starting ventilating blowers, as the circumstances may require.

9930.42 IDENTIFICATION OF VENTILATING DUCTS

1. The ventilating system is designed either to supply fresh air to the various compartments or to exhaust from these compartments the foul air and any toxic gases. The label "Supply" or the label "Exhaust" is painted on the ventilating blower casing or on the adjacent structure, on ventilating closures, and also on the operating mechanism. These labels bear, in addition, letters and numbers which indicate what compartments are served. Usually there is a supply and exhaust trunk or duct in each compartment. As a means of familiarizing himself with the fire main, ventilating, flushing, and dewatering or drainage systems aboard his ship, the fire fighter should consult the damage control diagrams available in each damage control locker and trace out the actual installation while referring to these diagrams.

2. When a Naval ship is put in "material condition" for battle, most of the ventilating ducts are closed. At the time of fire, it may be advisable to close still others. The supply system, for instance, could be harmful in that it might spread fumes to inboard areas that would otherwise be free from this hazard. It might further spread the fire by supplying air (oxygen) to smoldering embers or to a small incipient blaze consequently producing a hot, raging fire. The exhaust system likewise might be harmful in that it might spread a fire.

9930.43 DISCONNECT ELECTRICAL EQUIPMENT

The fire fighter at the scene of a fire aboard a Naval ship must look also to the electrical equipment in the fire area. When so directed, he will open switches to cut off the supply of current to equipment in compartments on fire or in which large quantities of water must be used. This is done for two reasons: one, to remove the danger of electric shock, and the other to reduce the hazard of explosion due to sparks from electric motors and generators operating in air containing explosive vapors.

9930.44 DRAINAGE SYSTEM

1. While the dewatering or drainage systems of a Naval ship are not to be classified as part of its fire-fighting equipment, the fire fighter must bear in mind that a standard Navy 2½-inch nozzle with 1-inch orifice operating at 100 psi nozzle pressure will deliver water at the rate of nearly 1 ton per minute. He should remember that every gallon has to be pumped out again, and should have some knowledge of the system through which this task is accomplished.

2. Water is pumped out of the various compartments by means of the drainage system. As a general rule, each compartment either is connected to the pumps by piping or is arranged to drain through sluice valves into other compartments that can be pumped out.

9930.45 SMOKE CLEARANCE

1. As smoke is secondary in nature to fire, it should be considered by the fire fighter in combatting the fire. The primary objective must be to extinguish the fire and when that has been accomplished completely, then steps should be taken to remove the smoke and fumes that remain. Although smoke and fumes must be considered hazardous to the breathing of personnel, the hazard can be completely avoided by the use of Navy type oxygen-breathing apparatus. The reduction in visibility by smoke is a hazard as well as a nuisance which must be endured until the fire has been completely entinguished.

2. This procedure differs radically from that practiced ashore where ventilation is used to rid a building of accumulated heat and smoke, making access easier for rescure and fire fighting. Since a single ventilation system aboard ship frequently serves a number of compartments, premature use might result in spreading a fire beyond established boundaries. This is further discussed in the following articles.

3. Fire that occurs in the open on weather decks does not present such a serious smoke problem, as this type fire can normally be combatted from the windward side, the smoke being carried away by air currents. The problems confronted by the fire fighter in combatting a fire in a below-deck space are more difficult because of the presence of smoke and fumes. The fire fighters' objective must be to extinguish the fire despite other difficulties.

4. Generally there is no effective means for combatting smoke or fumes during the progress of an interior fire. In most instances, ventilation should not be attempted during the progress of a fire in an effort to improve visibility. The known additional fire hazard resulting from the use of ventilating systems or ducts during a fire is considered of greater importance than the doubtful improvement in visibility resulting from their use. To conform with fire-fighting procedure as explained in this chapter, all ventilating system closures, both supply and exhaust, are secured in the area where a fire exists. Not only should the ventilating system closures be secured, but the electrical systems to blowers and similar devices should be deenergized also.

5. Open ventilating ducts, particularly in vertical systems, will act as vents for the fire thereby prolonging the life of the fire and contributing to the difficulty of bringing the fire under control. In addition to the introduction of air (oxygen) to the existing fire, there is always the hazard of spreading the fire by combustion of dust and other debris which collects in ventilating systems as the result of infrequent or improper cleaning. Some idea of the magnitude and seriousness of this dirt problem as a fire hazard may be gained from certain tests which indicated that a large ship will take into its ventilating systems an estimated 5 tons of dirt in a day. Not all of this dirt remains in the ship, but enough of it adheres to the interior surfaces of the ventilating ducts to form a combustible encrustation.

6. Ventilating ducts which remain open to a compartment in which there is a fire can quite easily become the vehicle for spreading fire and fumes to areas of the ship which otherwise would be unaffected. Combustible gases or fumes passing a sparking motor may easily explode, causing further damage and possibly additional fires. The foregoing is particularly true when the access to the compartment has been opened for the purpose of fighting the fire. The open access in combination with an open ventilating duct will cause a natural draft. Ventilating system closures are provided and fitted to assist in preventing the spread of smoke and fumes to other parts of the ship as well as for preservation of watertight integrity and reserve buoyancy.

9930.46 PRECAUTIONS IN VENTILATING

1. When it has been difinitely determined that the fire has been completely extinguished, natural ventilation and forced ventilation, either by the installed systems or by portable ventilating fans, can be used very advantageously for clearing compartments of smoke and fumes. However, prior to the introduction of ventilation, either natural or mechanical, certain precautions must be observed:

a. Determine that the fire has been extinguished.

b. Inventigate ventilating systems to the affected area to make sure they are free from fire or smoldering material.

c. Have fire parties and equipment standing by the blower and controller of the ventilating system.

d. Have permission of engineer officer to open ventilating system closures and start blowers as required to ventilate the compartment.

2. Exhaust systems should be used for clearing compartments of smoke and fumes resulting from fires. The use of exhaust systems will create an indraft from adjacent spaces and prevent the smoke and fumes from spreading. Supply systems, if used, normally will force smoke and fumes into adjacent spaces causing possible smoke damage and further inconvenience to personnel. Spaces directly open to weather can be cleared conveniently by use of supply systems.

9930.47 USE OF PORTABLE VENTILATING BLOWERS

1. Portable ventilating blowers are basically auxiliary equipment, and normally are not as efficient or convenient as permanent ventilating systems. However, in the presence of explosive vapors or fumes, it may be unsafe to use the permanent systems, and only portable ventilating blowers which are equipped with explosionproof motors can be used.

2. There are 2 types of protable ventilating blowers in common use, one or more of which (both as to type and quantity) are carried on the Allowance List of all vessels. The 2 types are:

a. The 0½ (A or D) 1X axial-flow type fitted with 8-inch diameter noncollapsible hose.

b. The A3/4T air-turbine driven centrifugal type fitted with 8-inch diameter noncollapsible hose.

3. The rated capacity of the 0½ aixial-type blower is 500 c.f.m. with about 200 feet of 8-inch hose attached. This blower is driven by an explosionproof motor. It should be pointed out that while these motors are explosionproof when assembled by the factory, the explosionproof quality is not necessarily present after overhaul; and where there is possibility of explosive vapors being present, the air-turbine blower should be used in lieu of the electric-driven blower with an overhauled motor. It should be further pointed out that because different hazardous gases have different characteristics, they are classified under several separate groups as far as electric equipment is concerned. The most common of these groups is identified by the

National Electric Code and Military Specification MIL-E-2036 as group D, which includes explosive atmospheres of gasoline, petroleum, naphtha, alcohol, acetone, lacquer solvent vapors, and natural gas. Explosionproof electric equipment which has been approved for use in these gases, and which may bear the designation group D, is not necessarily explosionproof in explosive atmospheres of acetylene, hydrogen, ethyl ether, metal dust, coal dust, and grain dust. Therefore electric equipment, even though labeled "explosionproof," should not be used in atmospheres containing explosive concentrations of these latter named materials unless the applicable identification plate, drawing, or technical manual clearly indicates that it is suitable for such operation.

4. The A3/4T air-turbine drive type was developed to handle air which contains explosive vapors. This blower has a capacity of 750 c.f.m. with about 100 feet of 8-inch hose attached. The compressed air supplied to the turbine should not exceed 80 psi; the consumption of compressed air is about 55 c.f.m. at atmospheric pressure (free air). The compressed air connection to the unit is a ½-inch diameter screwed connection for compressed air hose (hose not furnished with the unit) connected to the ship's service air.

Part 2. The Fire Main System

9930.51 GENERAL

The fire fighter should have a working knowledge of the fire main piping system, its valves, and its outlets. He should know the measures to be taken in anticipation of possible battle damage and after battle damage has occurred to assure service of water for fire fighting. Since hose lines are in effect extensions of the fire main, they are also considered as well as are hose nozzles and their attachments. Portable pumps for emergencies complete the equipment for the distribution of water for fire fighting.

9930.52 FUNCTIONS OF FIRE MAIN SYSTEM

The fire main system aboard Naval ships is a system of piping that receives water pumped from the sea and delivers it to fireplugs and sprinkler systems. It has certain additional functions such as supplying water to flushing systems and cooling water to auxiliary machinery, and in certain installations it serves other purposes as well. Inasmuch as the fire main system is vital in combatting fire at sea, the fire fighter should have, as noted above, a working knowledge of its general plan and, in particular, of the location of fireplugs and cutout valves. Furthermore, in view of the possibility of damage resulting from battle, he should be acquainted with the procedures for localizing and offsetting the effects of battle damage.

9930.53 OTHER PIPING SYSTEMS

Before undertaking to study the fire main system, the fire fighter should realize that it is only one of a number of piping systems on Naval vessels. Others are the systems for fresh water, fuel oil, diesel oil, lubricating oil, gasoline (in some vessels), compressed air, steam, flushing, and drainage. (Some of the older ships did have a separate damage-control main for counterflooding and drainage.) In addition to these there are pipes for electric conduits, voice tubes, and ventilation ducts. All these systems are highly important. Some of them, or parts of them, are required for battle service and, therefore, additional precautions are taken to keep them functioning as well as the fire main.

9930.54 TYPES OF FIRE MAINS

1. The type of fire main installed on Naval ships is governed by the physical characteristics and functions of each ship. The specific types of fire mains may be as follows:

a. A single main system which consists of a single main extending fore and aft on or below the damage control deck. This main is led near the centerline of the ship and extends as far forward or aft as necessary to supply various services.

b. A horizontal loop system which consists of two cross-connected mains extending fore and aft on or below the damage control deck and separated athwartship as far as practical but installed inboard of wing tanks or torpedo defense bulkheads. In armored ships the two mains are connected at their extremities to form a loop within the armor protection. Single mains extend forward or aft from this loop as necessary.

c. A vertical loop consists of two mains in a vertical plane and separated athwartship and cross-connected to form a series of verticle loops. The lower main is located as low as practical in the ship and the upper main is located on the damage control deck.

d. A composite system which consists of a combination or variation of the above systems in which the upper or lower mains of a vertical loop may in turn consist of a harizontal loop. The mains in the horizontal loop are separated in the same manner as those in the horizontal loop system described above.

9930.55 FIREPLUGS

1. The numerous fireplugs in the fire-main system are served by branches from the fire-main system. On the larger Naval ships most fireplug outlets are 2½ inches in diameter, and, where necessary, reducing connections are used, either the straight reducing connection, with a 1½-inch outlet, or the double Y-gate connection, with two 1½-inch outlets. Some of the larger ships have double fireplug outlets, each 2½ inches in diameter.

2. On destroyers and smaller ships fireplugs will be 1½ inches in diameter throughout the ship.

3. Fireplugs on the larger ships are located so that any pint aboard can be reached with 100 feet of hose from each of 2 or more fireplugs. On the smaller ships they are located so that any point on the ship may be reached with a 50-foot line, a "length" of hose, from each of 2 or more fireplugs. Fireplugs below the weather decks are set either 5 or 6 feet above the deck with outlets downward. Here the 2½-inch outlets are reduced by Y-gates to two 1½-inch outlets. Fireplugs on the weather deck are set about 13 or 18 inches above the deck with the outlets horizontal. The lower fireplugs will be found on the older ships. The height was raised on the newer ships to facilitate installation of strainers. In the turret handling rooms fireplugs are installed in addition to the connections for supplying the turret-sprinkling system.

9930.56 WATER SPRINKLING SYSTEMS

Sprinkling systems are installed in magazines, turrets, munitions-handling rooms, ready service rooms, stowage spaces for flammable materials, such as pyrotechnics and film lockers, and in some ships in aircraft hangar spaces. Water for these is taken from the fire main. Valves for the sprinkling systems and other firemain valves are hand-operated at the valve. Some of them are, in addition, operated at a distance by hand (with reach rods), by electricity, by hand-operated hydraulic units or, in the case of magazine sprinkling valves, automatically by heat-actuated devices. The non-automatic fog head sprinkling systems are also supplied by the fire main. Hose lines are used for connecting some of these nonautomatic systems to fireplugs, while others are permanently piped to the firemain.

Hangar Deck. In ships with between deck hangars, dry-pipe-sprinkler systems are provided with commercial type, open sprinkler heads. These heads are spaced on 8-foot centers with alternate heads staggered and special heads provided around the periphery of the elevator well to permit sprinklering a plane stored on the elevator. The systems are provided with electrically or hydraulically (oil) operated sprinkler control valves, also actuated automatically by a thermo-pneumatic control system.

In aircraft carriers the sprinkler system for the hangar deck is similar but more extensive. The entire overhead is subdivided into groups comprised of three or four loops. Each loop is supplied from both sides of the ship through independent risers. At certain locations, transverse water curtains are provided.

The sprinkler control valves are located on the second deck. The valves are either electrically or hydraulically solenoid operated. Both types are operated manually at the valve, remote control being provided from the hangar deck and the conflagration stations above the hangar deck. Remote control stations for closing the valves are also located along the sides of the hangar deck. The conflagration stations also can start the electrically operated fire pumps supplying the firemain.

The sprinkler control valves in the port and starboard risers are provided with a separate test casting located on the dry side of the control or incorporated in the sprinkler control valve to permit flushing out of the lines and control valve. The details of the system as installed in any particular ship may be obtained from the General Information Book, or from the Piping Systems Technical Manuals.

9930.57 GAGES

Gages which indicate the water pressure within the fire main are normally located at the pumps, at the engineer officer's station, at the main damage control station, and also along the second or damage control deck.

9930.58 VALVES

Valves in the fire-main system are the cutout valves reducing valves, and relief valves.

9930.59 CUTOUT VALVES

1. Cutout valves are installed in the fire main proper, in the risers, and in the horizontal leads. Their function is to cut off the supply of water in any part of the fire main-system for the usual peactime purposes, such as adjustments and repairs. In wartime they serve to sectionalize the fire-main system as a precaution and to isolate parts of the system ruptured in battle. Many cutout valves have remote control for operation at a distance. This control is, of course, in addition to control at the valves.

2. For battle service involving the fire-main system, root valves located below the armored deck can be operated at the valve and from the damage control deck. When the fire main system is sectionalized, these valves are usually kept open in order to have the service ready for instant use, notwithstanding the danger of rupture in battle.

3. As might be supposed, the closing of cutout valves in order to sectionalize a Navy ships' fire-main system (and other piping systems as well) is not delayed until actual battle damage has occurred nor, indeed, until a battle has begun. Although many cutout valves must be kept open until extreme emergency requires that they be closed, other cutout valves (and also certain doors, hatches, and fittings) are kept closed as a general precaution in wartime, or they are closed as a special safety measure in anticipation of damage. The commanding officer of a ship determines what these precautionary measures are to be, but he observes the minimum requirements that are prescribed by Navy Regulations for stated circumstances and for stated classes of ships. These minimum requirements are what is meant by "material condition" for battle.

9930.60 REDUCING VALVES

Reducing valves are installed in all branch lines taken from the fire main for supplying the flushing system. These valves in addition to relief valves are provided to avoid imposing fire-main pressure on the flushing system and fixtures. The reducing valves take the pressure down from the fire-main pressures to approximately 50 pounds; and the relief valves operate when pressures become excessive. The latter are usually set to relieve pressure when it rises 10 percent above the working pressure of the system. On some ships the flushing system is an independent unit supplied by a flushing pump.

9930.61 RELIEF VALVES

Relief valves are no longer provided on centrifugal pumps. Turbine-driven centrifugal fire pumps usually have the pressure govern set to maintain pump discharge pressure 50 psi above standard fire-main pressure. Constant-speed, motor-driven centrifugal pumps supply water at pressure governed by the quantity of water discharged. Operating personnel should be familiar with the centrifugal pump capacity curve at various pressures in order to understand this characteristic of these pumps. Fire main working pressures vary from 50 psi on small craft to 175 psi on recently built ships. They should be tested to 135 percent of design pressure.

9930.62 MATERIAL CONDITIONS

The fire fighter needs to know about all "material conditions" as it is one of his duties to keep the fire-main system, or as much of it as possible, in service. He must know how to carry out all instructions from damage control in regard to isolating damaged sections, setting or breaking segregation, how to resort to jumper lines, use of the gasoline handybilly, P-250 and P-500 pumps. He should remember that every gallon of water he puts into his ship must be taken out again. The engineer officer is kept informed of fire-fighting operations so that he may watch the list and trim and make corrections as may be necessary. The judicious use of water is of great importance. The number of hose lines which are to be used for fire-fighting purposes should be carefully determined as water is being supplied from the fire main for cooling of guns and other services required during battle conditions.

9930.63 QUICK-CLEANING STRAINER

A quick-cleaning strainer (figure 9930-6) is attached directly to the fireplugs and to it is attached the 2½-inch hose

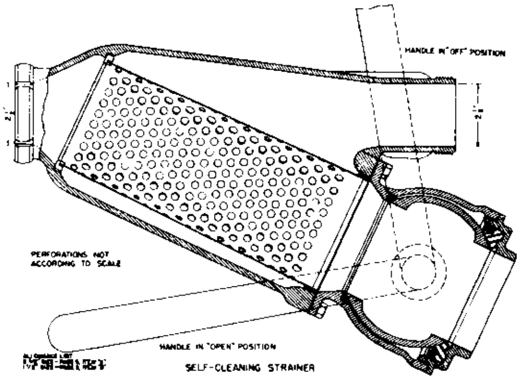


Figure 9930-6

or the Y-gate or 1½-inch hose, as circumstances require. This strainer should be supported on the deck or bulkhead with a metal support so as to relieve the strain from the thread of the fireplug. In some cases it is necessary to provide a short length of hose to connect the strainer to the fireplug, in which case the strainer and hose are hung adjacent to the fireplug. This arrangement should be used only when direct attachment of the strainer to the fireplug is not practical, due to clearance or location (figure 9930-7).

9930.64 PURPOSE OF STRAINER

Foreign substances, such as encrustation particles from the fire main and, especially, in the tropics, marine growth, accumulate in the fire-main system. If no strainer were used to remove them, they would pass into hose lines and to the nozzles. Concussions from explosions in battle would also aggravate the situation by shaking loose additional encrustated particles and thus add to the hazard. Periodic flushing of all fireplugs under full fire-main pressure in order that incipient marine growth will be blown out before it has an opportunity to adhere strongly to the fire main is recommended. (Ships should completely fill and flush their fire mains with fresh water whenever shore water is available in order to take advantage of the fact that marine growth dies upon exposure to fresh water.) On occasion, sections of the fire main are removed and inspected for encrustation. Some fire mains are especially treated with antifouling paint on the interior by means of special apparatus located at many Naval shipyards. This treatment tends to keep down marine growth. If upon inspection it is revealed that the firemain must be cleaned, there is available a chemical (acid) cleaning method for accomplishing this task. The strainer should be removed and cleaned quarterly.

SUB-SECTION E – FIRE FIGHTING SERVICES AND EQUIPMENT, DETAILS OF OPERATION AND MAINTENANCE

Part 1. Fire Hose

9930.71 MATERIAL AND DIMENSIONS

1. The standard Navy fire hose is double-jacketed, cotton, rubber-lined, either 1½, 2½, or 3½ inches in diameter. It is made in convenient 50-foot lengths with a coupling at each end. (In special cases shorter lengths of hose may be procured.) The 50-foot lengths of hose are normally referred to simply as "lengths" of hose. Thus a hundred feet of hose may be described as two "lengths" of hose, and so on.

2. Suction hose for the handybilly, P-250 and P-500 pumps is reinforced rubber, and should be used for its intended purpose only. The 4-inch fueling-at-sea hose can be used as suction hose for the P-500 pump.

3. Some destroyers and Naval ships of similar and smaller size use 1½-inch hose throughout. Larger Naval ships use 2½-inch hose on the weather deck and 1½-inch hose below the weather deck, with such exceptions on each of these ships as arise from the fact that wherever used, jumper lines and lines to the water-motor proportioners are 2½-inch hose. Another exception is the use of 2½- and 3½-inch hose aboard carriers for the high capacity fog-foam system.

4. Hose couplings have National Standard Hose Threads except for 1½-inch hose which has pipe threads. Threads for fire hose used on board ship are:

Size (inches):	Threads per inch
1½	11½
2½	7½
3½	6

5. Fireplugs on Naval ships that use 2½-inch hose connections are reduced to 1½-inch hose connections on superstructures and below deck areas to facilitate handling of

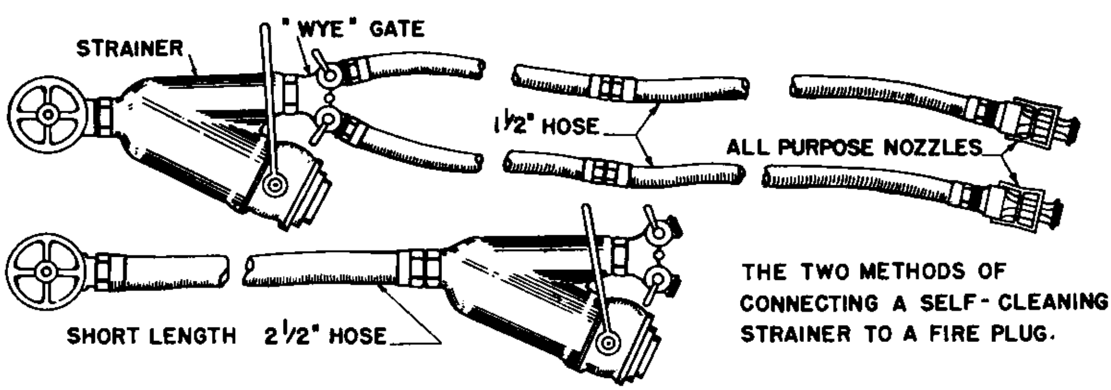


Figure 9930-7.

hose. This is accomplished by reducing connections or Y-gate valves.

6. On ships with 2½-plugs, 100 feet of 2½-inch hose is stowed and connected to each main weather deck plug. In below deck areas 200 feet of 1½-inch hose is stowed with each plug but only 100 feet is connected to one of the Y-gate outlets.

7. On all superstructures and all areas of 1½-inch plug ships, 100 feet of hose is stowed at each plug with only 50 feet connected.

9930.72 FAKING HOSE

Fire hose that is not in use or stowed in the repair party locker or elsewhere is faked on racks attached to bulkheads. When 2 hose lines are faked beside a fireplug, the general practice is to leave one unconnected and the other 100 feet connected (figure 9930-10). However, in certain small compartments 50 feet of hose may be sufficient. The line is always faked with the ends hanging downward so that the couplings and nozzles are readily at hand for instant use. The bottom of the folds should be at least 6-inches above the deck to allow proper swabbing. The lines are equipped with all-purpose nozzles. Applicators equipped with fog heads and the spanner wrench are racked on the bulkhead near them.

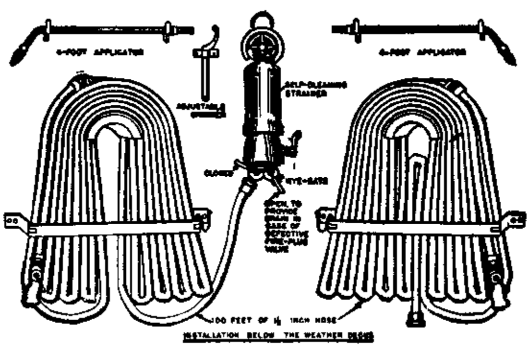


Figure 9930-10.

9930.73 STOWING HOSE

Hose to be stowed is rolled into a coil and sometimes tied with a small line. The coil is made by first laying the hose out on deck and doubling it so that the male end reaches 3 to 5 feet from the female end. The rolling is started at the fold, which is rolled inward on the part of the hose leading to the male end. The completed coil will then have the female end of the hose on the outside, and about 3 feet behind it, at the end of the second fold, the male end of the hose. The male coupling is thus protected from damage to its thread (figure 9930-11).

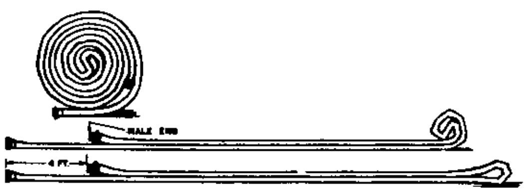


Figure 9930-11.

9930.74 IMPORTANCE OF PERIODIC INSPECTION

Hose maintenance consists of periodic inspection and servicing of hose in use and in storage, also vigilant examination of all hose for signs of injury or deterioration. Division officers should ensure that personnel are trained to recognize the importance of hose upkeep. Improper and careless hose maintenance shortens hose life and may result in hose failure at a critical time.

9930.75 MAINTENANCE DIFFICULTIES

Hose maintenance is complicated by the fact that its components present entirely dissimilar problems. The cotton jacket and rubber lining deteriorate with age whether or not the hose is used. However, good hose will last from 5 to 10 years if given proper care. Wherever possible, hose should be kept or stowed in cool, dry places as heat causes hardening and cracking of the rubber lining while moisture will cause mildrew to form on the jacket, a fungus growth that destroys the cotton fiber. Another common cause of hose failure is damage to the cotton jacket caused when the hose is not properly drained and dried. Hose is also ruined by gasoline and oils which act to dissolve the rubber or cement which holds the inner jacket and lining together. Couplings as well as the hose are subject to various forms of mechanical injury when carelessly handled. Methods for alleviating undue deterioration of hose are outlined in following article.

9930.76 INSPECTION RUBBER-LINED HOSE

Inspect cotton-jacketed, rubber-lined hose and rubber-covered, rubber-lined hose periodically using the following procedures:

1. **Weekly inspection.**

a. Check hose on racks to see that it is dry and correctly stowed on hose rack.

b. Inspect reserve hose rolls to ensure that they are properly stowed in racks in a cool, ventilated compartment and not in piles on deck.

c. Make sure that hose is not unnecessarily exposed to moisture.

2. **After use.**

a. Lay out, carefully inspect for abrasion of jacket, damage to couplings, and rupture of hose. Then clean. Never scrub with soap unless absolutely necessary to remove grease or oil. Drain and dry hose thoroughly before returning to hose racks.

b. Rubber-covered, rubber-lined suction hose should be carefully cleaned and wiped to remove all traces of oil or grease.

3. **Couplings.**

a. Examine threads. Clean with fine wire brush if necessary.

b. Clean dirty or jammed couplings, using soapy water to loosen hardened lubricant. Lubricate female coupling by immersing in a mixture of mild soap and water and allow to dry. Do not use strong soap, chemicals, gasoline, oil, or grease to clean or lubricate couplings as they may injure the hose jacket or lining.

c. Inspect the gaskets and replace if worn or damaged. Do not use gaskets which project into the water stream.

d. Any hose or coupling found damaged or defective should be replaced. The defective item should be turned in to the nearest repair activity for repair or replacement.

4. **Monthly inspections.**

a. Remove all 1½-, 2½-, and 3½-inch rubber-lined hose that has been on the racks continuously for 30 days, examine for excessive chafing or set, then rerack. Make sure that folds are not made at the same points as before, to prevent cracking of rubber linings.

b. 2- and 4-inch rubber suction hose for handybilly and P-500 pumps shall be visually inspected.

5. **Hydrostatic test.** Make a 250 psi hydrostatic test of all fire hose when alongside a tender or during shipyard availability. If practical, hydrostatic tests should be made every 6 months.

9930.77 FIRE HOSE FITTINGS

1. Many different fire hose fittings are used for assembling hose lines. Those used aboard ship are the female coupling, the male coupling, the double female coupling, and the double male coupling. Two reducing couplings are used: namely, the straight reducing couplings, and the Y-gate for reducing to two small lines, also the straight increasing coupling. All hose couplings for fire lines on Naval ships are made with uniform thread dimensions. They have an unobstructed waterway that is the full diameter of the hose; the rubber gaskets should not protrude into the waterway. The couplings are made fast to the hose ends by means of expansion rings, which are set inside the hose and force it against the coupling. To prevent cutting of the hose fabric at the place where the hose leaves the coupling, the tailpiece overhangs the expansion ring by 1/8-inch (figure 9930-12).

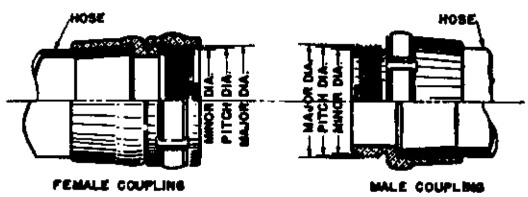
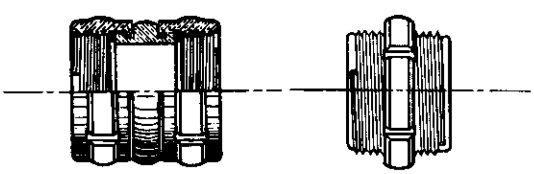


Figure 9930-12.

2. The double female coupling (figure 9930-13), 2½ or 1½-inches in diameter, is furnished in order to facilitate connecting 2 male couplings and for making up jumper line assemblies, and also for connecting a 2½- or a 1½-inch male coupling to a fireplug.

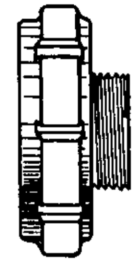
3. The double male coupling, 2½- or 1½-inches in diameter, is furnished to facilitate connecting 2 female couplings, and also for making nozzle connections on female outlets (figure 9930.13).



DOUBLE FEMALE COUPLING   DOUBLE MALE COUPLING

Figure 9930-13.

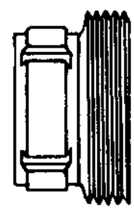
4. The straight reducing coupling serves to reduce a 2½-inch size to a 1½-inch size, either on a fireplug or hose line. It has female threads at the large opening and male threads at the reduced opening (figure 9930-14).



REDUCER COUPLING
2½" X 1½"

Figure 9930-14.

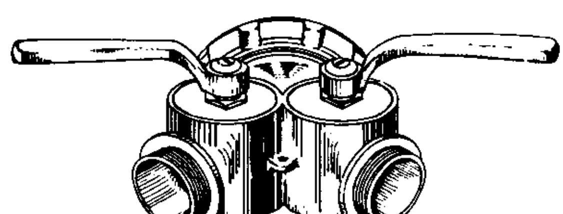
5. The straight increasing coupling serves to increase a 1½-inch size to a 2½-inch size, either on a fireplug, hose line, or a pressure proportioner. It has female threads at the small opening and male threads at the increased opening (figure 9930-15).



INCREASER COUPLING
1½" TO 2½"

Figure 9930-15.

6. The Y-gate is used to attach two 1½-inch lines to a fireplug or to reduce a 2½-inch line to two 1½-inch lines. The standard Y-gate is equipped with 2 stop valves, so that either lead can be controlled independently of the other (figure 9930-16).



"WYE" GATE. 2½" INLET. TWO 1½" OUTLETS

Figure 9930-16.

7. Additional couplings are furnished for use in connecting the handybilly and P-500 pumps to fireplugs and hoses. (See figures 9930-17, 9930-18, and 9930-19).

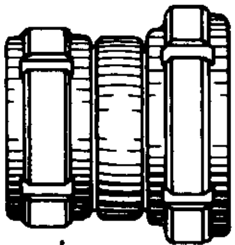


Figure 9930-17.

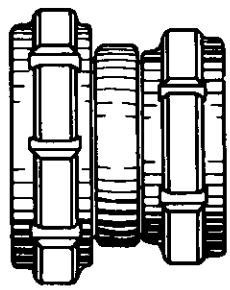


Figure 9930-18.

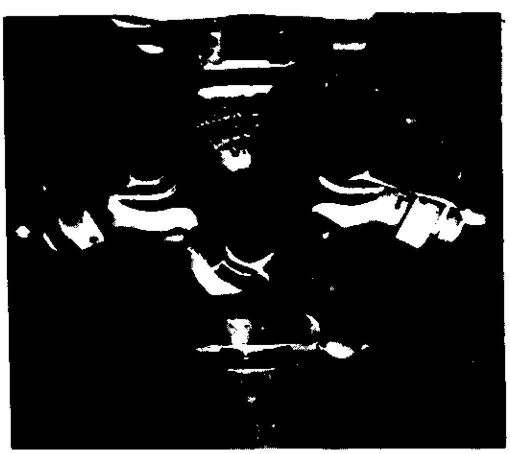


Figure 9930-19.

9930.19 CHECKING PRESSURE

1. When put into service, either the 2½-or the 1½-inch hose, equipped with the proper nozzle should deliver a stream of water that is consistent in volume, in pattern, and in distance. If there is a failure in these, the fire fighter should look back at the lay of his hose to see whether or not there is a double twist or kink which would have a tendency to break the stream a few feet from the nozzle or reduce the pressure. He then should inspect the nozzle tip for a possible obstruction at the edge that would cause premature breaking of the stream. If neither of these causes is present, it is probable that the pressure on the stream is too low.

2. Low nozzle pressure could result from clogging in the quickly-cleaning strainer at the fireplug. In view of this possibility, especially in tropical waters where marine growth is plentiful, or during battle when concussion would shake encrustation particles loose, the fire fighter should open the cleanout valve on the strainer and thus flush it out. Should the operation prove ineffective, he should immediately lay a line into the adjoining sectionalized fire main if possible; or in case of ruptures, he should close stop valves and install a jumper line to furnish the system with water. In certain circumstances he should use the portable pumps to increase a weak fire main pressure.

9930.79 LOSS OF PRESSURE DUE TO FRICTION

1. In appraising the performance of a stream of water from a fire hose, the fire fighter should take into consideration the loss of pressure in hose lines that is due to friction against the walls of the hose. When water is admitted to a hose, its lateral pressure on the walls of the hose causes small depressions to form in a rippling succession. The friction of the water against this uneven surface reduces the pressure as the stream moves along.

2. Friction loss not only in the hose but in the fire main and fittings as well accounts for much of the usual difference in pressure between the fire main pumps and the nozzles. The possible loss from clogging, just referred to, is a second factor; and a third is the further loss that results when pipes and hose are led upward, known as loss due to static head. Two other conditions that would cause a drop in nozzle pressure may be encountered; the line may be ruptured; or so many lines may be laid to a fire (or fires) that the capacity of that section of the fire main is overtaxed. In the latter event, if the situation cannot be remedied at the pumps, some of the hose lines should be shut off in order to increase the nozzle pressure on the lines laid to the most vital positions. A few properly charged hose lines are more effective than many undercharged hose lines.

9930.80 CALCULATION OF FRICTION LOSS

Loss due to friction can be calculated for all normal situations. Many such calculations have been made; and the results have been recorded in tables, which are available for reference when needed by those whose duty it is to maintain efficient fire-main service. For the calculation of friction loss, the length, diameter, and character of the line (whether pipe or lined or unlined hose) and the number, size, and design of fittings are considered. The National Fire Protection Association's Handbook of Fire Protection contains most of the accepted friction loss tables as well as formulae for calculating friction loss under various conditions.

9930.81 EFFECT OF VELOCITY ON FRICTION LOSS

These data alone, however, are insufficient, since the velocity of the stream also affects friction loss. In fact, friction loss increases approximately as the square of the velocity. In view of the effect of velocity on friction loss, it follows that anything which causes a change in velocity

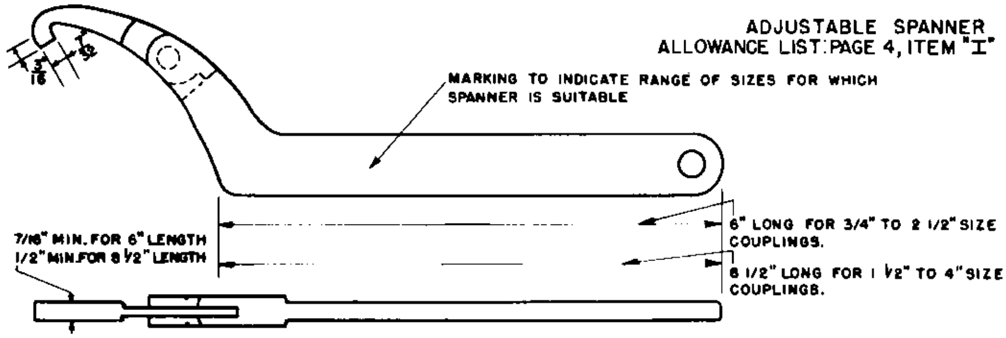


Figure 9930-20.

enters directly into the matter of friction loss. For instance, with the same nozzle outlet, increased pressure in a line would increase velocity; and with the same nozzle pressure (and the same line), an increase in the size of the nozzle outlet would result in increased velocity. Either of these changes alone would, therefore, increase friction loss. (A reduction in the size of the line would contribute twoard an increase in friction loss.)

9930.82 RESULT OF FRICTION LOSSES

The fire fighter does not have to calculate friction losses, but it is well for him to understand what happens when he connects additional hose, or reduces a single line to two smaller lines, or makes other adjustments. He will know then why it is, for example, that a fireplug pressure of 100 psi delivers only 83 psi to a 1-inch nozzle outlet at the end of 100 feet of 2½-inch hose, and delivers only 70 psi to a 5/8-inch nozzle outlet at the end of 100 feet of 1½-inch hose. In general, he will be able to lay out hose lines more intelligently.

9930.83 SPANNERS

To facilitate the laying of hose, adjustable spanners designed to fit the hose couplings automatically are provided in two sizes. (See figure 9930-20.)

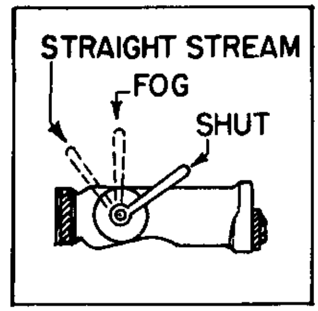


Figure 9930-21.

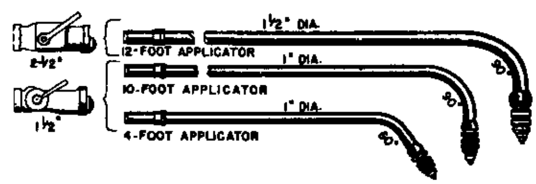


Figure 9930-22.

Part 2. All Purpose Nozzle

9930.91 OPERATION

1. The all-purpose nozzle is controlled for three operations by a single valve; it can project either a solid stream or a fog and it can be turned off. To put the nozzle in operation, the fire fighter pulls the valve back from the "shut" position to the "fog" position, which is half way back to the "open" or solid stream position. (See figure 9930-21.) The all-purpose nozzle is provided in 2 sizes; for 1½- and 2½-inch hose (figure 9930-22).

2. Fog is generated in the all-purpose nozzle either by a low-velocity fog head or a high-velocity nozzle tip; a number of small outlets drilled at converging angles in the head or the tip break down the water stream into fog particles by impinging the streams on one another. The size, design, and placing of these outlets determine the velocity with which the fog particles emerge from the nozzle. Control of this velocity is desirable, because for some fire-fighting tasks a low velocity fog is preferable and for others, a high-velocity fog.

3. If a high-velocity fog is desired, the high-velocity nozzle tip is left in place in the fog outlet on the nozzle (figure 9930-23). If a low-velocity fog is desired, the tip is removed, and an applicator equipped with a low-velocity head is snapped into place in the fog outlet on the nozzle. A bayonet joint holds the high-velocity tip or the applicator in the nozzle (figures 9930-22,9930-24, and 9930-25) when they are in use. The high-velocity tip is permanently attached to the nozzle with a short piece of chain.

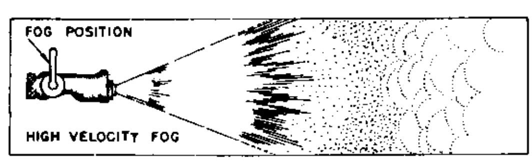


Figure 9930-23.

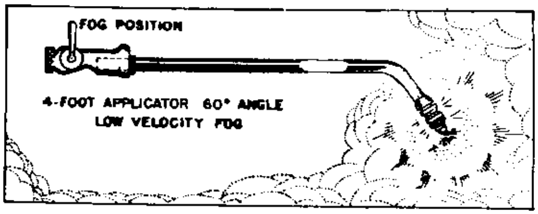


Figure 9930-24.

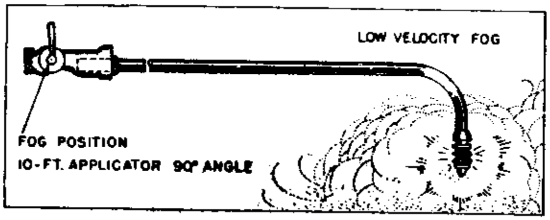


Figure 9930-25.

4. For both the low-velocity head and the high-velocity tip, the water pressure is the same, since pressure is not the differentiating factor in the velocity achieved by the two. For the best results with either, the water pressure at the nozzle should be maintained as close to 100 psi as possible. They operate acceptably with a water pressure down to 60 psi.

5. In the high-velocity fog nozzle tip (figure 9930-23), the outlets are larger and have a different angularity than those in the low-velocity fog head. At 100 psi pressure, the fog stream is projected a distance of more than 20 feet from the 1½-inch nozzle with the high-velocity tip and more than 30 feet from the 2½-inch nozzle with the high velocity tip. The fire fighter is more or less shielded behind it and can approach closer to the fire or stand away as the conditions require. Two and one-half inch high velocity tips currently on board ship are of two types, externally and internally impinging. The externally impinging tip makes a finer fog but the apparent greater velocity of the internally impinging tip drives back the fire better and gives the fire fighter better protection, particularly when advancing into the wind.

6. In the low-velocity fog head (Fig. 9930-24 and 9930-25) the outlets are smaller than those in the high-velocity nozzle tip and so designed and placed that the water stream is broken down into finer particles. The water particles do not have force for more than a few feet from the fog head. In consequence of this fact and for advantages in reach and precision, the low-velocity head is never used on the nozzle directly, but always with an applicator-a 4-foot piece of 1-inch pipe with a 60° curve at the outlet end or a 10-foot pipe of the same diameter with a 90° curve for the 1½-inch nozzle, or a 12-foot piece of 1½-inch pipe with a 90° curve for the 2½-inch nozzle (figure 9930-22). The fog head is screwed into the outlet end of the applicator, which is then snapped into place in the fog outlet on the nozzle. (There is a separate outlet for the solid stream.) Without the extended reach the applicator gives him, the fire fighter would not only be enveloped in a fog of his own making and, therefore, impeded in his work, but he would have to approach to within a few feet of the fire. The applicator, furthermore, enables him to reach over or around obstructions in order to place on the fire a cooling, smothering blanket of fog.

7. The all-purpose nozzle when equipped with the applicator and fog head projects a fog having the maximum of diffusion and, therefore, one that presents the maximum total surface for the absorption of heat. The fog pattern from the fog head is at its most effective dimensions 5 or 6 feet from the tip of the applicator. The high-velocity nozzle tip on the 1½-inch all-purpose nozzle sends a stream of fog several times this distance, and on the 2½-inch nozzle, five or six times this distance. High-velocity fog has a lower degree of diffusion, but it provides force and range. Whether from a low-velocity head or a high-velocity tip, the fog extinguishes fire by absorbing heat and by reducing the supply of oxygen through infiltration above the fire.

8. Applicator heads and high-velocity tips must not be cleaned with brightwork polish or emery cloth nor should applicator butts be cleaned with emery cloth. Brass parts may be kept clean with fine steel wool and those exposed to the weather may be wiped lightly with rustpreventive compound.

9. Low velocity 2½-inch piercing applicators are to be issued as allowance items for aircraft carriers. The piercing applicator is for shipboard use in aircraft fires for cooling munitions inside the burning aircraft, and to assist in the general fire extinguishment problems involved.

9930.92 WATER STREAM

When the valve of the 1½-inch all-purpose nozzle is moved to the "open" position, the nozzle releases a water stream through an outlet 5/8-inch in diameter. With a pressure of 100 psi at the fireplug, a solid stream is protected to a distance of about 65 feet. On the 2½-inch nozzle the solid stream outlet is 1 inch in diameter and the projection distance is about 75 feet. Water, either in the form of a solid stream or fog, is effective against class A fires (bedding and general stores), but a solid stream (figure 9930-26) should not be used on class B fires (oil and gasoline), where it will have a tendency to spread the fire. In combating class A fires, the solid stream should only be used for breaking up and penetrating class A material after surface fire has been reduced by water fog.

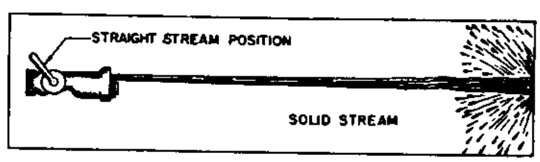


Figure 9930-26.

9930.93 NOZZLE DISCHARGE PATTERNS

The following figures 9930-27 to 9930-32 show the discharge rates and patterns for the all-purpose nozzle and associated equipment.

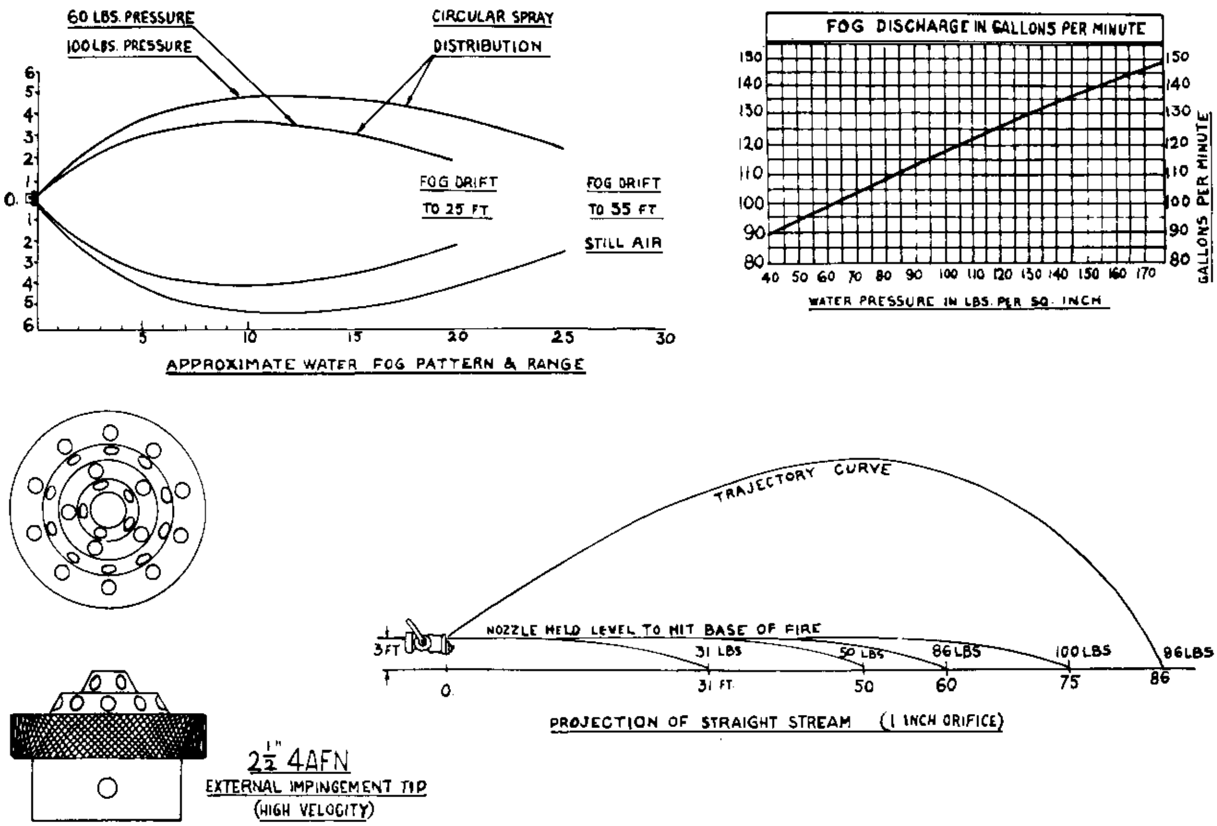


Figure 9930-27.

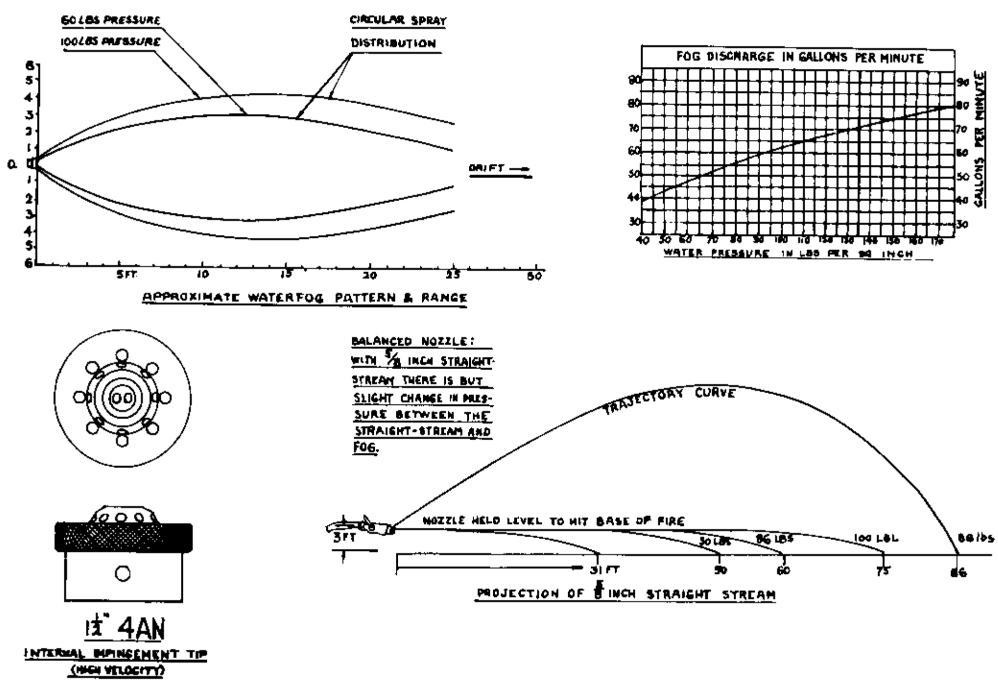
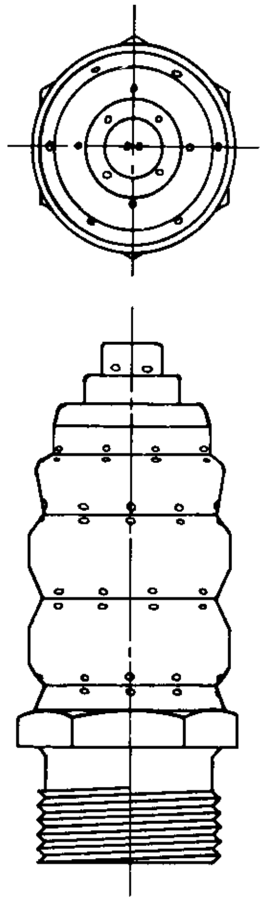


Figure 9930-28.



LOW-VELOCITY HEAD
2½" NOZZLE APPLICATOR

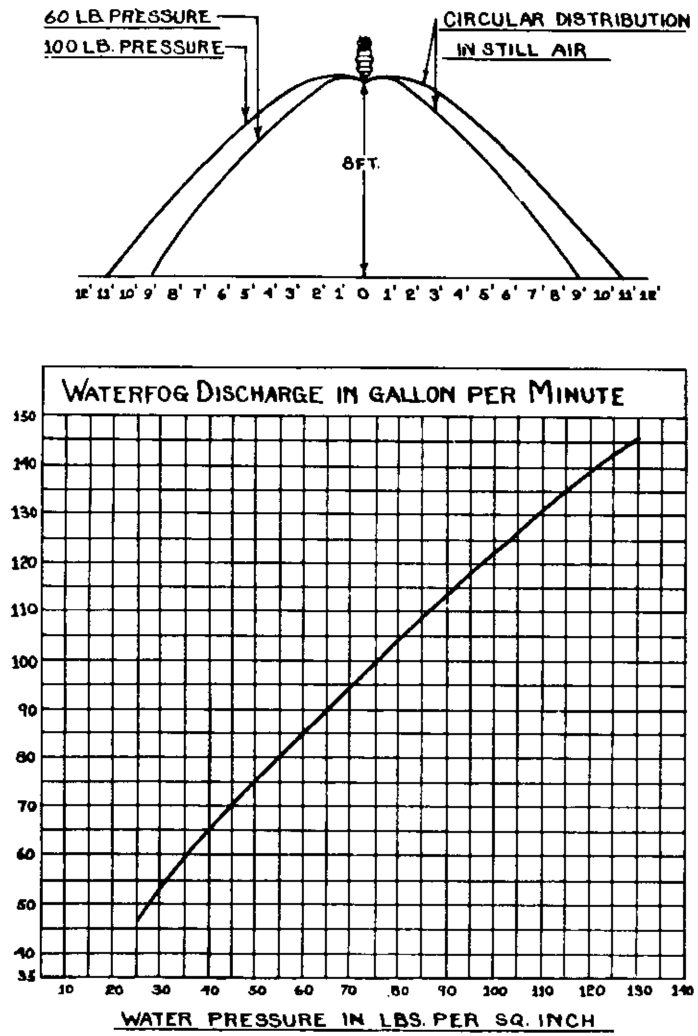
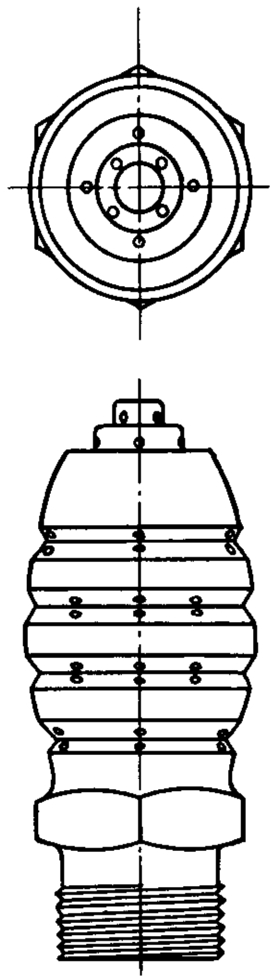
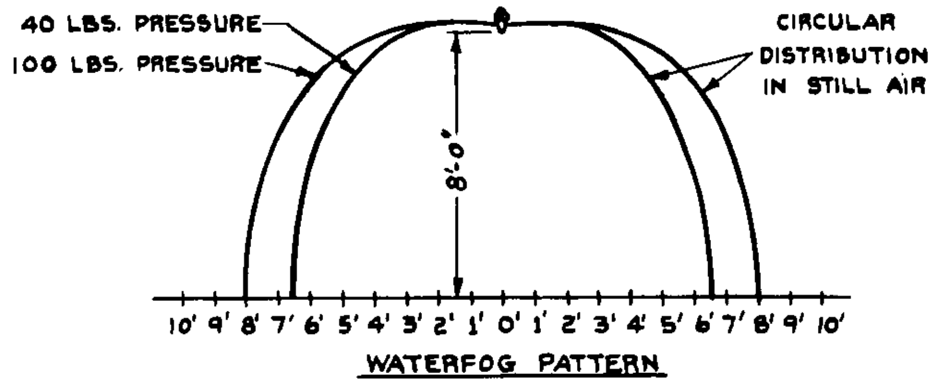
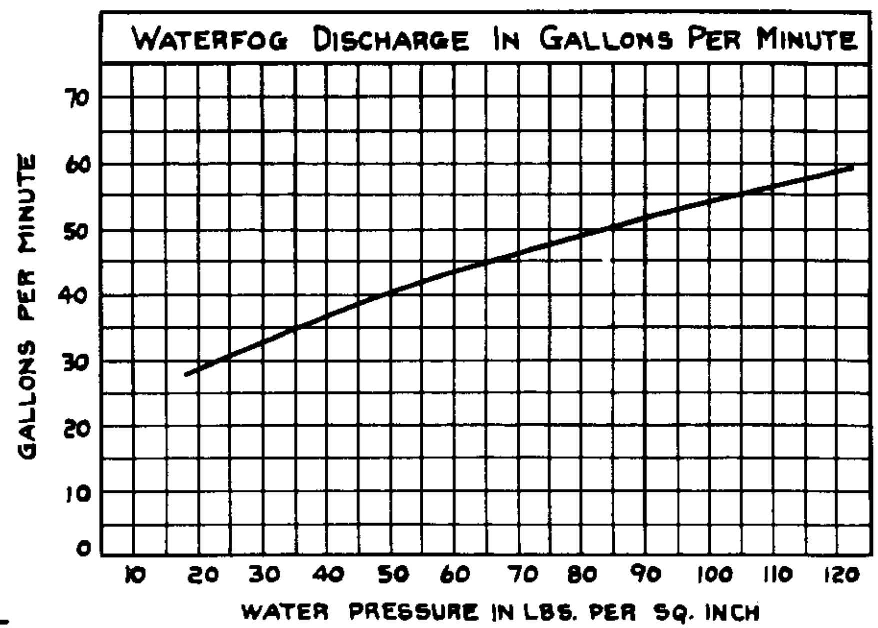


Figure 9930-29.

FOR OFFICIAL USE ONLY







L-11 WATERFOG HEAD

ROCKWOOD SPRINKLER CO.

Figure 9930-30.

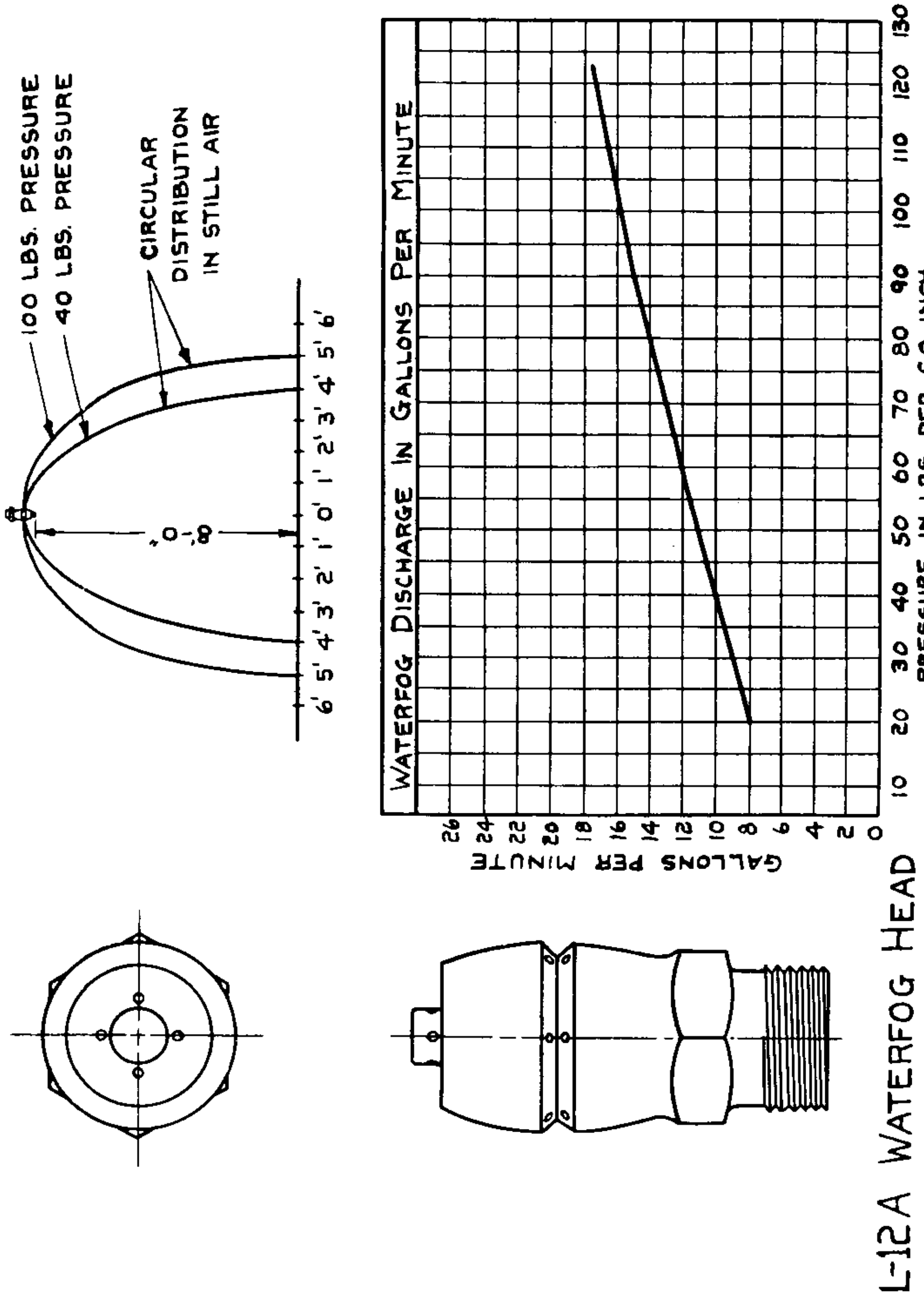


Figure 9930-31.

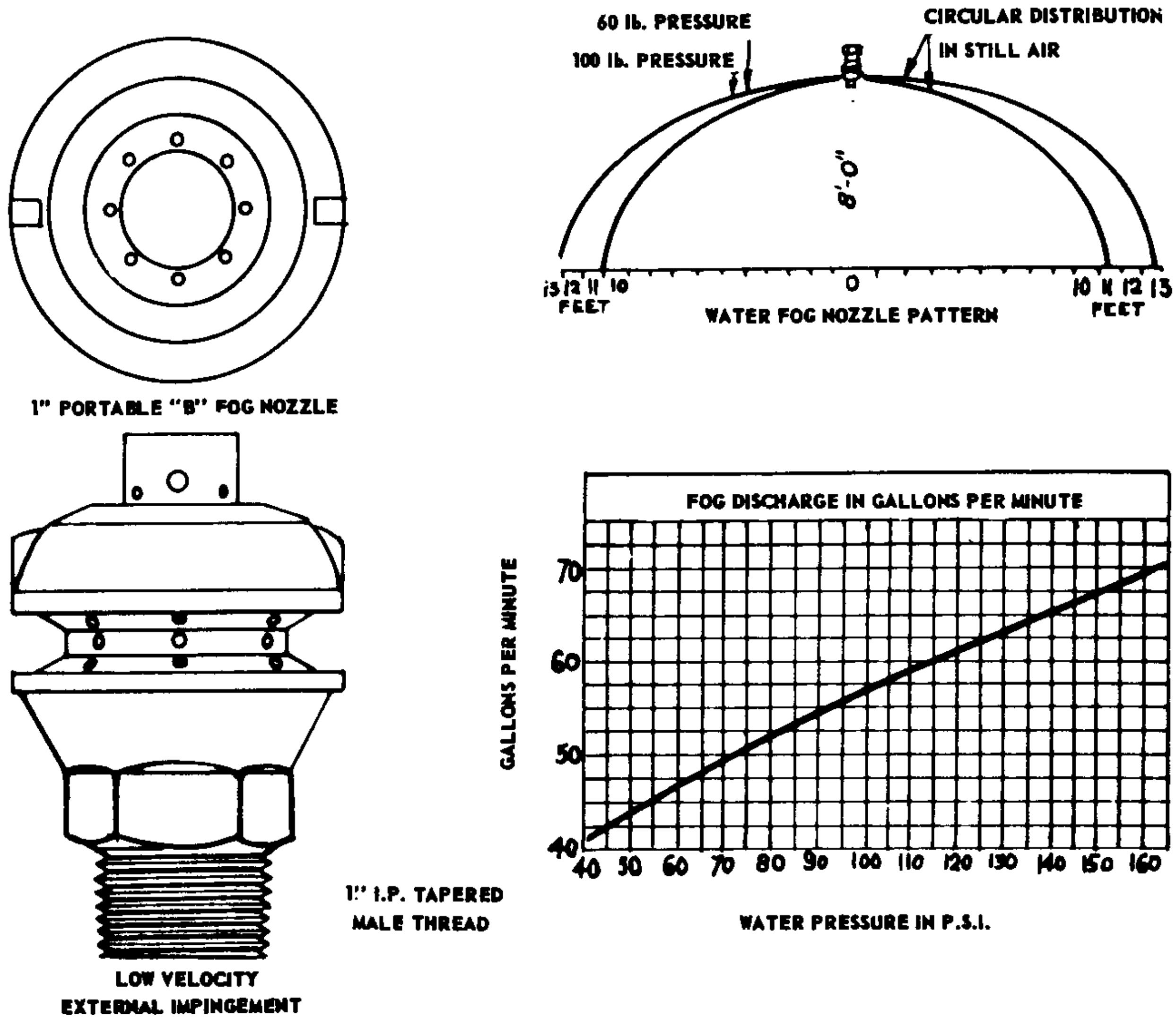


Figure 9930-32.

FOR OFFICIAL USE ONLY

Part 3. Fog-Spray Installations

9930.101 FIXED INSTALLATIONS

In certain Naval ships exceptional gasoline explosion hazards warrant the use of fixed fog-spray installations. These installations, which are nonautomatic consist of overhead fixed piping, equipped with fog heads, that are connected to two female hose connections. One of these connections is located on the opposite side of a bondary bulkhead of the protected area and the other is located on the deck above. A check valve is desirable in the piping near each connection. To operate the system a 2½-inch hose is connected to a fireplug and to one of the female connections, and water is admitted. The more convenient hose connection is used to furnish the system with water (figure 9930-33).

9930.102 FOG AND WATER CURTAINS

Water curtains are provided to sectionalize the hangar deck of those carriers not equipped with a hangar foam sprinkler system. These curtains are equipped with shovel-type open sprinkler heads and are installed athwartship. Nonautomatic fog heads are installed at specific boundary bulkheads on certain decks of vessels, such as transports and cargo ships, in order that tranverse fog curtains can be maintained to prevent the rapid spread of fires. These installations make it possible to sectionalize a ship for fire protection with a series of fog curtains. Spare fog heads are furnished for the purpose of replacements and the improvising of an emergency system. The number of spare heads is listed in the allowance list of fire-fighting material.

Part 4. Foam Equipment

9930.111 CHEMICALS USED

Mechanical foam is produced from a liquid foam-making solution known as the type 5 charge. Foam liquid consists essentially of a concentrated water solution of a hydrolyzed protein foaming agent. It also contains various materials which give the water-film globules sufficient heat stability so that breakdown does not occur. In tests, mechanical foam has demonstrated that it has firm texture, is free flowing and retains its consistency for long periods.

9930.112 EQUIPMENT USED

The equipment for proportioning and applying foam may be described as follows:

1. Mechanical foam depends upon the presence of a liquid-foaming agent in the water stream and the entrainment of air in the water-foaming agent mixture. This entrainment of air may occur in a FFF nozzle, a mechanical foam nozzle, or a sprinkler head. The easy manner in which the foaming agent can be introduced into the water stream recommends mechanical foam for shipboard use. This can be accomplished as follows:

   a. At the nozzle by means of a pickup tube (siphon).

   b. At the suction side of the internal combustion engine (handybilly) pump by means of a pickup tube (siphon) attached to an S-type suction proportioner.

   c. At any intermediate point in the hose line with a portable duplex pressure proportioner having continuous operation characteristics.

   d. At any point in the fire main system by permanently installing a duplex pressure proportioner.

   e. At any point in the fire main system or in the hose layout by installing a water-motor proportioner (proportioner pump).

2. These devices are designed so that proportioning results in a solution of 6 percent liquid foaming agent and 94 percent water.

3. Five gallons of the mechanical foam type 5 charge weighing 50 pounds are stored in sealed containers, and should be kept in a suitably sheltered place to protect them against temperatures below 25°F. or above 125°F. and external corrosion of the cans.

9930.113 THE PICKUP TUBE (FOR MECHANICAL FOAM)

Three devices are used in conjunction with pickup tubes for introducing mechanical foam liquid into the water stream. They are portable and all three use a pickup tube (a short piece of 5/8-inch metal pipe with a rubber hose on one end) to draw up the contents of 5-gallon containers.

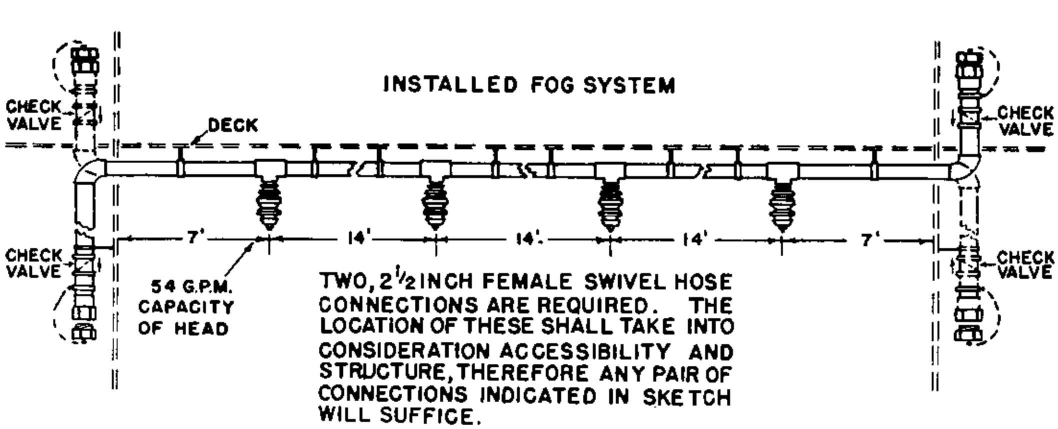


Figure 9930-33.

These pickup tubes are actuated by the suction created in the suction chamber of the mechanical-foam nozzle, foam pump side of the portable FP-180 water motor proportioner, or in the S-shaped suction proportion chamber that is attached to the intake side of a gasoline handybilly pump. The pickup tube should be fitted with a shoe that holds the inlet approximately 1½-inches above the bottom of the container. If a suitable shoe is not provided, one should be fabricated locally in accordance with figure 9930-34.

9930.114 THE MECHANICAL-FOAM NOZZLE

1. The mechanical-foam nozzle (figure 9930-34) consists of a 21-inch piece of flexible metal, or asbestos composition hose, 2 inches in diameter, with a solid metal nozzle outlet and, in the butt end, a suction chamber and an air port. The foam discharged is a mixture of water, liquid-foam solution, and air. The mechanical-foam nozzle is used with a pickup tube attached to it, but the pickup tube should be removed when the foaming liquid is introduced into the water stream by means of foam proportioner or the S-type suction proportioner on the handybilly pump.

2. When the pickup tube is used with the mechanical-foam nozzle directly, it is attached by its hose end to the suction proportion chanber in the butt end of the mechanical-foam nozzle, just behind the air port. The metal-pipe end is inserted into a container of mechanical-foam solution. One gallon of liquid-foam solution will produce about 133 gallons of mechanical foam. The contents of 1 can of liquid (5 gallons) will last approximately 1½ minutes, and produce about 660 gallons of foam in that time.

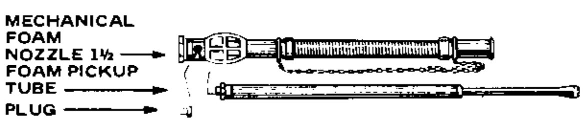


Figure 9930-34.

9930.115 TO OPERATE THE PICKUP TUBE ON MECHANICAL-FOAM NOZZLE

1. Screw the hose end of the pickup tube into the butt of the nozzle. (Care must be taken to make tight seal.)
2. Man the mechanical-foam nozzle.
3. Turn on the water at source of supply.
4. Insert the metal-pipe end of the pickup tube into a container of mechanical-foam solution; push it to the bottom and hold it down firmly (figure 9930-35).

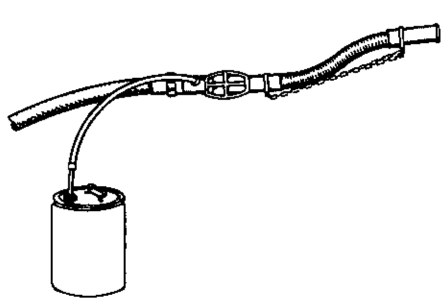


Figure 9930-35.

5. When the container is nearly empty (estimated at about a minute and a half after the pickup tube has been inserted) take out the pickup tube and insert it into another container.

9930.116 S-TYPE SUCTION PROPORTIONER (FOR MECHANICAL FOAM)

The S-type suction proportioner consists of a suction chamber on the suction side of an I.C.E.-driven pump (the gasoline handybilly) and a pickup tube. When the pickup tube is inserted into a container of mechanical-foam liquid and the pump is operated, the foam liquid is drawn into the suction chamber and forced into the water stream. It is carried through a 1½-inch hose to a mechanical-foam nozzle.

9930.117 TO OPERATE S-TYPE SUCTION PROPORTIONER

1. Man the mechanical foam nozzle.
2. Start the pump.
3. Insert the metal-pipe end of the pickup tube into a container of mechanical-foam solution, and push it to the bottom and hold it down firmly.
4. See that the cock on the S-type suction proportioner is in the position marked "Prime" or "water" and see that it remains in this position until the pump is primed and the water pressure reaches 100 pounds or more. Then turn the cock to "Foam" position; and set the pointer to the mark of the estimated lift from the level of the water supply to the pump.
5. When the container is nearly empty (estimated at about 1½ minutes after the pickup tube has been inserted) turn the cock on the S-shaped chamber back to the position marked "Prime or water" and insert the pickup tube into another container. Then turn the cock back to the position marked "Foam." (This procedure averts the possibility of the pump taking in air, and in consequence, losing suction) (figure 9930-36).
6. Before stowing the equipment, flush all channels thoroughly with fresh water and clean all screens.

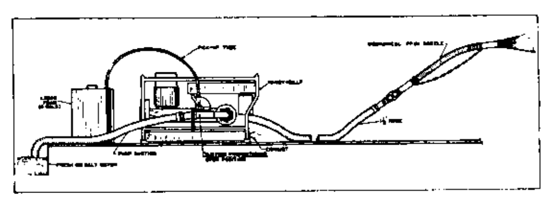


Figure 9930-36.

9930.118 THE DUPLEX PRESSURE PROPORTIONER

1. The duplex pressure proportioner is an installed or portable duplex cylinder for holding a mechanical-foam solution and injecting it in the proper proportion to a water stream at the time of fire. In order to provide a continuous, or nearly continuous flow of the solution-bearing stream to the fire, the cylinders, whether installed or portable, have an upper and lower chamber. One of these 10-gallon chambers is refilled while the other is in use (figure 9930-37).

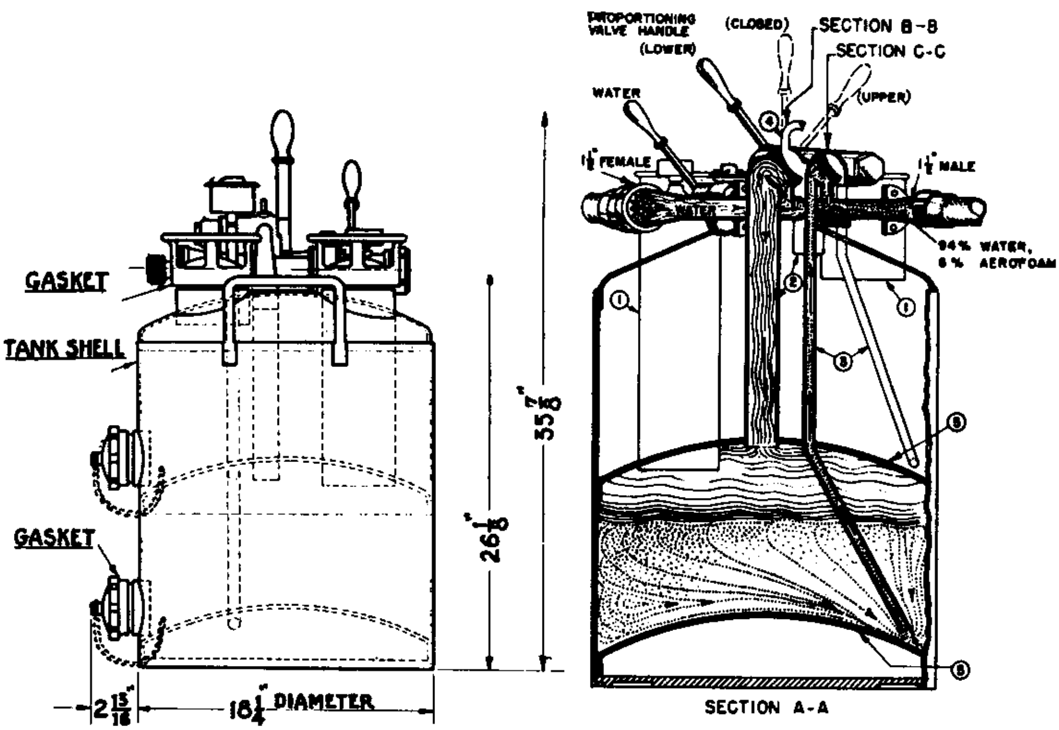


Figure 9930-37. Duplex pressure proportioner. Cross section shows lower compartment in operation.

2. For the operation of the pressure proportioner aboard Naval ships, water under pressure of 75 to 150 psi is admitted to a manifold at the top of the cylinder, and a portion of it is released into the main part of the cylinder, where it exerts a pressure on the foam solution. As a result of the pressure, the solution is forced up through a narrow tube that leads from the bottom of the cylinder to the top, and it allows the proper amount of the solution (6 percent) to feed into the stream leaving the cylinder. This process constitutes the "proportioning," that gives the device its name. The proportioner is equipped with a mechanical timer. By setting the timer at the start of operation, the operator will be warned when the time necessary to empty one tank has elapsed. From the "pressure proportioner" the solution of a foam and water is conveyed in a hose line to a foam nozzle.

9930.119 TO OPERATE THE DUPLEX PRESSURE PROPORTIONER

1. If the duplex pressure proportioner is portable (some are installed), locate it, if possible, to the windward side of the fire at a convenient distance.
2. Connect sufficient 50-foot lengths of 1½-inch hose from the source of water supply and connect the line to the inlet connection on the duplex pressure proportioner. The length of this hose line is immaterial if it permits sufficient pressure to be available at the proportioner (preferably 75 to 100 pounds).
3. Connect the discharge hose (1½-inch) to the male outlet of the duplex pressure proportioner. (The use of over 100 feet of 1½-inch hose is not recommended.)
4. Connect a foam nozzle to the end of the discharge line. (The pickup tube should be removed if a mechanical foam nozzle is used.)
5. Man the nozzle. (A nozzle man and a man to assist him take a position so that they can deposit the foam over the fire with a minimum of velocity.)
6. Open water valve on pressure proportioner (figure 9930-38).
7. Keep proportioner valve in vertical position. (Water then passes through proportioner without picking up foam liquid.)
8. Turn on the water at source of supply and wait until pressure gage on proportioner registers 75 psi or more.
9. Throw proportioner valve to the right or left (upper or lower compartment) and start timer (figure 9930-38).
10. When timer rings, throw proportioner valve to opposite position or other compartment, and reset timer.
11. To refill compartment, remove drain cap and fill cap. When drained, replace drain cap and refill compartment. Open two cans of liquid, using spike (which is built into under side of fill cap) to puncture a hole in top of each can to admit air. Pour both cans (10 gallons) into compartment and replace fill cap.
12. Repeat same process as long as foam is desired.
13. Clean and flush equipment after use.

9930.120 FP-180 WATER MOTOR PROPORTIONER

1. The FP-180 water motor proportioner has 2½-inch connections at both the inlet and outlet sides and two ½-inch foam pickup tubes. It is a positive displacement foam

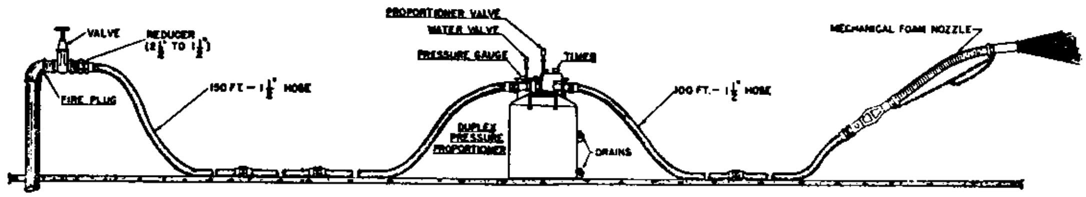


Figure 9930-38.

liquid pump driven by a positive displacement water motor. Flow through the water motor causes the foam pump to inject a metered amount of foam into the fire stream, depending on the position of the foam valve. (See figure 9930-39.)

2. The foam valve has 3 positions, 1 for each of the 2 pickup tubes and an "off" position. A plexi-glass sight tube enables the operator to determine when to shift from 1 pickup tube to the other as a foam can becomes empty, thus ensuring a continuous supply of foam. In the "off" position, with flow through the fire line, water is delivered through the foam pump under pressure, and both water-motor and pump "float" on the line making the fire line available for conventional fire fighting.

3. The FP-180 may be permanently installed for some applications. In this case flexible couplings must be attached to the water motor inlet and outlet and a fixed pipe leading from an installed foam tank will be attached to one pickup tube inlet and the other inlet will be plugged. The foam valve is placed in one position only.

4. The water motor proportioner is designed to proportion 6 percent foam liquid into the fire lines at inlet pressures of 75 to 175 psi and with flows of 60 to 180 g.p.m.

5. Foam can be dispensed by any of the four following combinations:

a. One 1½-inch line equipped with foam nozzle and proportioner supplied by either a 1½- or 2½-inch hose line.

b. Two 1½-inch lines wyed off from the 2½-inch outlet. Both lines equipped with foam nozzles.

c. Three 1½-inch lines with foam nozzles.

d. One 2½-inch line equipped with foam nozzle.

9930.121 OPERATION OF THE PORTABLE FP-180 PROPORTIONER

1. Connect inlet to 2½-inch hose line and connect discharge lines, within capacity of proportioner and as needed. (On ships having 1½-inch fireplugs single 1½-inch inlet and outlet lines can be used.)

2. Set foam valve to "off" position. Foam valve should always be in "off" position except when actually drafting foam.

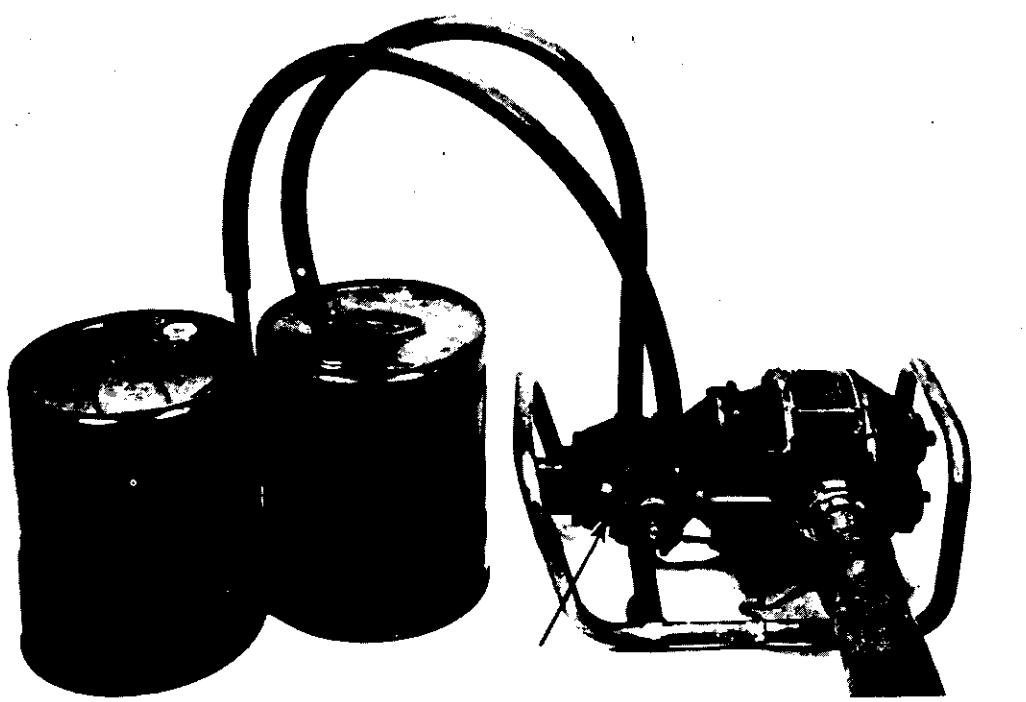


Figure 9930-39. Incoming, or upstream side, arrow points to handle in a foam position.

3. Insert each pickup tube in full foam can.

4. Actuate hose line. To start proportioning foam, shift valve to "foam" position. The valve is so designed that, in intermediate positions, a jet of water flows through the pickup tube, purging air and ensuring an immediate prime of the foam pump. No noticeable dwell at intermediate positions is necessary to complete the action. If foam liquid color does not show in the plexiglass tube within a few seconds, shift to the other foam position and check for a blocked pickup tube or an air leak in the line.

5. When a foam can is almost empty, shift to other "foam" position and replace empty can.

6. After proportioning foam, always flush the foam pump by running the proportioner two or three minutes in the "off" position, then work the valves two or three times when the unit is running. Return valve handle to "off" position when finished.

9930.122 OPERATION OF PERMANENTLY INSTALLED FP-180 FOAM PROPORTIONER

1. Installed FP-180 foam stations are arranged the same on all ships but may differ in type of controls used to actuate the system. Controls may consist of local manual control valves or remote hydraulic control valves.

2. The station will be composed of an FP-180, 50-gallon foam tank and associated piping and valves. The foam tank is arranged for quick filling from 5-gallon cans. Fitted with a vent, drain connection gage glass and access plates for cleaning.

3. The stations are installed to supply foam for machinery spaces and helicopter landing platforms. Proportioners for landing platforms are arranged for local manual control at the station. Those for machinery spaces may be arranged for remote control from the foam hose outlets in the machinery and/or local manual control at the station. Figure 9930-40 shows the latest machinery space foam installation. The system is activated by turning the control cock to "drain", relieving pressure on value 1 which opens admitting seawater. Valve 2 is then opened by firemain pressure admitting foam liquid to the proportioner. This type system fails open, that is, any breech of control lines actuates the foam proportioner. The foam outlet valves still have to be opened to supply the hose lines.

4. On older installations, valve 1 is similar to valve 2 and is opened by turning the control cock to a position which admits firemain pressure to the valve bonnet, opening the valve. This type system fails closed when the control lines are breeched.

5. On still older installations the foam outlets are located outside the space on damage control deck with the foam station. In this case, one must leave the space to obtain the hose line and activate the station.

9930.123 CARE AND MAINTENANCE OF THE FP-180 WATER-MOTOR PROPORTIONER

1. Foam liquid dries into a hard-surfaced sticky film that may prevent operation of the proportioner. It is therefore important that the pump and water motor be carefully flushed after each use. The unit should be thoroughly drained after flushing. Stand the unit on the water motor discharge and turn the extended shaft clockwise with a wrench applied to the milled flats on the end of the shaft.

2. After draining, a few ounces of light lubricating oil should be squirted into the motor through the suction and discharge openings. Oil should also be squirted into the foam valve and foam pump. To get oil into the foam pump, place the foam valve in a "foam" position and pour oil into the corresponding pickup tube opening. Turn the extended shaft several revolutions by hand to distribute the oil within the proportioner.

3. The proportioner should periodically be checked for free turning. Always replace the cover over the extended motor shaft to prevent oil leakage or entrance of foreign matter.

4. If the unit fails to turn freely and there are no foreign objects in the water motor visible through inlet or outlet connections, look for dried foam liquid or foreign matter in the foam pump. Have the foam valve in one of the "foam" positions. Pour water through the corresponding inlet connection and turn the rotors first one way then the other. Hot water dissolves caked foam liquid deposits faster than cold water. Never use gasoline or any solvent to wash out dried foam liquid. It may be necessary to remove the foam valve and accessory piping from the pump and pour water directly into the pump ports. At any time that this is done, it is well to clean all foam-carrying accessories before they are replaced on the unit.

9930.124 HIGH-CAPACITY FOAM SYSTEM

Another water-motor proportioner is the FP-1000 used in the high capacity foam system. This system was designed to protect the hangar of well, vehicle and flight decks ships from fires involving large areas of burning fuel. It has also been adapted for installation on certain fire fighting tugs.

9930.125 TYPES

1. The arrangement of the high capacity foam stations is generally the same on most ships. The following paragraphs will discuss only those installations on aircraft carriers, but an analogies can be drawn between these stations and those provided for the protection of well decks and vehicle cargo holds.

2. On aircraft carriers two types of installations have been developed and tested for the foam risers downstream of the proportioner. The major difference between the two is that in one the risers from the foam-injection stations are charged at all times while in the other these risers are dry. Since wet-type installations are being replaced by the dry type, discussion in this chapter will deal principally with the latter, and important differences between the two types will be pointed out.

9930.126 FIRE MAIN RISERS FOR FOAM INJECTION STATIONS

In the majority of instances, the water supply for the foam-injection stations is taken by special risers from the nearest vertical cross-connection of the fire main. These risers are equipped with root valves which are locked open but may be closed in the event of damage to the riser or when it is necessary to make repairs on the system. These risers serve the foam system only and should be so stenciled. Diagrammatic sketches of injection stations are shown in figures 9930-41, 9930-42, and 9930-43.

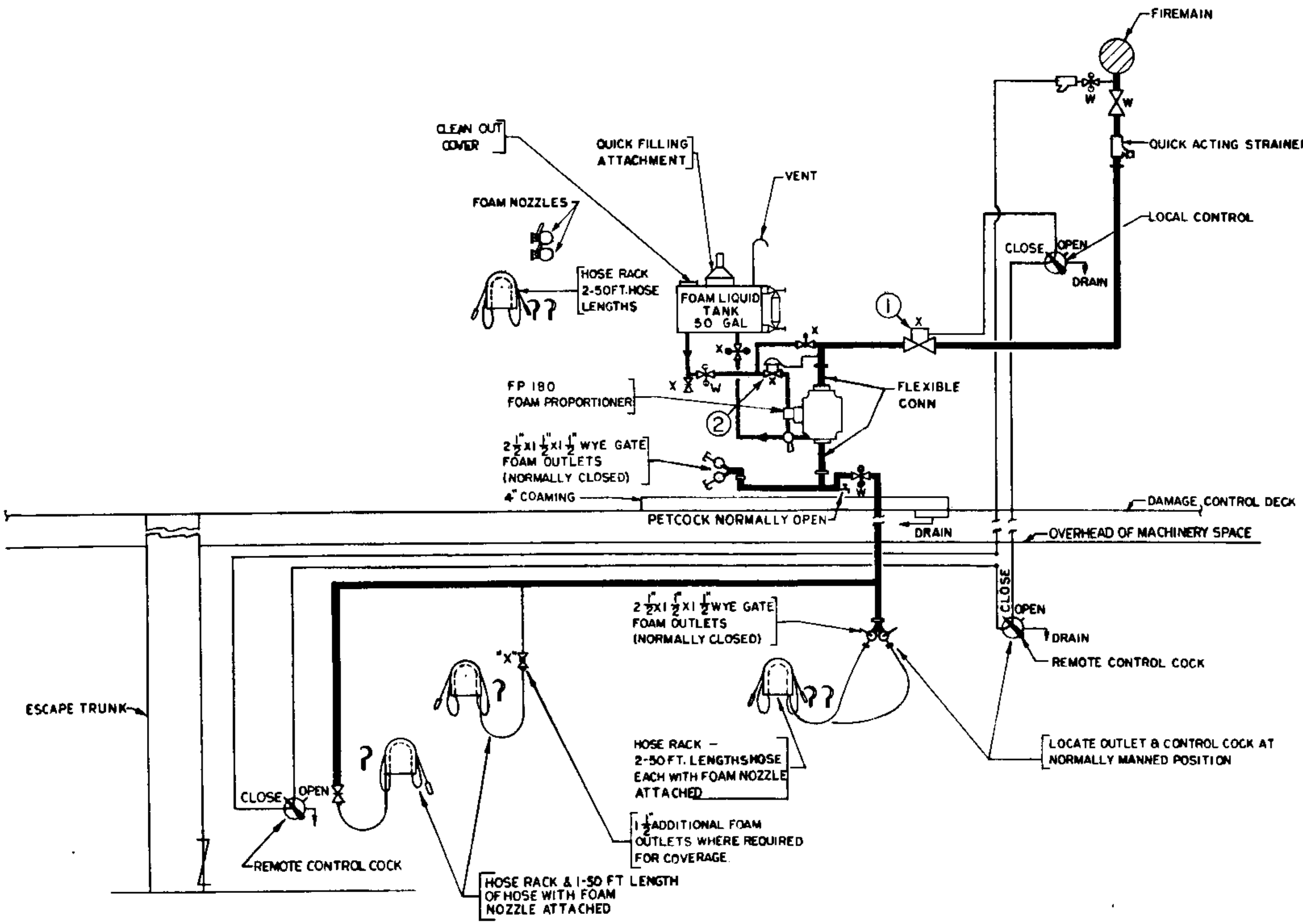


Figure 9930-40. Diagrammatic arrangement of foam hose system.

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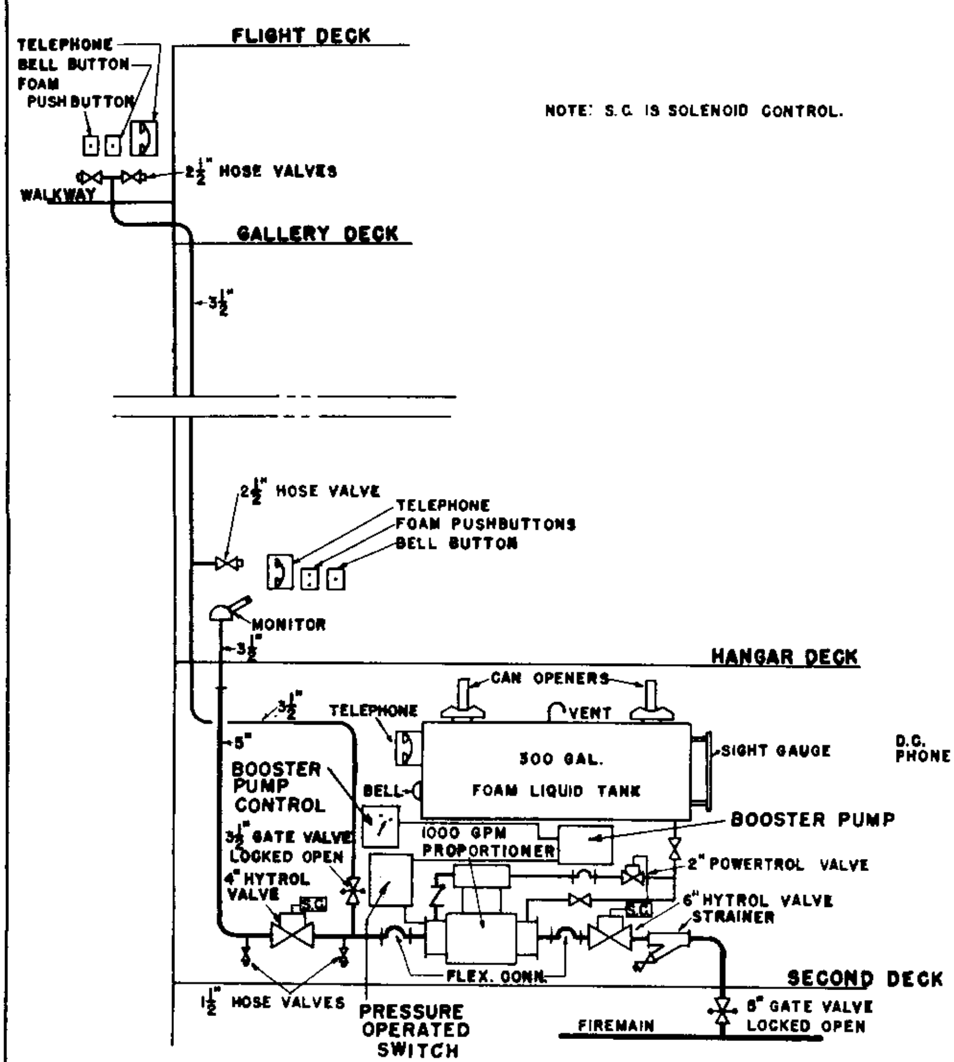
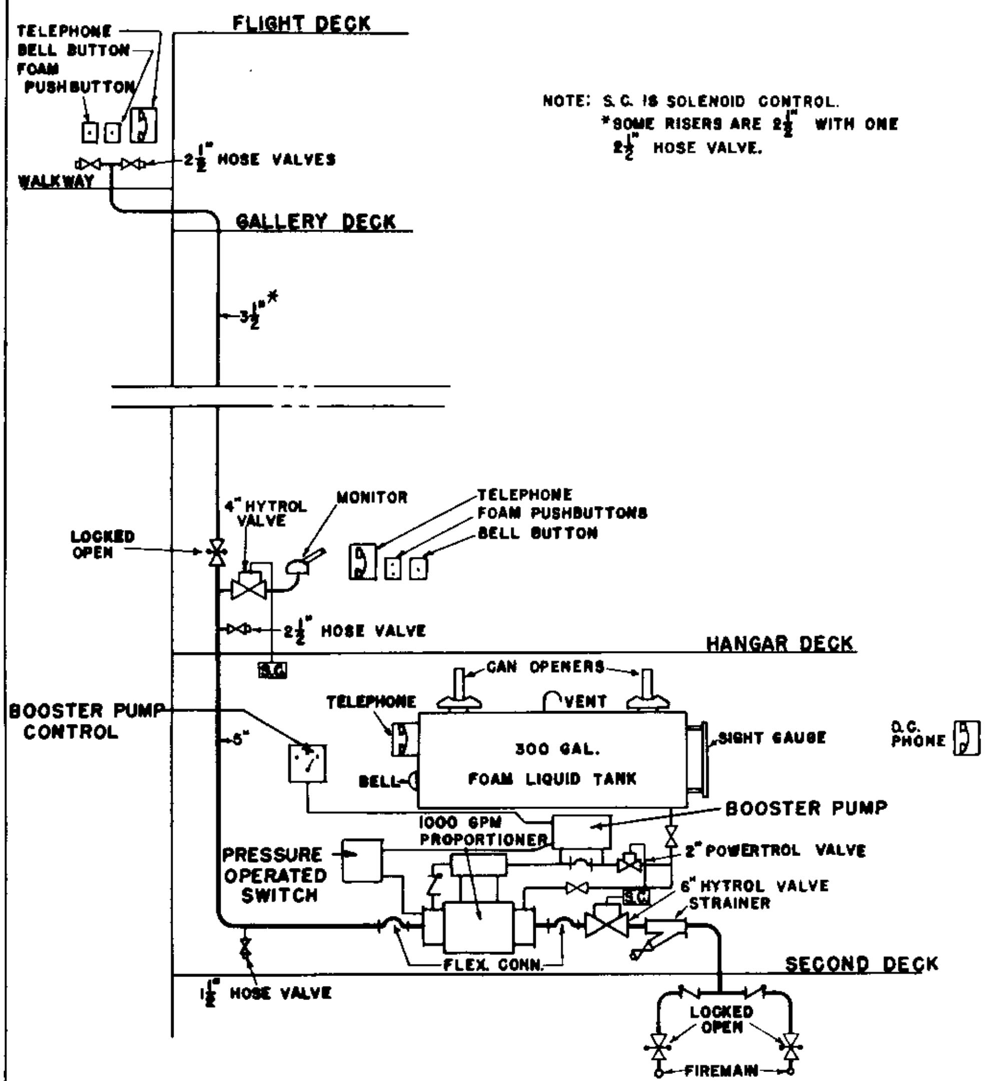


FOG FOAM SYSTEM INJECTION STATION
DRY TYPE, DUAL RISER

Figure 9930-41.



FOG FOAM SYSTEM INJECTION STATION
DRY TYPE, SINGLE RISER

Figure 9930-42.

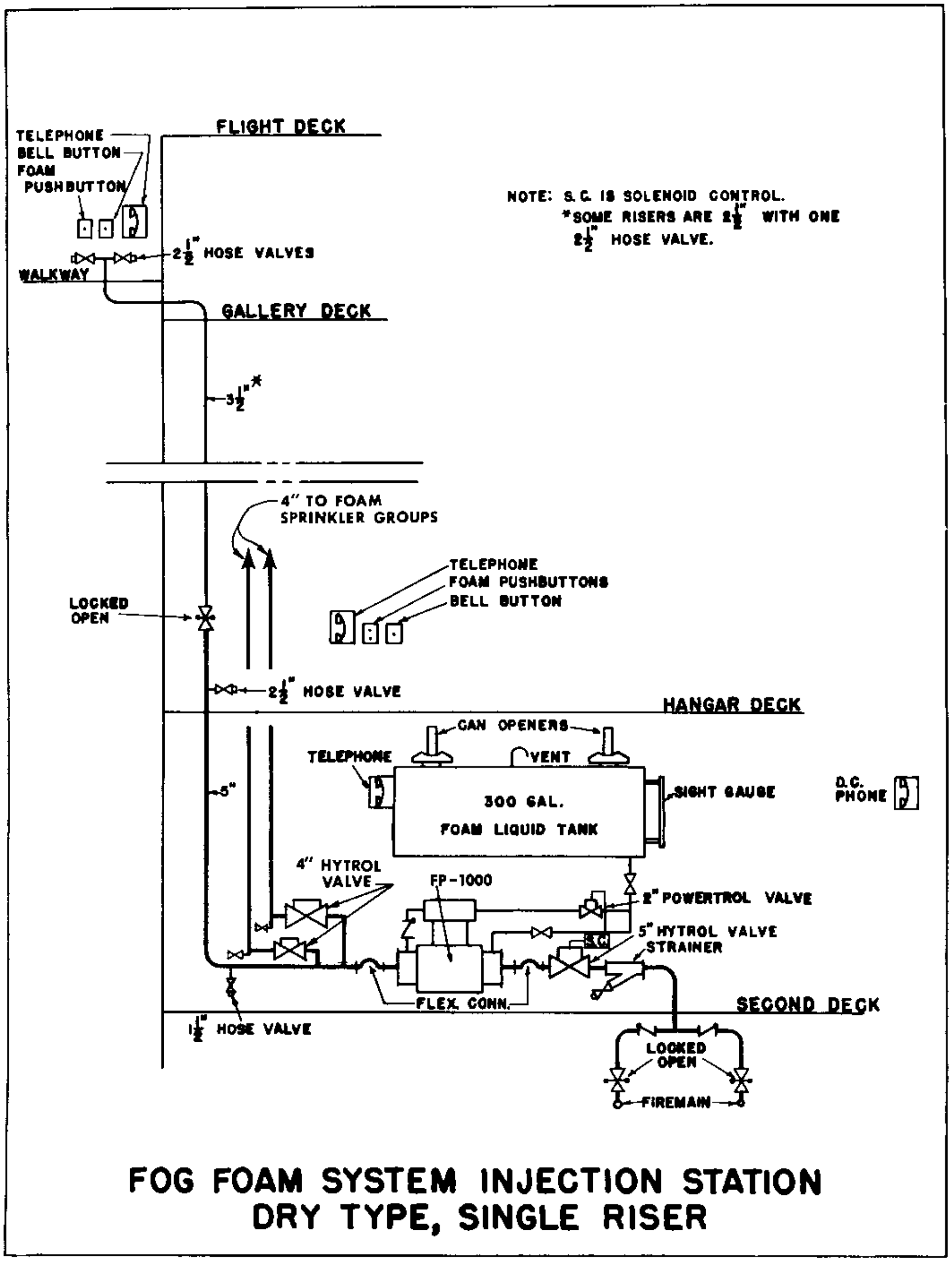


Figure 9930-43.

9930.127 FOAM-INJECTION STATIONS

1. The foam-injection stations are normally located on the second deck, but in some ships, a few of the stations are on the third deck. Each foam-injection station supplies a water and foam liquid solution to overhead foam sprinkler system and to foam service outlets located on the hangar and flight decks and, in some cases, near elevator pit accesses on the second deck. A typical foam-injection station consists of the following equipment:

a. A 300-gallon tank for ready stowage of foam liquid. The tank is equipped with a glass sight gage, a vent, cleanout plates, drain plug, a large lid, and can-opening devices. The tank is usually located several feet above the deck so that the foam liquid will be fed to the proportioner by gravity.

b. The can-opening devices were not included in the original installations. The latest model of this device operates on the same principle as a beer can opener. One cutter pierces a triangularly shaped hole in the bottom of the can, allowing the liquid to run into a funnel and thence into a pipe leading down to within approximately 3 inches of the tank bottom. This pipe aids in preventing excessive foaming of the foaming liquid during transfer to the tank. The opener bracket is also equipped with a smaller cutter which pierces the side of the can as it is forced upright, thus admitting air so the foam liquid will flow out rapidly.

c. A 5-inch marine Y-type strainer is installed in the fire main riser as it enters the foam-injection station. This strainer is equipped with a plug cock for flushing the strain-strainer if it becomes clogged with debris.

d. A 5- or 6-inch salt water hydraulic valve is located between the strainer and the proportioner. It may be opened from remote locations by an electrical solenoid-powered pilot valve. It must be closed manually. The pilot admits line pressure to the power chamber to open the valve. The valve stem is spring loaded to close in event of loss of line pressure.

e. The proportioner is a positive displacement water motor coupled to a positive displacement foam liquid pump. The pump and water motor are so sized that the discharge of the unit consists of 6 percent foam liquid and 94 percent water. The unit will give accurate proportioning from 200 to 1,000 g.p.m. when the water motor inlet pressures are between 100 and 175 psi.

2. The pressure drop through the unit varies from 14 to 35 psi at the pressures stated above, while the foam liquid concentration fluctuates from 6.0 to 7.0 percent. Complete detailed data on these proportioners is contained in the manufacturer's instruction book, NAVSHIPS 393-0627.

3. Early foam pumps were only accurate in ranges between 400 - 1,000 g.p.m. and 500 to 1,000 g.p.m. Manufacturers instruction books should be consulted for details on these foam pumps.

4. The proportioner is isolated from the fire main riser and the foam service riser by two high-pressure flexible rubber connections, which prevent transmission of excessive vibration into the unit. The supply line from the foam liquid tank is connected to the foam liquid pump side of the proportioner. The supply line is also fitted with a stop valve, 2-inch hydraulic valve and flexible connection. The 2-inch hydraulic valve is controlled by the same pilot that controls the 5 or 6-inch valve in the fire main riser. This valve, however, is closed by a spring and opened by fire main pressure induced into the lower power chamber. The discharge line from the foam liquid pump to the water downstream side of the water motor is fitted with a check valve.

a. On early installations when water flow through the proportioner is reduced below 500 g.p.m., the foam pump introduced insufficient foam into the foam riser. To remedy this, a booster pump was installed in the foam supply line. It has been deleted on later stations because of improvements in the proportioner. The booster pump, when set on automatic control, is energized by increased pressure on the pressure operated switch and foam in proper proportion is delivered to the foam pump. As additional hose lines are opened and flow increased, the pressure drops and the booster pump is de-energized. Continuous operation of the booster pump is accomplished by setting the control switch to "manual." The booster pump should normally be set on "automatic."

b. Eventually there will be three different types of foam service risers installed.

1. The type shown in figure 9930-37 in which separate risers are led from the injection station to the hangar and flight decks.

2. The type shown in figure 9930-38 in which a single 5-inch riser is led from the second or third deck to the hangar deck where it reduces to a 3½-inch riser which supplies the two 2½-inch hose valves on the flight deck.

3. The type indentical to figure 9930-38 except that the hangar deck riser terminates in a foam sprinkler system. This is shown in figure 9930-43.

a. Pressure at the flight deck and elevator pit outlets is obtained by opening the 5- or 6-inch hydraulic valve. Pressure at hangar deck monitor stations or sprinkler system is obtained by opening the 5- or 6-inch and a similar 4-inch hydraulic valve. This valve is located either at the injection station or on the hangar deck, refer to figures 9930-41, 9930-42, and 9930-43. The 4-inch hydraulic valve is omitted from risers fitted with hose valves located on the hangar and those stations which have flight deck outlet.

b. Racks for stowing 60 spare containers of foam liquid are provided at each foam-injection station. The arrangement of these racks has in most cases been tailored to the particular compartment in which the unit is located. This foam liquid is for replenishing the tank, or, if extended use has depleted the supply at certain stations, it can be reallocated until additional supplies can be obtained.

9930.128 FOAM-INJECTION STATION OPERATION

The foam-injection stations should always be manned during general, fire, or flight quarters. A detail of at least 3, but preferably 4, should be assigned to each injection station.

1. One man should be assigned the task of ensuring that stop valve in the foam suction line is open and flush valve is closed. This man should stand by for manual operation of pilot valves and strainer blowout.

2. The X50J sound-powered telephone should be manned immediately. The pushbutton on the handset must be held down to talk and listen.

3. The solenoid which operates the pilot valve used to control the opening and closing of the hydraulic valves gives a distinct buzz when energized. The pilot valve opens

or closes with a solid thud or clang. The manual control is inside the box enclosing the solenoid. When manual operation is necessary, turn it the same as any other valve: clockwise to close, counterclockwise to open.

4. The remaining man should start removing the locking bars from the spare foam stowage racks. The tank has been fitted with can openers which operate on the same principle as a beer-can opener. To operate:

a. Remove knife covers, two per opener.

b. Remove filler pipe plug.

c. Lift foam container, using handle on top and placing other hand along the side of the container. Do not put hand under the bottom of the container or it may be cut by the larger knife.

d. Place the container in the sloping lip of the can opener. Give a slight push against the top to make sure it is down far enough for the bottom rim to engage the catch.

Again CAUTION– *When opening cans, extreme care should be taken that hands are clear of the leading rim and face of cans in way of knives.*

e. Give a hard push upward and inward.

f. Pull can back slightly to remove vent knife from hole and wait for container to drain.

5. All 3 or 4 men should start passing and pouring foam into the tank as soon as the unit starts operating. If the operation of the stations is prolonged, relief teams will be required for the men at the injection station. With 1 or 2 men inserting, opening, and removing cans, the foam liquid supply can be maintained at about 50 percent of the maximum rate of usage of 60 g.p.m. flow, or about 100 percent when only one 3½-inch nozzle is being used. It follows then that, during flight deck fires where only one or two 2½-inch nozzles are being filled, the filling detail will have to keep a check on the tank sight gage to keep from overflowing the tank. However, when the unit is operating at full capacity, they will have to work with maximum effort to prevent the tank from being drained by the proportioner before all cans have been emptied. If it appears that the tank will be drained prior to extinguishing the fire, the Damage Control Officer should be notified so that additional foam liquid supplies may be ordered from an adjoining station or that word may be passed to fire-fighting parties that "foam-station–will have to secure in–minutes due to lack of foam liquid." Unless additional foam liquid arrives before the tank is drained, close the 4-inch and then the 6-inch hydraulic valves by means of the manual control in the solenoid box. It is important that the 4-inch valve be closed first. Continuing to discharge water through the monitor for an extended period of time will break up the foam blanket already formed.

6. It is important that a procedure be developed to prevent empty foam containers from cluttering the working space around the foam-liquid tank. Where possible it may be desirable to put them back in the racks. Empty containers should not be tossed into passageways.

9930.129 SECURING AFTER OPERATION

1. The closing of the 4-inch hydraulic valve and the hose valves will cause the proportioner to stop operating. The men in the injection station should not take this as a signal to start securing, but should use this opportunity to complete filling the foam tank. Securing should not be started until the word has been passed to do so.

2. The following are the steps to be taken in securing the system:

a. Close the foam liquid suction valve and open the flushing valve while proportioner is stopped.

b. Open all outlets and thoroughly flush the system. Set booster pump on manual to ensure flushing; reset to automatic after flushing.

c. Shut the 4-inch hydraulic valve while water is flowing through the system.

d. After it has seated, shut the 5- or 6-inch hydraulic valve.

NOTE. – Two 2½-inch outlets should be open while they hydraulic valves are being closed. The sequence listed in (c) and (d) must be followed, otherwise the 4-inch hydraulic valve may not close and will result in foam being discharged momentarily on the hangar deck the next time the flight deck system is used.

e. Open the drain valves and drain the risers from the flight and hangar deck. Outlets must be left open while doing this. Stations located on the third deck are provided with pumps to pump this water overboard.

f. Close flushing valve and open foam valve.

g. Complete refilling of the foam liquid tank then remove the can openers and wash them with water. The knife blades should be dried before reinstalling the openers on the tank top.

h. Some installations have a strainer provided in the foam-liquid suction line. This strainer should be cleaned each time the system is used.

9930.130 OPERATION FEATURES OF THE HIGH-CAPACITY, FOAM SYSTEM

1. When the high-capacity, foam equipment is put into use, each fire pump station should be manned and all pumps operated to ensure ample water supplies for foam service as well as water for water curtains, etc. Pressure at the supply side of the water-motor proportioner should be maintained from 100 to 150 psi. With the inherent static head and friction loss of the system, nozzle pressures of less than 100 psi can be expected at the 3½-inch foam-service outlet on the hangar deck if pressures at the proportioner are 100 psi. Consequently, it is advisable that maximum pressures be maintained when the system is in use. At least 70 to 80 psi pressure is required at the foam nozzles to produce foam of the desired qualities of stability and fire-fighting ability.

2. Foam-injection and supply stations are designed to furnish a sufficient rate of foam-liquid injection to provide the optimum 6-percent solution in water at a maximum flow of 1,000 g.p.m. in the foam-service nozzle. This will supply four 2½-inch foam nozzles or two 3½-inch foam nozzles operating simultaneously.

3. The following table indicates the time element involved under various operational conditions with nozzle pressures of 100 psi:

Number of foam nozzles in operation	Rate of flow in foam service riser (g.p.m.)	Rate of foam liquid injection injection (g.p.m.)	Time to empty 300-gallon foam liquid tank (minutes)	Volume of foam produced at fire (g.p.m.)
2 2½-inch	400	24	12½	2,400
1 3½-inch	550	33	9	3,300
1 2½- and 1 3½-inch	750	45	6½	4,500
1 3½- and 2 2½-inch	950	57	5¼	5,700

4. It may be easily seen that the foam-liquid tank at the foam-liquid station must be adequately manned to recharge the supply tank depending on the number of foam nozzles in operation. To facilitate operation of this procedure, the following foam can consumption rates are given:

Rate of foam liquid consumption (g.p.m.)	Number of 5-gallon cans of foam liquid required per minute to tank
24	5
33	6½
45	9
57	11½

9930.131 MAINTENANCE

The dependability of the foam system like any other relatively complex system, will be proportional to the maintainance it receives. It is recognized that the probability of large hangar fires is not as great in peacetime as it is in wartime. Fire does not, however, recognize chances or probabilities, nor does it require enemy action to strike. Heavy seas, a few planes not completely defueled and some parted lashings are the only excuses it needs. It is therefore necessary that the maintenance of the foam system be given high priority among other items of ship's work.

1. **Root valves.** These valves should be given the same if not slightly better maintenance than any other valves in the fire-main system.

2. **Foam-liquid tanks.** The tanks should be drained once a year and thoroughly cleaned. Foam drained from the tank should be placed in clean dry containers while the tank is being cleaned. Some of the older types of foam have been found to precipitate in storage, forming a heavy gummy sludge. If this is allowed to accumulate for too long a period of time, it will clog valves, strainers, and may cause trouble in the proportioner. All 5-gallon cans of foam liquid more than 10 years old should be replaced with new stock, if convenient. Old stock should be turned in to fire fighting schools for training use.

3. **Valves.** The valves in the foam liquid suction line should be cleaned at least once each year and preferably once every 6 months.

4. **Foam strainer.** As previously stated, the strainer in the foam-liquid suction line should be cleaned as part of the securing operations. When the system is not operated for prolonged periods of time, it should be cleaned every 6 months.

5. **Fire-main strainer.** Two of the most likely causes of clogging the 5-inch strainer in the riser at the injection station are shock (due to near misses) and operation of the fire-main system while in a yard or at anchor in shallow water. This strainer should be flushed or the element removed and cleaned weekly for 3 or 4 weeks after either yard availability or shock to the fire-main. Thereafter they should be cleaned as necessary, since any tendency of the strainers to clog will result in pressure loss at the nozzles.

6. **Hydraulic valves.** The manufacturer's recommendations should be followed for maintenance of the 2-, 4-, 5- and 6-inch hydraulic valves.

7. **Solenoid controls.** Instructions for maintenance of the solenoid controls are also furnished by the manufacturer.

8. **Flexible connections.** The care and maintenance of the proportioner has been covered in the manufacturer's instruction book. The following are some items which have been found as the result of service use:

a. As originally furnished, steel nuts were used on brass studs for securing end plates. Galvanic action has caused many of the studs to corrode. Replacement of steel nuts with manganese bronze has been authorized as a ship's force item.

b. The proportioner is a machine that depends on close tolerances for proper functioning. Its care should, therefore, be assigned to someone accustomed to working to fine tolerances.

9. **Condensed maintenance instruction.**

Water motor proportioner pumps. These proportioners when operating properly should pull a vacuum at the foam pump inlet equal to 15 inches of mercury at a flow of 1,000 g.p.m. (60 g.p.m. of foam liquid).

a. Thoroughly flush foam-liquid pump with water after each use.

b. Check oil level in ball bearing reservoirs after use of proportioners.

c. Check oil level in drive unit housing after each use. Drain and refill every 6 months.

d. Check proportioner for free turning weekly by applying a wrench to the extended motor shaft. Always replace the cap that fits over the end of this shaft or oil will be lost from the bearings.

10. The drain valve in the foam service riser should receive the same maintenance recommended for the root valves in the firemain risers.

9930.132 PILOT VALVES, SOLENOID OPERATED

1. The foam system is controlled basically by means of pilot valves. Operation of the pilot valve is controlled by electrically operated solenoid coils which are energized through pushbutton stations from a power-distribution system.

2. The solenoid control consists of two 18-pound pull, 440-volt solenoids, linkage, switch, and pilot valve. The linkage converts the fore and aft motion of the solenoid to a circular motion which opens or closes the pilot valve. In the open position the pilot valve vents the power chamber of the 4-, 5- or 6-inch hydraulic valve to the atmosphere which allows fire main pressure to open the valve. In the closed position the pilot valve allows fire main pressure to be fed into the power chamber. The switch is actuated by the linkage and energizes the circuit to the indicator lights in the **CONFLAG** station. No lights are provided for closed position.

3. The 6-, 5- and 2-inch valves are closed by hand operation of the manual-control knob. The 4-inch valve may be

both opened and closed by a pushbutton. However, all of the pilot valves may be hand operated in case of power failure.

4. The 2-inch hydraulic valve in the foam fluid line is operated along with the 5- or 6-inch valve through the 1 pilot valve. It is opened by water pressure from the fire main and closed by venting the lower power chamber to drain and allowing the spring loaded stem to seat the valve.

9930.133 FOAM SERVICE OUTLETS

General. All aircraft carrier hangars and flight decks are equipped with 2½-inch foam outlets. In hangars on early carriers 3½-inch foam monitors and hose outlets were also installed. These have been deleted on later carriers.

1. **Monitor stations.** The hangar monitors are fitted with a 3½-inch outlet and a 2½-inch hose valve. A swivel-type monitor is connected to the 3½-inch outlet. The 4-inch salt water hydraulic valve, when on the hangar deck, is located in the monitor branch. The solenoid-controlled pilot for this valve is located on the second deck for added protection. Monitors are fitted with 3½-inch fog foam nozzles and stream shapers. These nozzles do not contain quick-acting shutoff valves. A pushbutton station is provided adjacent to the monitors for opening both the 6- and 4-inch hydraulic valves simultaneously. This pushbutton station also provides for closing only the 4-inch valve since the monitors do not have a local shutoff valve.

Generally where the fire is over 40 or 50 feet from the monitor, the stream shaper should be put on the nozzle to ensure that the foam will reach the fire. The stream shaper cannot be placed on the nozzle while it is in operation. Operating the pushbutton controlling the valve in the monitor supply branch is the only action required to put the monitor in operation.

a. The monitors may also be put into operation from the second deck by means of the manual control in the solenoid which operates the 4-inch valve. This means of operation should be reserved for large fires which make local control at the monitor impossible or where electrical control fails. Since hangar conflagrations are always a possibility whenever fueled aircraft are present in a hangar, the monitor should always be trained athwartship at the angle of elevation (or depression) calculated to give the greatest coverage without undue impingement on the overhead or parked aircraft.

b. The monitors can be operated with little or no decrease in efficiency, with the barrel removed from the yoke. Removal of the barrel will decrease the length about 15 inches and will permit the monitor to be trained athwartship with practically no interference to planes parked nearby. The threads on the monitor yoke are the same as those on the barrel so the change can be made without any alterations. There are a few monitor stations which are recessed alongside of bulkheads. Retention of barrels on these monitors will be necessary in order to avoid blanking off portions of the area protected.

2. **Hangar hose stations.**

a. The hangar deck foam service outlets are located alternately port and starboard in the general vicinity of the injection stations, from which they are supplied. The CVA type, and CVL48-49 class carriers are provided 2 hose stations 1 port and 1 starboard in protected areas immediately forward and aft of the hangar proper. The CVE class and CVL-22 class have only 1 hose station forward and aft of the hangar proper. The 2½-inch outlets are located inside the hangar while the 3½-inch outlets are outside. Equipment at each of these stations consists of one 3½- and one 2½-inch foam nozzle with quick-acting shutoff valve, stream shaper for each nozzle, 150 feet of 3½ and 100 feet of 2½-inch cotton rubber-lined hose; 100 feet of each size hose should be connected to the foam service outlet valves ready for use. On newer ships only 2½-inch outlets are installed outside the hangar, two fwd and two aft. Each outlet has 100 feet of 2½-inch hose with nozzle and stream shaper. A pushbutton station is located adjacent to the 2½- and 3½-inch outlets for opening the 5- or 6-inch hydraulic valve in the injection station serving that riser. This pushbutton station does not provide for closing the hydraulic valve.

b. A 2½-inch foam nozzle and stream shaper are also provided at each monitor station. The 2½-inch fire hose for these stations is obtained, as required, from adjacent fireplugs.

c. Some classes of carriers also have a 2½-inch outlet adjacent to the second deck access to the elevator pit. The station may be charged by manual operation of the 6-inch solenoid at the station or, in the case of the riser arrangement shown in figure 9930-38 by pushing first the open then the close pushbutton for that riser in the hangar.

d. The operation or use of foam hose lines is, in general, the same as regular fire-hose lines. The hose must be pulled off the rack, strung out, and the foam-service valve opened. However, the only difference in the use of the foam-hose lines and the regular fire-hose lines is that the foam system has to be started electrically from the foam-hose station, by operating a local pushbutton. Since the 3½- and 2½-inch foam nozzles used on hose lines are equipped with shutoff valves, the nozzleman can control the operation of the nozzle at will. The decision as to whether to use a stream shaper will vary with the situation. The stream shaper should not be used at close range since the foam is delivered with sufficient force to such a small area it tends to break up the foam blanket. When a stream shaper is being used on a foam nozzle, a second group should provide protection with another foam line without stream shaper.

e. Leading out the 3½-inch foam lines located fore and aft of the hangar requires at least 8 men for each line. Start the system with the pushbutton; then before opening the foam-service valve, the hose should be pulled from the rack and stretched out in a passage or compartment in such a manner that it will not bind against the bulkheads when the pressure is turned on. The primary function of these lines is for gaining access to the hangar when large fires engulf most of the hangar or for bringing foam in when 1 or more monitor stations are inoperable. At 100 psi nozzle pressure, the 3½-inch nozzle discharges 550 gallons of liquid or 3,300 gallons of fog foam per minute. They also use 33 gallons of foam liquid per minute which means that 7 containers have to be emptied into the tank. Do not be stingy with the foam, but do not waste it.

3. **Flight deck hose stations.**

These stations are normally located on the gallery deck walkway under the overhang of the flight deck. Some may be located in compartments off the gallery deck walkway.

The stations may consist of one or two 2½-inch outlets. When required for a flight deck fire, the hose should be pulled off the rack and led up onto the flight deck, the system can be started while this is being done. An uncharged hose is much more maneuverable and can be led out much faster than a charge one. Flight deck teams should be trained to open the foam-service valve as soon as the hose is led out whether the system is energized or not. The question of whether to use a stream shaper is the same as that covered under hangar hose stations. Generally the stream shaper should be used only to increase the reach of the stream or for deflecting the stream from the deck or bulkheads onto the base of the fire. The conical discharge of foam nozzle, without a stream shaper, affords good protection from heat and should be used to protect personnel when effecting rescue from a burning plane.

The flight deck outlets are provided a 2½-inch nozzle with a shutoff valve, stream shaper, and 100 feet of 2½-inch hose for each outlet, a pushbutton for operation of the 5- or 6-inch hydraulic valve in the injection station, a telephone, and buzzer. The phone and pushbutton are located in boxes for protection from the weather.

9930.134 NOZZLES

Foam nozzles are furnished in 3½-, 2½-, and 1½-inch sizes. The nozzles for use on hand lines are equipped with shutoff valves (figure 9930-44). The 3½-inch nozzle used on the monitors does not have a shutoff valve. The nozzles are made up from corrosion-resisting aluminum castings. A collar is built onto the forward end of the nozzle which serves as a mounting for the stream shaper. The nozzle should be shut off to install or remove the stream shaper. The action of these nozzles is to eject a number of single spray-streams from the orifices in the fog-foam heads. They might briefly be classified as an internal impinging jet type nozzle; i.e., the orifices in the tip are so located that jets of water and foam-liquid solution collide as they are passing through the tip. The resulting turbulence causes air to be sucked in and mixed with the solution forming foam. The quantity of air drawn in and mixed with the solution expands it to six times its original volume. These nozzles may be used to form ordinary water fog similar to the all-purpose nozzle, but in the foam usage, expansion of the foam liquid and water causes large supplies of foam to be discharged. The cone-shaped pattern of the foam discharge from these nozzles affords considerable protection to persons advancing behind it into a fire area.

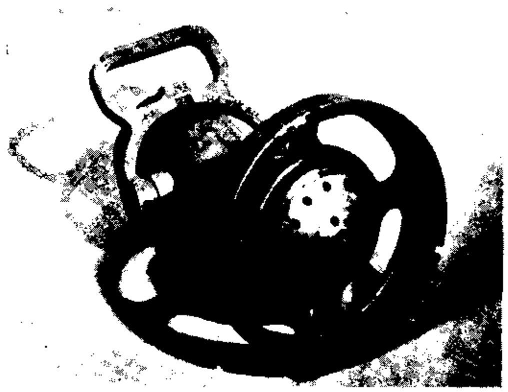


Figure 9930-44.

9930.135 USE OF STREAM SHAPER

When the fire within reach of the foam nozzles has been successfully coped with, it may be necessary to project foam streams to a greater distance. At such time the stream shaper may be employed on the nozzle, figure 9930-45. This lightweight tube is fitted at the discharge side of the nozzle and is designed in such a manner that all of the foam formed is collected and discharged in a single bushy solid stream. The volume of foam production and rate of discharge are not affected when stream shapers are used, but the range of the solid stream increases in the order of 1 foot per additional pound of nozzle pressure.

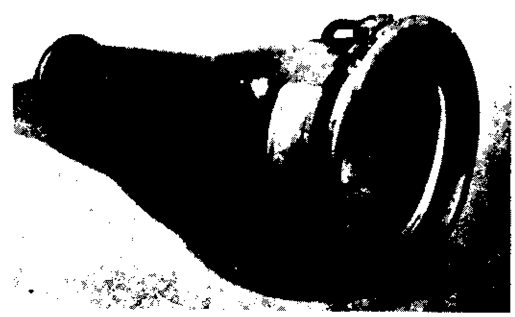


Figure 9930-45.

9930.136 MAINTENANCE FOR SERVICE OUTLETS

1. **Monitors.** The monitors should be greased after each use, or when not used for extended periods of time, each quarter.

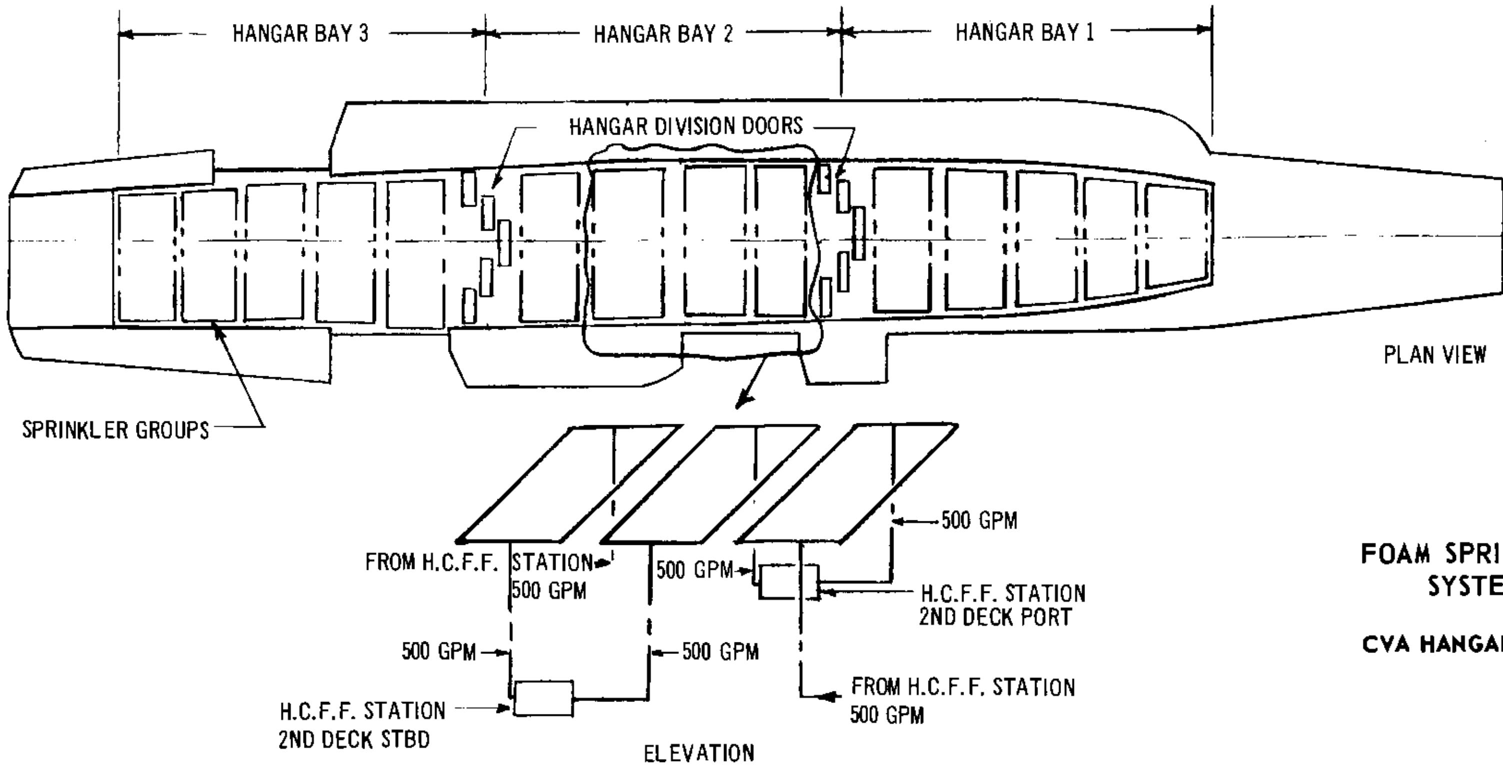
2. **Nozzles.** Nozzles should be thoroughly rinsed in fresh water after each use and allowed to dry before being coupled to the hose. A light coating of grease may be applied to the threads to aid in prevention of corrosion.

3. **Hose.** Hose should be thoroughly flushed with water and hung up to dry before being refaked on the racks. It should be given the same hydrostatic test as regular fire hose.

9930.137 FOAM SPRINKLER SYSTEM

1. Overhead foam sprinkler systems have been installed in hangars, well decks, vehicle cargo holds, and fuel pump rooms of many ships. The sprinkler systems may be installed as group sprinkler systems or simultaneous type sprinkler systems. In the latter case the entire area is sprinkled simultaneously while in the group type system a certain area can be singled out and sprinkled. Only the group type system will be covered here as the simultaneous type is similar and only used where foam rates are around 1,000 g.p.m. or less.

2. Figure 9930-46 shows the group type sprinkler system installed in overheads of CVA hangar decks. Each



FOAM SPRINKLER SYSTEM

CVA HANGAR DECK

Figure 9930-46.

group is supplied from two risers, one from a port foam proportioner and one from a starboard foam proportioner. Each riser is sized to supply approximately 500 g.p.m. for a total of 1,000 g.p.m. per group.

3. The foam sprinkler systems and sprinkler heads are designed to allow sprinkling with foam or water.

4. The individual foam sprinkler groups are actuated by push buttons. Each push button opens the 5-inch valve to the proportioner and the 4-inch valve to the individual group. A "close" button is also installed which closes only the 4-inch valve.

9930.138 ELECTRICAL CONTROLS FOR FOAM SYSTEM

As mentioned previously there is an electrical push-button station at each foam outlet.

1. Each flight deck outlet, hangar deck outlet and valve outlet fore and aft of the hangar has a single "open" button which opens the main 5- or 6-inch hydraulic valve upsteam of the proportioner. By operating this pushbutton the risers are charged to the hose valves. No "close" position is provided since the system can be shut down with the hose valve or the nozzles.

2. Each monitor station has an open-close pushbutton. The "open" button opens both the 6-inch hydraulic valve and the 4-inch hydraulic valve located in the monitor riser or branch, figures 9930-41 and 9930-42. The "close" position closes only the 4-inch. The 6-inch hydraulic valve is not provided with electrical closing. It must be closed by operating the manual control knob on the solenoid located at the injection station. The 2½-inch outlets located at these stations remain operable as long as the flight deck riser is charged. They can be operated without operating the monitor by completing the open-close cycle of the pushbutton.

3. On ships fitted with foam sprinkler systems, "open-close" buttons are provided within the hangar, port and starboard, in way of each sprinkler group. The "open" button opens the 4- and 5-inch valves, figure 9930-43. The "close" button closes only the 4-inch valve.

4. Manual-control knobs are provided on the solenoid mechanism at each injection station. In the case where 4-inch hydraulic valves are located in the monitor supply branch in the hangar, the solenoid controls are located, as nearly as possible directly below the monitor on the second deck. Their location is noted on a nameplate at the injection station. These manual controls are used to start the system in event of electrical failure and to shut the 6-inch valves.

5. Each hangar monitor control is duplicated in the conflagration control station. An open-close pushbutton is located in CONFLAG for each monitor in the same bay with the conflagration station. On vessels which have hangar doors, a master switch (and remote indicating lights) is provided in CONFLAG for starting all monitors in the adjoining hangar bay(s). No close position is provided with the master switches. In instances when it is necessary to resort to the use of the conflagration station master switch, starting of the remote foam system (opening of the remote 4- and 6-inch Hytrol valves), will energize the indicator lights associated with master switch.

6. On ships fitted with foam sprinkler systems, the CONFLAG station within each bay will have "open-close" buttons for all foam groups in that bay and adjacent bays. CONFLAG stations nearest the hangar division doors will include controls for all foam groups.

9930.139 POWER-DISTRIBUTION SYSTEM

A power-distribution system is provided for electrical control of the fog-foam installation. The system is divided into several units, consisting of from 2 to 4 distribution centers depending on the ship class. Each distribution center is supplied power from the ship's service and emergency supply is by means of electrically operated automatic bus transfer units. These distribution centers supply power for the operation of specific groups of solenoid-operated valves. Power for the indicator lights located on the conflagration switch control panel is not taken from these distribution centers but is supplied from lighting circuits (local to foam-injection station having both ship's service and emergency sources).

9930.140 ROOT VALVES

Root valves in fire main risers to foam injection stations should be kept open at all times unless it is necessary to close them to isolate damage or make repairs to the system. When station is manned, ensure that steps are taken to provide ready access to root valves which may require closing in event of damage to riser. Root valves are kept open.

9930.141 TELEPHONES

1. Each hose or monitor outlet on a given riser is connected to the injection station by the X50J sound-powered telephone circuit.

2. A buzzer is provided at each outlet for calling the injection station. The conflagration-control station can call each injection station supplying outlets in the same or adjacent hangar bays by means of a selector switch. The JZ circuits have been extended in order to place one outlet in the same watertight compartment with the injection station to provide a means of calling Damage Control Central.

9930.142 THE WET-TYPE SYSTEM

The principal differences between this type system and the dry type are:

1. The 5-inch gate valve in the wet type foam solution line is normally open.

2. Since the wet type has no booster pump a minimum of 500 g.p.m. flow through the system is needed to generate satisfactory foam. The 500 g.p.m. minimum can be maintained by operating two 2½-inch lines with 2½-inch nozzles or one 2½-inch line fitted with a 3½-inch nozzle.

3. The wet type has manual control only.

Part 5. Carbon Dioxide (CO_2) Extinguishers

9930.151 CONSTRUCTION

Carbon-dioxide (CO_2) extinguishers are steel cylinders designed to hold carbon dioxide under high pressure, and release it through CO_2 hose or fixed piping when control valves are opened. Some of these extinguishers are single, portable cylinders, with a short CO_2 hose and horn-shaped outlet. Others are installed cylinders, usually in batteries of two or more, with either a length of reeled CO_2 hose and horn outlet, or fixed piping. (The choice of the reeled-hose or fixed-piping installation is determined by the character of the space to be protected, as is explained in following sections.) The size of carbon-dioxide cylinders is referred to according to the weight of carbon dioxide they contain. Cylinders stamped "NM" are nonmagnetic, and are issued to minesweepers only.

9930.152 CAPACITY OF CYLINDERS

The portable carbon dioxide cylinders used aboard Naval ships are of 15 pounds capacity (except in some small craft) while cylinders used in fixed systems are of 35 or 50 pounds capacity. A 15 pound portable extinguisher with remote pull-box control is installed in the engine compartment on some small craft of special design; and on them, smaller portable extinguishers are also used. The portable cylinders have a squeeze-grip type valve. The installed cylinders have disk-type valves. All carbon-dioxide cylinders have safety release disks.

9930.153 CONTROL MECHANISM

Certain differences in the control mechanism are to be noted in the two makes of CO_2 installations approved for use in Naval ships, although all have disk-type valves, with cutter heads of various designs, that are operated either locally or at some distance by means of a pull box. In fixed installations the carbon dioxide is released from 1 or 2 "pilot" cylinders by direct lever action, and from the other cylinder or cylinders by the pressure of the released carbon dioxide, or there may be lever action throughout. In hose reel installations carbon dioxide may be released from single cylinders independently.

9930.154 PRESSURE

1. In all Navy carbon-dioxide extinguishers the carbon dioxide is held under a pressure of 850 psi at 70°F. Any increase in temperature increases the pressure, and any decrease in temperature decreases the pressure. Since pressure builds up rapidly as the temperature rises, three means are resorted to in order to avoid the danger of explosion: the cylinders are never filled to more than 68 percent of their volume capacity, they are strong enough to withstand pressures up to 3,000 psi and they are equipped with safety release disks.

2. All 50-, 35-, and 15-pound cylinders are charged to their rated capacity, except those cylinders located in machinery spaces where temperatures are excessive which are charged to 90 percent of their rated capacity.

The full volume capacity of carbon-dioxide cylinders is the amount of water at maximum density (39°F.) they will hold.

3. The following table shows the pressures of carbon dioxide when it is held in containers filled to 68 percent of their volume capacity, and subjected to temperatures ranging from minus 10° to 160°F.:

Temperature	CO_2 pressure, psi abs	Temperature	CO_2 pressure, psi abs
°F.	Pounds	°F.	Pounds
-10	260	80	975
0	310	90	1,205
10	360	100	1,465
20	415	110	1,725
32	504	120	1,995
40	565	130	2,265
50	650	140	2,545
60	744	150	2,825
70	850	160	3,105

(The above pressures are absolute, and are 14.7 psi greater than would be recorded by an ordinary pressure gage.)

9930.155 EXPANSION WHEN RELEASED

When carbon dioxide is released from an extinguisher cylinder at normal temperatures, it expands rapidly to approximately 450 times its stored volume. In consequence of this rapid expansion, it is immediately reduced in temperature to – 110°F. and the liquid is vaporized to carbon-dioxide gas; some of it, however, forms carbon-dioxide "snow."

9930.156 SIPHON TUBE

The cylinders of the carbon-dioxide extinguishers are fitted with a siphon tube, and the valve has a relatively large orifice as compared with the valves used on commercial cylinders. The purpose of the siphon tube is to convey the liquid carbon dioxide from the bottom of the cylinder to the release valve at the top. When all the liquid has been released, the entire contents are considered expended, since the remaining gas has little value as an extinguishing agent.

9930.157 SAFETY DISK

1. Whether portable or installed, every carbon-dioxide cylinder used to store the liquid CO_2 for fire extinguishment has a valve at the top for discharging its contents; and every cylinder has also a safety disk to safeguard against the possibility of the cylinder bursting if excessive pressure should develop as the result of heat.

2. The safety disk will burst between 2650 and 3000 psi. The head of the safety nut is drilled to prevent recoil when the disc bursts, figure 9930-47. Since the burst pressure is dependent upon the strength and thickness of the disc and the diameter of the hole in the safety nut, it is imperative that replacement disks and safety nuts and washers be in accordance with the manual furnished by the equipment manufacturer. A plastic cap or ring is fitted on the safety disk nut to cover the outlet holes and indicate that the disk is intact.

9930.158 CARBON DIOXIDE AS A SMOTHERING AGENT

Notwithstanding the low temperature of the expanding carbon dioxide as it leaves the extinguisher cylinder, its cooling effect on fire is slight. Carbon-dioxide snow has a latent heat of 235 B.t.u. per pound; but only part of the liquid release from the cylinder forms snow, and therefore, the total cooling effect of the gas and snow is about 100 B.t.u. per pound. This is small compared with water, which has a theoretical cooling effect of about 1,000 B.t.u. per pound, assuming that it is all evaporated into steam. Carbon dioxide is employed primarily, therefore, to smother fire. It is an excellent smothering agent because it will not

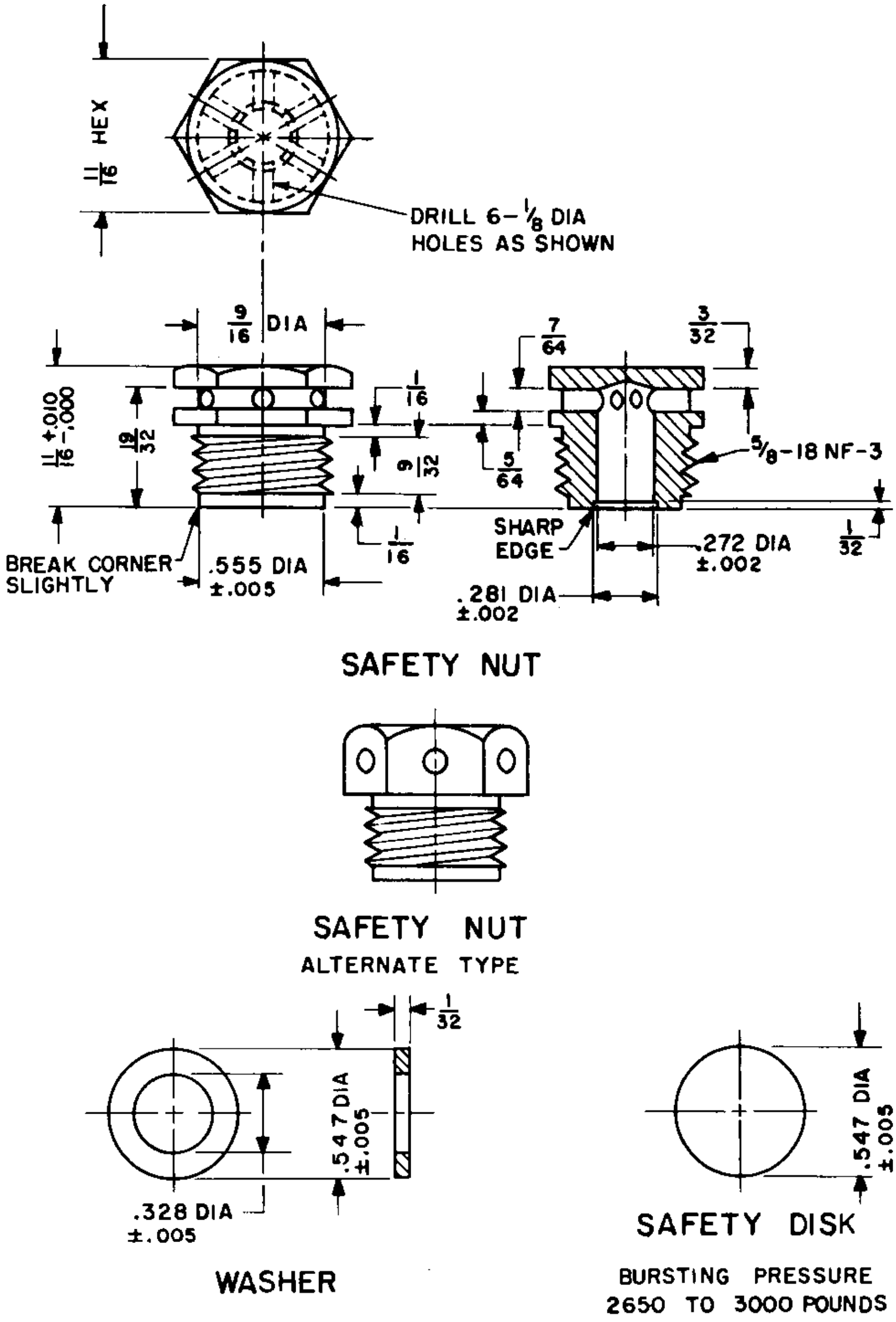


Figure 9930-47. Safety nut, washer and disk.

support combustion. When the 21 percent oxygen content of the air is reduced to 15 percent or lower by using carbon dioxide, combustion in most cases cannot continue. (Some chemicals, it should be noted, continue to burn until the oxygen of the air is reduced to about 8 percent and a few others until only about 6 percent of the oxygen.) This is true only to the extent that the burning material is not one which supplies its own oxygen. An example of this is where nitrocellulose film is involved. Nitrocellulose will burn even when immersed in water if it gains any particular headway. Use of carbon dioxide in such a case would be entirely ineffective to extinguish a fire in such materials. Inasmuch as carbon dioxide is 1½ times heavier than air, it flows down and over a fire, and, if it is not disturbed by air currents, it will hover long enough to put the fire out when the concentration is sufficient.

9930.159 USE ON OIL FIRES AND ELECTRICAL EQUIPMENT FIRES.

1. Applied promptly, carbon dioxide is effective on burning oil, provided the burning fuel is not in the form of a spray emitted from a pressurized line. The explanation of this effectiveness lies in the fact that the combustion of oil occurs only at the surface. Except for a layer there, the bulk of the oil is comparatively cool in the early stages of a fire; and there is even less danger of rekindling from glowing bulkheads or overhead structure in the event that the carbon dioxide should be drawn away from the surface.

2. Not only is carbon dioxide effective for extinguishing fires in burning liquids, such as fuel, gasoline, and paint, but it is also effective for fires in electrical equipment. When carbon dioxide, a nonconductor of electricity, is properly applied to Class C fires, there is no danger of injury to the firefighter electric shock; however, if the horn is allowed to touch energized electrical equipment, ice collected on the horn may transmit a shock to the firefighter.

9930.160 SAFETY PRECAUTIONS.

1. The firefighter must be warned that the very qualities which make carbon dioxide a valuable extinguishing agent also make it dangerous to life. Certainly, when it replaces oxygen in the air to the extent that combustion cannot be sustained, respiration cannot be sustained either. Prolonged breathing in an atmosphere of high concentration of carbon dioxide will cause suffocation, very much as immersion in water does when a person drowns. This gas cannot be seen or smelled; it, therefore, gives no evidence of its presence that can be recognized by the senses. Since it is heavier than air, it does not rise, but remains close to the surface in a deep or shallow pool, according to the area covered and the amount of CO_2 used. With a portable carbon dioxide extinguisher there is little danger, inasmuch as its 135 cubic feet of CO_2 in the average compartment lies in a shallow pool, well below the average breathing level.

2. The "snow" will blister the skin and cause burns if it is allowed to remain on the skin.

3. When a fire fighter must enter a compartment that contains carbon dioxide (or any other harmful gas) in a dangerous concentration, he must wear a Navy oxygen breathing apparatus.

4. Except in an emergency, the fire fighter should not open a CO_2 flooded compartment for at least 15 minutes after it has been flooded. This delay is precautionary to allow all burning materials time to cool down below their ignition temperatures, and to prevent their reignition upon admission of fresh air. Before operating CO_2 flooding systems make sure no one is in the protected compartment.

5. Installed systems described in articles 9930.171 through 9930.176 may be a source of danger if not properly installed and maintained. Ship specifications require protection against inadvertent discharge of CO_2 in the form of guards over exposed remote operating cable and safety pins and seal wires for local operating levers and handwheels. These safeguards are adequate when all system components are properly fastened both to the ship structure and to connecting components. In addition to items on the routine inspection the following should be checked:

a. Where two or more cable operated control heads are installed in series between two banks of cylinders in a Kidde system, make sure that the cable protection conduit is secured to the lock nut in the end of the control head toward the pull box and that the conduit is rigidly supported at the slip fit end (figure 9930-52). Cylinders operated as described in this paragraph should be adjacent and only a very short nipple (about 8 inches long) should be used. The cylinder clamps will then assure support of the slip fit end.

b. Fastenings which secure the cable conduit to the bulkheads must be tight.

9930.161 PORTABLE CARBON-DIOXIDE EXTINGUISHERS (15-POUND)

The standard 15-pound portable carbon dioxide extinguishers have a squeeze-grip type release valve which is operated by a simple "squeeze grip" (figures 9930-48 and 9930-49). A safety disk is provided that is designed to remain intact until the internal pressure reaches 2,650 to 3,000 psi. The pressure is reached with a filling density factor of 68 percent, if the carbon dioxide should be heated to 130° to 140°F. The safety disk ruptures before the internal pressure becomes critical and dangerous, and the carbon dioxide is released.

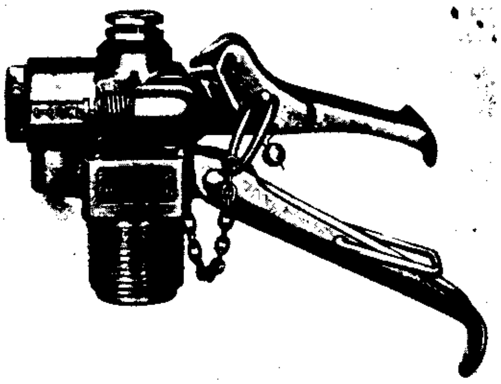


Figure 9930-48.

Figure 9930-49.

9930.162 OPERATION OF SQUEEZE-GRIP VALVE

To operate the 15-pound squeeze-grip CO_2 extinguisher:

1. Carry the extinguisher in an upright position and approach the fire as closely as the heat permits.
2. Remove the locking pin from the valve.
3. Grasp the horn handle. (It is insulated to protect against frostbite.)
4. Squeeze the release lever, thus opening the valve and releasing the carbon dioxide, and direct the flow toward the base of the fire. (The maximum effective range for 15-pound extinguishers is 5 feet from the outer and of the horn.
5. Direct the discharge at the base of the fire. If practicle, attack the fire from the windward side, so that the wind will blow the heat away from the operator and at the same time carry the carbon dioxide over the fire.
6. In fighting fire in electrical equipment or on a bulkhead, direct the discharge of the carbon dioxide at the bottom of the flaming area. Move the horn slowly from side to side and follow the flames upward as they recede.
7. Release the lever to close the valve as soon as conditions permit and continue to open and close it as may be necessary. (It can be opened and closed repeatedly without loss from leakage.)
8. When continuous operation is desired or when the valve is to remain open for recharge, the D-yoke ring on the carrying handle is slipped over the operating handle when the latter is depressed. (The D-yoke permits continuous operation.)

9930.163 CLOSING AND REOPENING RELEASE VALVE

1. A fire fighter sometimes finds it desirable to close the release valve on a portable fire extinguisher and open it again while he is extinguishing a fire. The squeeze-grip type release valve maintains a gastight seat and, therefore, unexpended carbon dioxide is held indefinitely. Once used though, the extinguisher should be replaced with a charged one.
2. The horn-shaped nozzle at the end of the length of hose, attached to a hose-reel type carbon dioxide installation, has a valve that can be turned off and on by the fire fighter, but it is not leak proof.

9930.164 TO CHECK WEIGHT OF PORTABLE CO_2 CYLINDERS

1. The quantity of carbon dioxide in a cylinder cannot be determined by the pressure gage. This is so because the pressure varies with changes in temperature. The cylinders must be weighed. The cylinder is either placed on a platform scale or picked up with the supporting hook on a spring scale.
2. From the total weight, the following items are deducted for calculating the weight of CO_2 in the cylinder:
   a. The known weight of the cylinder when empty. This is about 30 pounds. Cylinder weights may vary a few pounds.
   b. The known weight of the hose and horn. This is about 2 pounds.
3. Stamped on each cylinder valve are (1) the weight of the cylinder, empty, and without the horn and hose; and (2) the weight of the cylinder, filled to capacity, and without the horn and hose.

9930.165 RECHARGING CARBON-DIOXIDE CYLINDERS (15-POUND PORTABLE)

The 15-pound portable carbon dioxide cylinders are recharged from 50-pound commercial cylinders, carried on board most Naval ships for this purpose. The process of recharging CO_2 extinguishers should be accomplished in a well-ventilated space. The recharging is accomplished in either of two ways: Directly from the supply cylinders to the 15-pound cylinder through a CO_2 hose (with or without a bypass valve)–the bypass method; or by means of a transfer unit, which consists of an electric motor, pump, CO_2 hose and control valves–the transfer unit method. The latter method effects a saving of CO_2.

9930.166 EQUIPMENT REQUIRED

1. For the bypass method the following equipment is needed to recharge the squeeze-grip type 15-pound cylinder:
   a. 50-pound commercial cylinder of CO_2.
   b. Tilt racks and scale.
   c. Adapter (tailpiece).
2. For the transfer unit method the equipment needed is the same as for the bypass method, except that the CO_2 hose is a part of the transfer unit.

9930.167 REPLACEMENT OF OBSOLETE VALVES

Any 15-pound portable CO_2 extinguisher valve which is not the squeeze-grip type shall be replaced with a squeeze-grip type of approved design.

9930.168 TO RECHARGE SQUEEZE-GRIP TYPE POTRABLE CO_2 CYLINDER (BYPASS METHOD)

1. The squeeze-grip type portable cylinder may be empty or partly charged. It is not necessary to discharge the residual contents of these cylinders.

2. Remove horn and hose from extinguisher. Do not remove elbow.

3. The bypass valve assembly consists of a valve, a 3-foot hose, and a 6-foot hose for connecting the supply cylinder and the portable extinguisher. Connect the 6-foot hose to commercial cylinder valve, using the hose adapter furnished, attaching the ring nut to commercial cylinder valve outlet. Using ¼-inch size adapter furnished with bypass assembly, connect the 3-foot hose directly to the elbow on the portable extinguisher valve. For complete hookup see figure 9930-50. To do this, place it in rack, tighten chain securely about cylinder, and invert it.

4. Place the portable extinguisher on a scale in a horizontal position, or inverted if a supporting rack is used (adapter, bypass hose attached). Carefully determine the total weight of the extinguisher and then set the scale to equal the fully charged weight shown on the side of the cylinder valve.

5. Remove locking pin from the squeeze-grip valve, squeeze the grip and lock it open with the D-yoke. (This valve will open automatically, but to relieve resistance, it is better to lock open while recharging.)

6. Open valve on 50-pound capacity commercial cylinder and allow a few pounds of carbon dioxide to flow into extinguisher and then close the valve on commercial cylinder.

7. Open the bypass valve and allow carbon dioxide to escape. This cools the portable extinguisher cylinder below the temperature of the commercial cylinder and permits a full transfer of the carbon dioxide in the next step of the procedure. (If the extinguisher has just been discharged and is cool, 15-pounds of carbon dioxide can be transferred without cooling.)

NOTE: If squeeze-grip valve is not locked open, it is necessary to squeeze the grip valve while allowing cylinder to chill.

8. Close bypass valve and open valve on 50-pound commercial cylinder again and allow carbon dioxide to flow into extinguisher until it has a complete charge of carbon dioxide, 15-pounds (except for extinguishers to be used in firerooms, which should only be charged with 13½-pounds of carbon dioxide). If the extinguisher does not take a full charge of carbon dioxide, operations 7 and 8 should be repeated to allow further cooling of extinguisher cylinder so that the carbon dioxide will transfer. Watch the scale carefully. (If the carbon dioxide stops flowing into the cylinder being recharged, the weight of the cylinder being recharged will stop increasing.) When full capacity of cylinder being recharged has been reached, stop the flow.

9. Release squeeze-grip by removing D-yoke from squeeze-grip valve. This automatically closes valve.

10. Close the valve of the 50-pound cylinder and disconnect bypass connection from commercial cylinder.

11. Test the portable extinguisher for leakage as follows:

a. Allow portable extinguisher to stand vertically.

b. Submerge bypass hose (adapter, ring-out connection) outlet in pail of water.

c. Allow bypass hose outlet to stay submerged for 5 minutes and note whether or not bubbles of carbon dioxide escape.

d. Remove all water from bypass hose outlet after testing is complete and wipe dry.

e. If any leak is detected, squeeze the grip and release it immediately to give the valve seat a new position. Then retest. Do not return any carbon dioxide extinguisher to service until careful testing shows it is free from leaks.

12. Disconnect bypass hose assembly from portable extinguisher.

13. Reattach horn and hose assembly to portable extinguisher.

14. Insert locking pin, which is chained to valve and seal with lead wire seal. If lead wire seal is not available, copper wire may be used provided it is not heavier than the standard lead wire, since heavier wire might prevent pulling the pin to operate the extinguisher.

15. Record date and cylinder weight on cylinder record card, NAVSHIPS 428(2-52). Extinguisher is now ready for use.

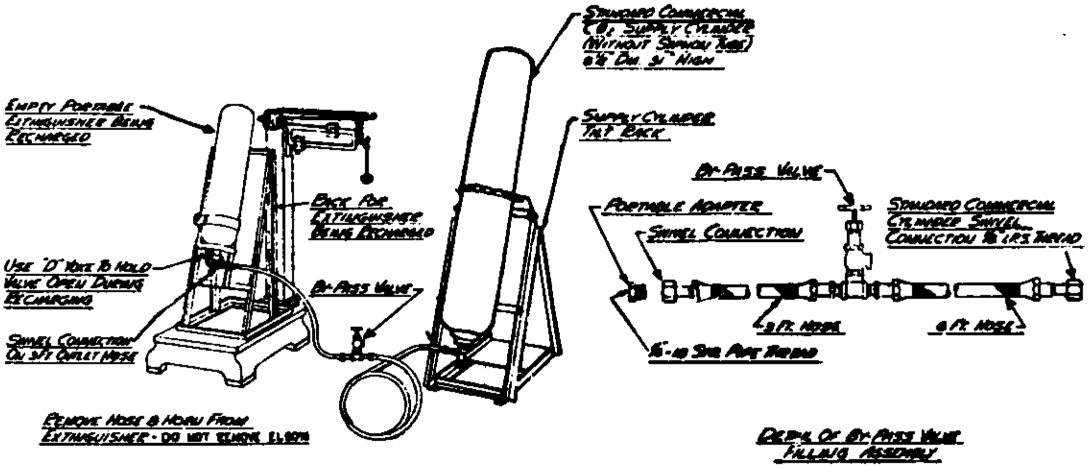


Figure 9930-50.

9930.169 THE CARBON DIOXIDE TRANSFER UNIT

The carbon dioxide transfer unit consists of an electric motor and pump, high-pressure hose, control valve, adapters, and fittings (figure 9930-51).

9930.170 PREPARATION FOR OPERATING

Before operating the CO_2 transfer unit, make certain that the switch on side of the motor is in the "off" position. Check the circuit from which the motor is to be operated and make certain that it is the same as that indicated on the nameplate on top of the motor. If 220-volt, 60-cycle, single-phase current is available, the hookup of the motor leads should be rearranged so that the motor will operate on this circuit. A wiring diagram for operation on 220 volts is on the motor nameplate. Check all gas connections on both the inlet and outlet hose (the 6-foot hose is the pump outlet hose) and make certain that all connections between the various parts are tight. This is important, as carbon dioxide is stored under high pressure, approximately 850 psi at atmospheric temperature of 70°F.

9930.171 OPERATION

1. With the transfer unit, scale, and tilt racks in place, check the supply cylinder. If the supply cylinder is not fitted with a siphon tube, it must be inverted. If the supply cylinder is fitted with a siphon tube, it must be used in a vertical position.
2. Connect the pump inlet hose to the supply cylinder outlet. The connection adapter of this hose is fitted with a screen to prevent the entrance of any foreign matter into the transfer unit or cylinder being recharged. Do not open supply cylinder valve.
3. Connect the pump outlet hose to the recharging adapter. The pump outlet hose is fitted with a shutoff valve. Check all connections and make certain that they are properly and securely made up. This checking is very important. When making up connections, use a 12-inch wrench, with a slow, steady pull. Do not jerk or hit the wrench with a hammer.
4. Make certain that the shutoff valve in the pump outlet hose is in its tightly closed position and that the valve of the cylinder being recharged is in its open position. Open fully the valve of supply cylinder.
5. Place the empty cylinder on the scale; inverted, if a rack is used, otherwise horizontally.
6. Balance the scale; note the weight. On beam-type scales, set scale to the weight of the extinguisher and the charge.
7. Open shutoff valve in pump-outlet hose and allow the carbon dioxide in the supply cylinder to transfer under its own pressure to the cylinder being recharged.
8. When the weight of the cylinder being recharged stops increasing, which indicates that the carbon dioxide has stopped flowing under its own pressure, start the transfer unit and watch the scale carefully.
9. When fully capacity of cylinder being recharged has been reached, perform the following operations in rapid succession:
   a. Stop transfer unit motor.
   b. Tightly close shutoff valve in pump outlet hose.
   c. Close valve of cylinder being recharged.

CAUTION: Do not close valve of cylinder being recharged or the shutoff valve in the pump outlet hose while the transfer unit is pumping.

10. Disconnect the hose from the cylinder being recharged. Do this very slowly in order to allow the CO_2 trapped between the shutoff valve and the cylinder being recharged to escape. Then remove adapter.
11. Weigh recharged cylinder carefully.
12. After recharging is complete, close supply cylinder valve tightly and open the shutoff valve in the pump outlet hose very slowly and allow all the gas in the pump to discharge to atmosphere.

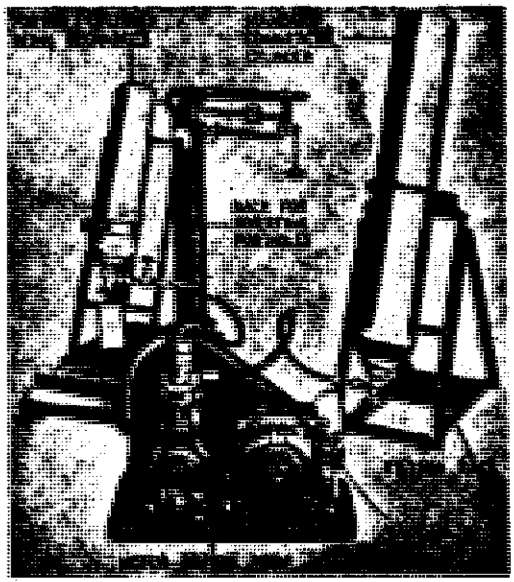


Figure 9930-51.

9930.172 MAINTENANCE OF CARBON-DIOXIDE TRANSFER UNIT

Refer to the applicable technical manual for maintenance of the transfer unit.

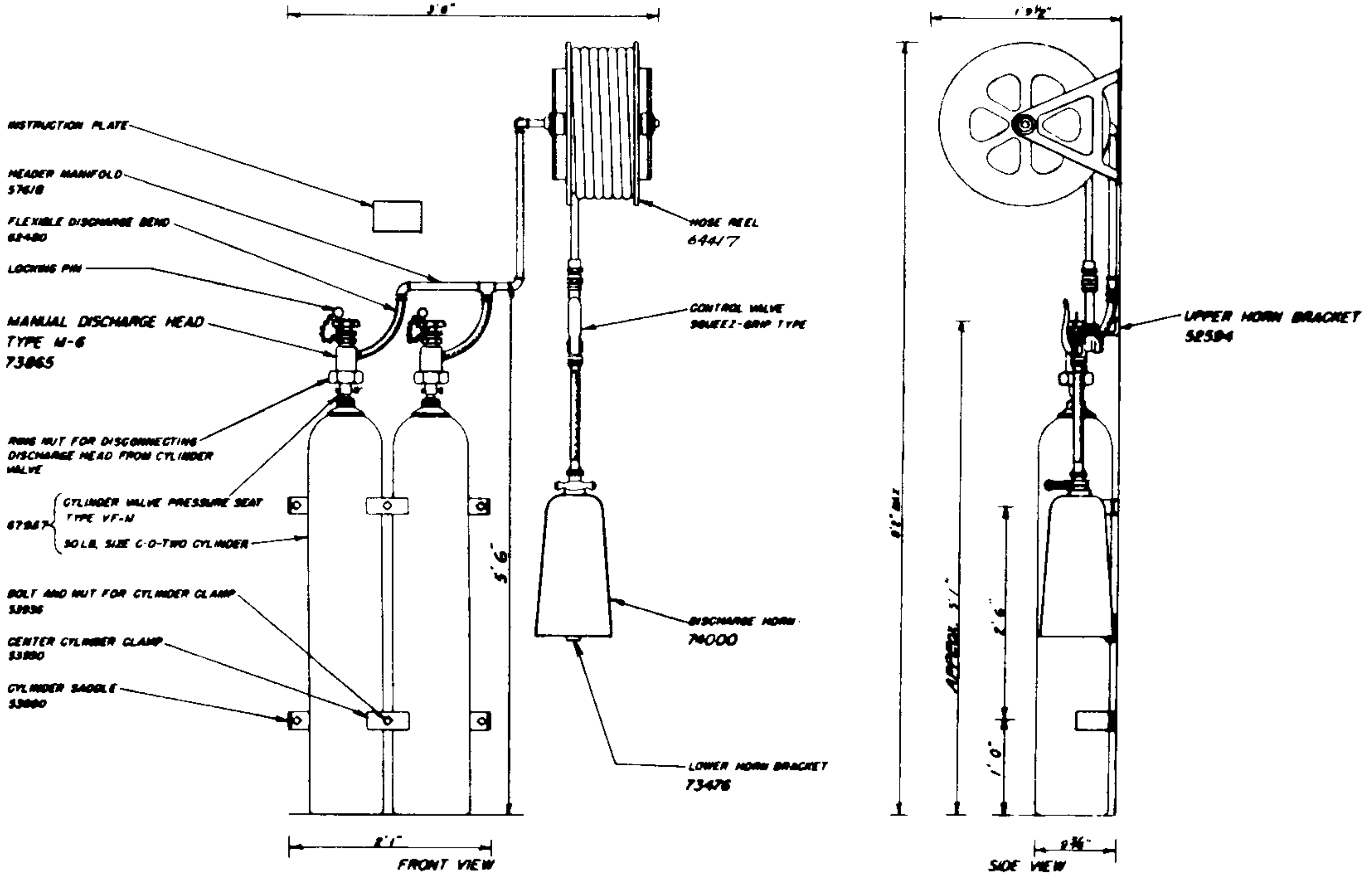
9930.173 INSTALLED CARBON-DIOXIDE EXTINGUISHERS (50-POUND)

Carbon dioxide extinguishers are installed in Naval ships to provide a dependable and ready means of flooding, or partly flooding, with this smothering gas, certain areas that present more than ordinary fire hazards. The cylinders of the installations have a 50-pound capacity each, and they are installed either singly or in batteries of 2 or more. Except for size and releasing mechanism, the cylinders are essentially the same as those of the 15-pound portable extinguishers.

9930.174 TYPES OF INSTALLATION

The installed CO_2 extinguishers are either the hose-and-reel installation or the flooding system—for areas not normally occupied by personnel.

1. The hose-and-reel installation consists of two cylinders, a length of special CO_2 hose coiled on a reel, and a



C-O-TWO
HOSE REEL SYSTEM-LOCAL CONTROL TYPE
FOR MACHINERY SPACES

Figure 9930-52.

horn-shaped non-conductor nozzle equipped with a second control valve. When the hose-and-reel are both installed adjacent to the normal access each of the two cylinders is provided with an individual on-off control (See figure 9930-52). If the cylinders are not located adjacent to the hose reel, remote control pull boxes, located at the hose reel are provided for discharging each cylinder individually. (See figure 9930.53).

2. The CO_2 flooding system consists of one or more cylinders connected by piping from their valve outlets to a manifold (figure 9930.52 and 9930.53). Fixed piping leads from the manifold to various areas of the compartment to be flooded. Cables run from the valve control mechanism to pull boxes, which are located outside of the compartment containing the cylinders. The cylinders may also be located outside of the compartment to be protected. To release the CO_2 the firefighter breaks the glass in the front of the pull box, and pulls the handle contained therein.

3. In the flooding system there are usually one or two valve control devices depending on the number of cylinders in the bank. The remaining cylinders in the bank are provided with pressure actuated discharge heads which open automatically when pressure from the controlled cylinders enters the discharge head outlet depressing the piston and unseating the cylinder valve (See figures 9930-54 and 9930-55). The installations in Naval ships are supplied by several manufacturers and there are a few minor differences. For details of description, adjustment, and maintenance of installed systems consult the specific NAVSHIPS technical manual and manufacturers' instruction books provided in the publications allowance.

4. **CAUTION**: In all remote control CO_2 system the operating chain or cable must be shielded or run through piping wherever it may be exposed in compartments, passageways, trunks, and ladders.

5. In order to readily identify some possible system deficiencies the following information is furnished:

a. All discharge heads on Kidde hose-reel systems must have 2 grooves machined in the corners of the union nut (grooved-nut-type).

b. All discharge heads in Kidde flooding systems must be of the plain nut-type (no grooves).

c. If CO_2 **(FRY-FYTER)** AP-6 discharge heads (figure 9930-54) are used in a remotely controlled hose-reel system (figure 9930-53). External check valves must be installed to prevent automatic discharge of the second cylinder when one is operated.

9930-175 BEFORE OPERATING CO_2 INSTALLATION

Before operating either the hose-and-reel or the flooding installation, the fire fighter must see that all openings in the compartment on fire are closed. He must see also that the ventilation machinery is turned off, or that it turns off automatically when the carbon dioxide is released. These precautions are to prevent the loss of CO_2. He should remember that when the carbon dioxide is released through the flooding system, it cannot be turned off. The hose-and-reel type of installed extinguisher has a hand-controlled valve at the horn-shaped outlet and, like the portable extinguisher, it can be turned off and on as the work on the fire fighting progresses in accordance with the technical manual supplied with the system.

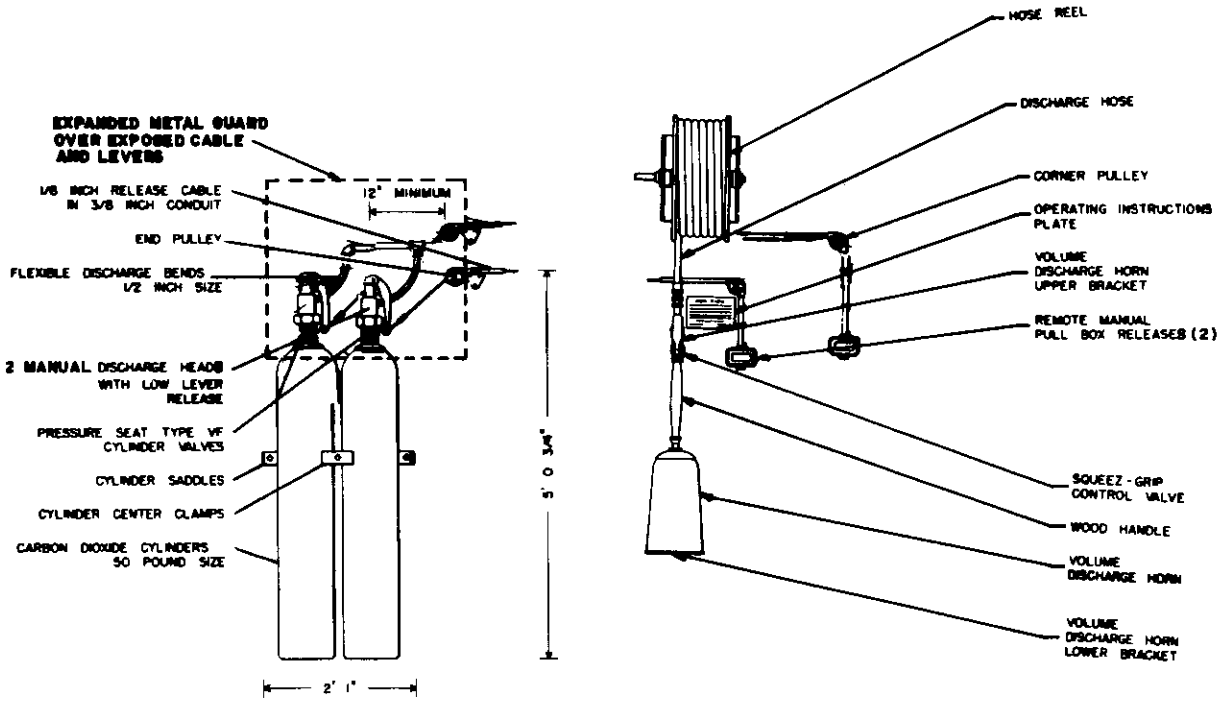
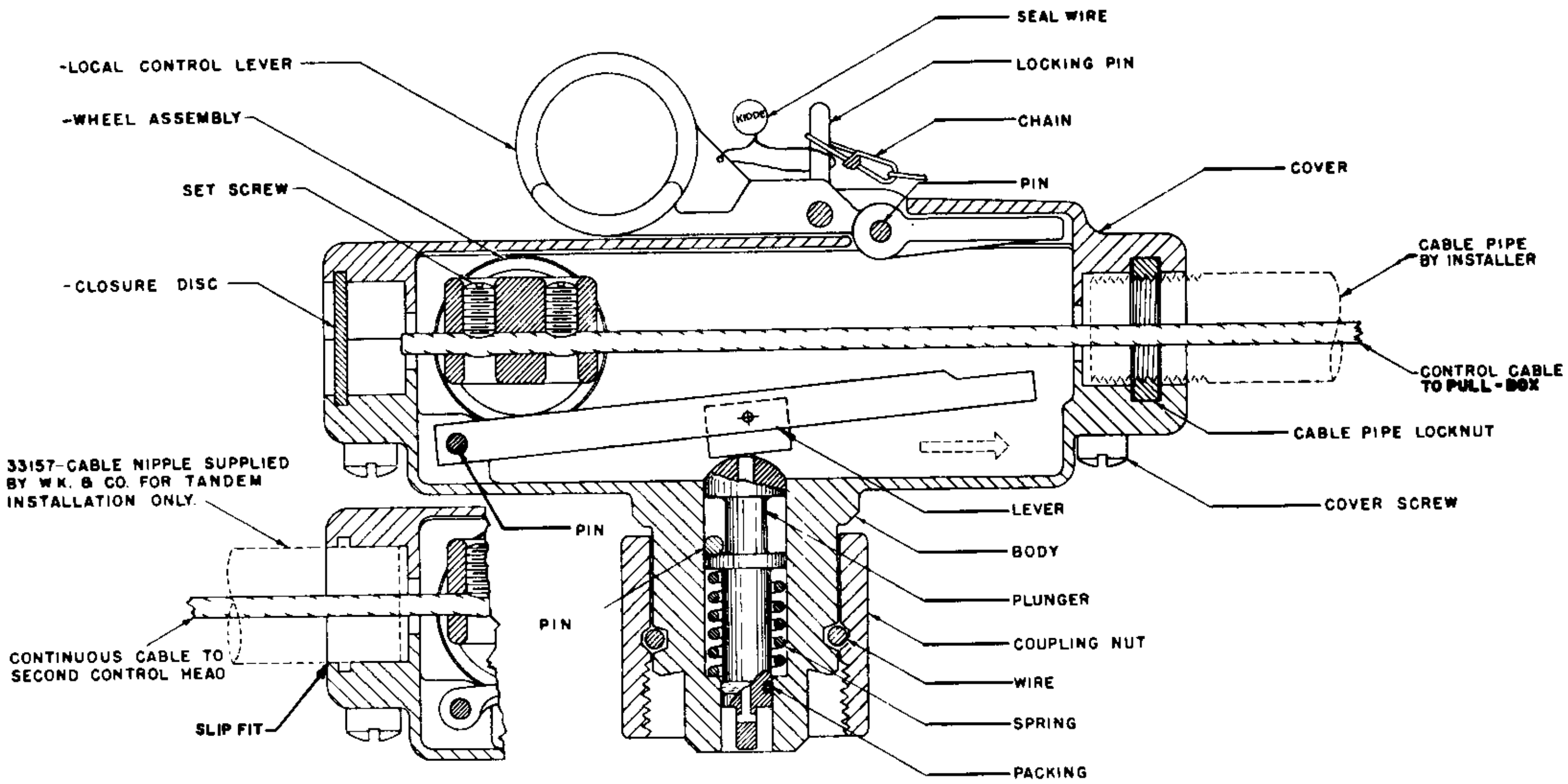


Figure 9930-53.



INSTALLATION INSTRUCTIONS

SINGLE CONTROL HEAD

1. CAUTION—TO AVOID POSSIBILITY OF ACCIDENTAL DISCHARGE, DO NOT INSTALL DISCHARGE HEAD ON CONTROL CYLINDER UNTIL AFTER CABLE-OPERATED CONTROL HEAD IS INSTALLED.
2. SECURE CONTROL CYLINDER IN CYLINDER RACKS WITH CONTROL OUTLET FACING IN PROPER DIRECTION, THEN REMOVE CONTROL OUTLET PROTECTION CAP.
3. REMOVE COVER FROM CONTROL HEAD AND TAKE OUT WHEEL ASSEMBLY, CABLE PIPE LOCKNUT, AND CLOSURE DISC.
4. MAKE SURE PLUNGER IS BELOW SURFACE OF CONTROL HEAD BODY, THEN COUPLE BODY TO CYLINDER WITH ARROW POINTING IN DIRECTION OF PULL.
5. ASSEMBLE CABLE PIPE LOCKNUT TO CABLE PIPE AND PLACE CABLE PIPE IN POSITION IN CONTROL HEAD BODY.
6. SLIDE WHEEL ASSEMBLY ON CONTROL CABLE TO PROPER "SET POSITION," THEN TIGHTEN SET SCREWS SECURELY. MAKE SURE WHEEL ASSEMBLY IS AT START OF STROKE. DO NOT DEPRESS LEVER AS THIS WILL CAUSE DISCHARGE OF GAS.
7. CUT OFF EXCESS CONTROL CABLE CLOSE TO WHEEL ASSEMBLY, INSERT CLOSURE DISC AND REPLACE COVER ON CONTROL HEAD.
8. EXAMINE SEAL AT LOCKING PIN, MAKE SURE IT IS INTACT.
9. INSTALL DISCHARGE HEAD ON CONTROL CYLINDER.

TANDEM CONTROL HEADS

10. INSTALL FIRST CONTROL HEAD AS DESCRIBED IN STEPS 1 THRU 9 EXCEPT THAT IN STEP 7 CLOSURE DISC IS OMITTED AND CABLE IS NOT TO BE CUT UNTIL SECOND HEAD IS INSTALLED.
11. REPEAT STEPS 2, 3, AND 4 FOR SECOND CONTROL HEAD.
12. ASSEMBLE SECOND CABLE PIPE LOCKNUT TO CABLE NIPPLE, SLIDE NIPPLE OVER FREE END OF CONTROL CABLE AND PLACE IN PROPER POSITION BETWEEN THE CONTROL HEADS.
13. REPEAT STEPS 6, 7, 8, AND 9 FOR THE SECOND CONTROL HEAD.

Figure 9930-54.

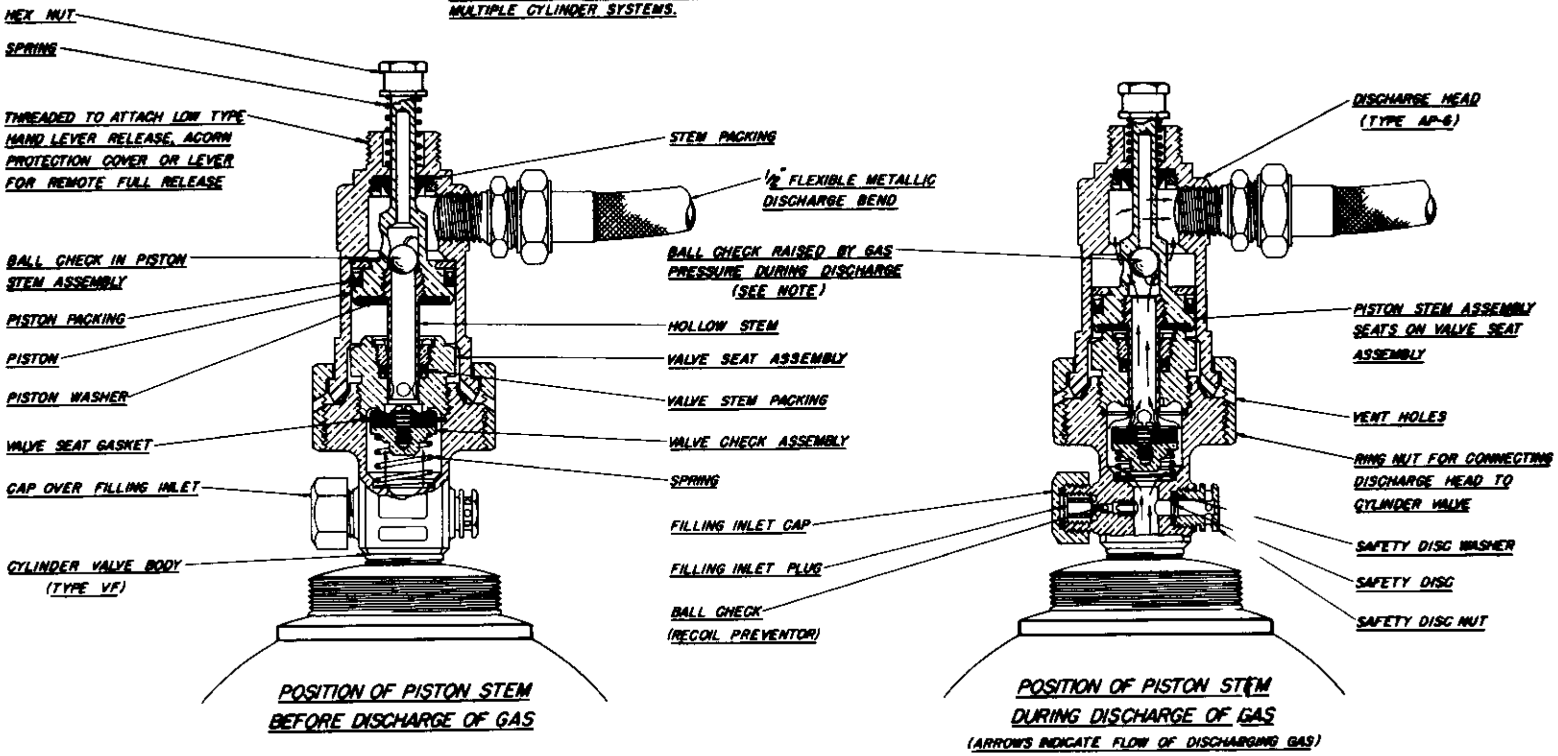
NOTE- THE FLEXIBLE METALLIC DISCHARGE BEND CONNECTING THE DISCHARGE HEAD TO THE HEADER MANIFOLD IS PULLED WRENCH-TIGHT FOR PERMANENT INSTALLATION. THE RING NUT CONNECTING THE DISCHARGE HEAD & CYLINDER VALVE IS ASSEMBLED HAND-TIGHT ONLY

WITH C-O-TWO IT IS NEVER NECESSARY TO DISCONNECT THE FLEXIBLE METALLIC DISCHARGE BEND FROM THE DISCHARGE HEAD OR HEADER MANIFOLD FOR MAINTENANCE.

PERIODIC WEIGHT INSPECTION OF CYLINDERS & TESTING OF DISCHARGE HEAD IS MADE WITH THE DISCHARGE HEAD REMOVED FROM THE CYLINDER. THIS ELIMINATES ANY POSSIBILITY OF ACCIDENTAL DISCHARGE.

TO REMOVE DISCHARGE HEAD, UNSCREW RING NUT COUPLING AND LIFT DISCHARGE HEAD FROM CYLINDER THE DISCHARGE HEAD IS THEN HELD BY THE FLEXIBLE METALLIC DISCHARGE BEND

THE BALL CHECK OVER THE HOLLOW STEM PREVENTS LOSS OF GAS IN EVENT OF FIRE OR SYSTEM OPERATION WHEN THE DISCHARGE HEAD IS REMOVED FROM A CYLINDER OF MULTIPLE CYLINDER SYSTEMS.



C-O-TWO
SHOCK-PROOF VALVE ASSEMBLY
AUTO-PNEUMATIC DISCHARGE HEAD TYPE AP-6
AND PRESSURE-SEAT CYLINDER VALVE TYPE VF-N

Figure 9930-55.

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