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ABSTRACT

Prepared by a team of fire control officers, the training guide is designed to help fire crewmen learn the fundamentals of water use. The entire package can be used for a complete course or individual lessons and can be adapted to specific training needs. Throughout the guide, emphasis is placed on one primary training objective, performance in real fire situations. The main sections of the guide include: (1) Supply: drafting water from a source below the pump and from a pressurized source, trouble shooting through gauge readings, and use of ejectors; (2) Delivery: delivery equipment, hose lay systems, planning water delivery systems for mop-up, water use hand signals, care of hose and fittings, connecting hose and fittings, broken hoses, and locating equipment; and (3) Application: principles of water application, initial attack with water, mop-up, and selecting or outfitting a tanker. Lesson plans provide objectives, instructor and student references, and step-by-step lesson presentations. Many lessons contain exercises appropriate for indoor fire training. Most lessons direct the instructor to specific visual aids (vu-graphs/transparency masters, slide/tape programs, and films). More than half of the document consists of instructional photos and the cross-referenced appended vu-graphs/transparency masters. (EA)

WATER IN FIRE CONTROL -
Basic Training Course
TT-90-(5100)

May 1975

U. S. Department of Agriculture
Forest Service
Division of Fire Management
Division of Cooperative Forest Fire Control

U. S. Department of Interior
Bureau of Land Management

Washington, D. C.

Preface

This guide was prepared by a team of Fire Control Officers, people with extensive knowledge of fire control problems, techniques and training. Throughout the guide, they have emphasized the importance of one primary training objective--performance in real fire situations.

No firefighter can complete his training in the classroom. He must work with practical exercises to learn the problems and situations he will encounter in the field under actual fire conditions. But even lecture and exercises are of little value unless they are followed with repeated drills; for it is the repetition of drills that will enable him to learn to perform his job efficiently and competently. The authors of this guide have placed great emphasis on the practical aspects of water use by following a problem approach in each lesson and by emphasizing the need for practice drills. Whenever possible, instructors should emphasize student involvement by using questioning and discovery techniques, self-testing, team problem solving and other appropriate instructional methods.

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Effective use of this guide depends a great deal on the capabilities of the instructors. Keep in mind that it is not a cookbook. Rather, it is a guide to help instructors in a variety of situations.

Using This Guide

This training guide has been prepared to help fire crewmen learn the fundamentals of water use. You may find the approach used in this guide different from others you have used. One thing you'll notice right away is the organization. For the most part, the lessons are learner-oriented rather than instructor-oriented. This simply means that the focus is on what a trainee will be able to do as a result of training. After all, if there is no measurable improvement in trainee performance, the instruction has been a waste of time.

This trainee-oriented approach may make the training job more difficult for the instructor. The guide may not appear to be organized for "logical" presentation by the instructor, because we've tried to organize it in a form which is logical for the trainee. In addition, the instructor frequently is called on to provide needed examples or substitute local examples and situations to make the material more appropriate for the trainees' area.

At the same time, we've tried to arrange material in modular form to provide flexibility for instructors to select only the lessons, or parts of lessons, they need. Similarly, we've provided exercises, when possible, in varying degrees of complexity and for use in differing situations. For example, you may want to use the entire package for a complete course, or you may select only certain lessons to meet specific limited training needs. You may even want to use only certain exercises for drill. In many lessons you'll find a variety of practice activities for use in widely differing situations. Also, since some fire training must take place when practice fires are not possible, many lessons contain exercises for indoor use. These exercises vary from simple to complex.

In many of the lessons, you'll find aid cues of instructional materials--vu-graphs, slide/tape programs and motion pictures--that can be used as part of that lesson. Also, you'll find a complete listing of the source of such aids in the bibliography in the appendix. Although these items are known to be good materials, instructors always should preview them before use. In many cases, the materials can be adapted for local use by simple modifications such as substituting different pictures or using localized examples.

LESSON PLAN SUMMARY

SUBJECT: WATER IN FIRE CONTROL

OBJECTIVE: After successfully completing this course, or selected parts of this course, the trainee will be familiar with the water equipment used, be able to describe the best ways of using such equipment in fire control work. Also, he will be better able to perform as an individual or crew member as a result of this knowledge and drill experience.

The trainee will demonstrate his knowledge and skills by:

1. Answering correctly a specified number of questions regarding appropriate parts of the text.

2. Demonstrating his ability through improved drill performance.

3. Performing as an effective member of a fire suppression crew using water.

TRAINEE POPULATION:

1. All untrained, inexperienced individuals who will be assigned water use firefighter duties.

2. Firefighters who have had previous basic firefighter training and some experience, but have not had water use training and are likely to be assigned such work.

3. Firefighters who have had water use experience, but who would benefit from refresher or reinforcement training.

4. Supervisory personnel who need a broad background in all fire control activities.

INSTRUCTORS:

1. Experienced fire control personnel who have demonstrated training abilities.

2. Others responsible for fire control training who would benefit from the prepared material and who have demonstrated training abilities.

TIME REQUIRED:

No specific time is established. Time needed will depend on the material used, method of presentation and drills used. This will be determined by trainees' indicated needs and responses to training presented.

COURSE OUTLINE:

The course is presented in three logical parts - SUPPLY, DELIVERY and APPLICATION. The elements of fire behavior, strategy and tactics are discussed as they pertain to the water use job. Additional materials that might be helpful are mentioned. The use of actual samples, personal experiences and on-the-ground practical exercises is stressed.

The SUPPLY segment concentrates on material concerned with getting water from a source into the delivery system.

The DELIVERY segment deals with the operations that move water from a source to the point of application on the fire.

The APPLICATION segment concerns the why, how and what of the methods and equipment for putting water on the fire.

CONSIDERATIONS:

Fire control training in general, and water use in fire control training in particular, will benefit from the maximum use of practical exercises, drills and the opportunity to practice under actual fire situations.

The interjections of real life experiences, pictures and situations by the effective instructor are vital ingredients of this training package.

Pre-work of any nature may be assigned to the trainees. The booklet, "Water vs Fire", provides a good basic background. Any readable material concerning water in firefighting, use of pumps, hose and fittings, pumper instruction cards or pump operator manuals can be assigned. Questions are needed to keep the training pertinent; and the course needs interplay to be most effective.

Testing should be done by the instructor. Test questions can be developed and used as appropriate; but performance in drills and on the fire undoubtedly will provide the ultimate test results.

OUTLINE AND CONTENTS

WATER IN FIRE CONTROL - BASIC TRAINING COURSE

INSTRUCTOR'S LESSON PLAN I A

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Drafting Water from a Source Below the Pump	Date:
TYPE: Lecture, Demonstration & Field Exercise TOTAL TIME: 4 hours' minimum	Instructor:
TRAINING AIDS: Overhead projector, vu-graphs, screen. Slide-tape "Pump Operation and Maintenance MK 3 & MK 26" Slide-tape "Pump Operation and Maintenance WGC 4" Film "Water vs Fire" (Proposed) Slide-tape "Operation of MK 3 and Gorman Rupp Pump" Pumping equipment	Assistant(s): Training Location:

OBJECTIVES:

Trainees will be able to set up and use pumping equipment to draft from a source below the pump and will be able to diagnose and solve common problems (specified by instructor). Satisfactory performance will be the delivery of water to the discharge side of the pump according to performance standards established by the instructor.

INSTRUCTOR REFERENCES:

"Water Handling Equipment Guide (WHEG)" 5162, USFS, "Water vs Fire" USFS, "Instructor's Guide for Standard Type of Pumping Equipment" USFS R5, "Performance Test on MK 26 Centrifugal Pump" Forest Fire Research Institute, Ottawa, Canada, "Performance Test on Gorman-Rupp Backpack Pump" Forest Fire Research Institute, Ottawa, Canada. Owner's manuals on all pumps to be used in demonstrations. Yellow card series on pump operation and care, USFS R5 form 7130-13, Fire Fighter Basic Training Lesson IVc, "Using Water in Suppression" USFS TT-87 (5100), Water vs Fire booklet.

STUDENT REFERENCES:

TIME	LESSON OUTLINE	AID CUES
	I. INTRODUCTION	
	To use water on the fire, you must first get the water from a source. In this lesson, we'll discuss how to properly use pumping equipment and how to diagnose and solve some common problems. Discussion and practice will be confined to those techniques that deal with getting water from a source through the pump. The variety of situations and equipment makes impossible the establishment of fixed performance standards in this lesson, so the instructor must establish these standards for the conditions and equipment used in each training situation. No attempt is made in this lesson to provide comprehensive training on the use of specific brand name pumps.	
	II. PRESENTATION	
	Situation:	Ask for examples
	Water source below the pump. This probably is the most common pumping situation. Examples: pond, lake, stream, stock tank, swimming pool.	
	A. Equipment:	
	The instructor should tailor this section to the pumping equipment used in his area. (If the equipment is not available, use aids such as overhead transparencies, slides or booklets.)	
	1. Suction Strainers: Used on the submerged intake end of a portable pumper or tanker suction line. Designed to prevent debris and most abrasive material from entering the pump where damage can occur.	Vu-graph I A-1
	2. Foot Valves: A combination foot valve and strainer is commonly used on the suction hose for centrifugal pumps. These foot valves should be capable of holding a water head equivalent to 500 psi, since water in a line can flow past centrifugal pump impellers when the unit is not running. The valve should not materially reduce the pump	Vu-graph I A-2

TIME	LESSON OUTLINE	AID CUES
	performance. Foot valves also may assist in priming worn gear-drive pumps by filling the suction hose before attaching to pump.	
	3. <u>Suction Hose</u>: Hard suction hose usually is used. This hose generally is identified by its stiffness and comes in lengths from 4' to 25'. Diameters used may vary from 1" on Eco pumps to 2" on Mark 3's. Tankers generally have larger hoses, depending on pump size. (Instructor: Demonstrate commonly used sizes in area.)	
	4. <u>Spanner Wrench</u>: Used to insure air tight hose seal on suction side. Do not over-tighten. (Instructor: Demonstrate.)	Vu-graph I A-3
	5. <u>Pumps</u>: This section will not cover pump operation in depth, due to the diversity of pumps in use. It will present basic information on portable pumps common to most areas. (It is expected that the instructor will tailor his presentation to the pumps common in his area. The instructor will have the opportunity to expand on this subject later in the lesson.) The portable pumps used in fire control vary in size, type of engine and type of water population mechanism.	
	a. Centrifugal pumps generally are used to deliver higher volumes of water. Common examples are Pacific MK 3 and MK 26 and Gorman-Rupp 61 1/2 D.F. (Instructor: Show how these pumps are equal. See WHEG 3.0--3, 3.1.1)	Vu-graph I A-4

TIME	LESSON OUTLINE	AID CUES
	(1) Advantages:	
	(a) Pressure can be changed by adjusting rpm.	
	(b) Volume can be changed by adjusting psi and rpm.	
	(c) Relief valves not required.	
	(d) Dirty water and small particles can be passed without damage.	
	(e) Refill performance good.	
	(2) <u>Disadvantages</u>:	
	(a) More power required for higher pressures.	
	(b) Primer usually required.	
	(c) To avoid heating, bypass is required when no water is moved.	
	b. <u>Positive Displacement Pumps</u>:	
	Generally, positive displacement pumpers are preferred for constant-flow, high pressure application. Common examples are Pacific Pumper WX-10 and ECO.	Vu-graph I A-5
	(1) <u>Advantages</u>:	
	(a) Higher pressures usually can be produced with less power.	
	(b) Primers usually are not required.	
	(2) <u>Disadvantages</u>:	
	(a) May be damaged by dirty water.	

TIME	LESSON OUTLINE	AID CUES
	(b) Relief valve required. (c) Fixed output and psi performance not easily changed. (d) Refill performance is low. (Low volume pump)	
	6. Pressure relief valves: Used with positive displacement pumps to relieve excessive pressure, line surges, and as a water flow bypass. If all nozzles are closed, will bypass water from the main hose line by a spring loaded release. This can prevent hose breakage or prevent killing the engine on small pumps. A manually-operated valve will adjust the relief pressure from 50 to 250 psi and a locknut holds adjustment.	Vu-graph I A-6
	7. Check and Bleeder Valves: A combination valve used at the pumper when vertical lift is 200' or more. A swing check valve holds the water back when the pump is stopped. This reduces back pressure on the suction hose and the load against the engine. When restarting the engine the bleeder valve is opened to facilitate starting the pump, then closed when the unit has gained sufficient head to pump against the load in the hose line.	Vu-graph I A-7
	8. <u>Safety Equipment</u>: The pump operator should have the following: - Sturdy work boots - Snug fitting clothes - Warm jacket - Hard hat - Gloves - Ear protection - Adequate lighting for night work	
	B. <u>Setting Up</u>: The instructor should have representative	

TIME	LESSON OUTLINE	AID CUES
	samples of all the equipment in use in the local area. The arrangement should be done at a pump chance if possible, but could be laid out indoors if necessary.	
	1. Select a proper pump location:	
	a. Close to Water: Suction hose must be able to reach far enough into the water to adequately cover strainer. Use a minimum lift wherever possible. (The volume of delivery on a Gorman-Rupp backpack is reduced 10 gpm when a pump is elevated from 10 ft. above the water to 15 ft. above the water.)	Vu-graph I A-8
	b. Pumper in Safe Location:	
	(1) Solid ground, flat (2) Cleared area (adequate footing) (3) Safe from fire	
	2. Set up Pump:	
	a. Portable Pumps	
	(1) Secure. May need additional leveling with shovel. Also may need to be tied or staked on slick surfaces.	
	(2) Suction side facing toward water.	
	(3) Gas can securely located.	
	b. Tanker: (1) Clear of traffic (2) Wheels chocked (3) Place warning lights, signs or flagmen where needed. (4) Avoid soft spots (weight will change as water is loaded)	Provide sketch or slide
	3. Set up Suction System a. Attach foot valve or strainer on suction hose. b. Select or construct a suitable spot to place strainer in water source.	Demonstrate each step

TIME	LESSON OUTLINE	AID CUES
	This should allow the strainer to be at least several inches under water. c. Protect the strainer from picking up debris or grit. Debris can clog strainers, and grit can be harmful to pumps, especially the positive displacement types. Place the strainer in a bucket, or, on a piece of plastic, shovel head, or a submerged log. d. Connect suction hose to suction side of pump. (1) Check the gasket in the female end of the hose for damage or grit. This can be visual or by running a finger over the gasket (especially useful in the dark). Make a habit of checking the gasket each time a piece of hose is handled. (2) Check the threads as above. (3) Screw on. (4) Tighten gently with spanner wrench. 4. Install Pressure Relief and/or Check Valve as Needed. a. Check gasket for damage of grit by visual inspection or finger in female end. b. Check threads. c. Screw on and tighten by hand. 5. Attach discharge hose. 6. Prime the Pump: Priming is required on all centrifugal pumps and can aid initial suction on worn positive displacement pumps. The instructor will demonstrate the priming of the pumps common to the area using the following methods where appropriate: a. Hand primer b. Filling the pump with water from a bucket or hard hat.	 If demonsration is not possible, use slide-tape "Operation of MK 3 and Gorman-Rupp Pumps" or similar.

TIME	LESSON OUTLINE	AID CUES
	c. Filling the suction hose and foot valve with water before attaching to pump. d. Squirting oil on gears of gear drive pump. e. The PLUNGE Method: Plunge intake end of suction hose into deep water several times--valve opens on down stroke, closes on up stroke. Do not plunge in shallow or silty water.	
	7. Starting the pump. Instructor: Demonstrate the starting drill for each pump used in the demonstration. Stress these safety items: a. Starter ropes wound clockwise. b. Keep men clear of whiplash from starter rope. c. Make sure nozzlemen are ready for water before charging hose.	Demonstrate or show slide tapes, "Pump Operation and Maintenance " a. MK 3 and MK 26 b. PACIFIC WGC4
	8. Review Setting Up and Starting. Answer questions.	
	C. Test the System: Find out whether the equipment is operating properly. This may be used to test each trainee on his ability to set up and operate each pump. Each trainee or pair of trainees will set up a pump chosen by the instructor. The instructor will inspect each assembly and direct the trainees to demonstrate their ability to start the pump and deliver water to the discharge side of the pump. The trainees then will shut off the pump and disassemble the pumping equipment. This will be repeated with different pumps until all pumps have been tested by all trainees.	
	D. Problem Situations:	
	1. Unable to get suction started. a. Air leak in line. Generally from a loose connection or a worn or missing gasket. Trainees will loosen suction connection at pump, start	Demonstrate

TIME	LESSON OUTLINE	AID CUES
	pump to demonstrate lack of suction, shut off pump, correct deficiency, reprine and restart.	
	b. Loss of Prime: Debris holding foot open. Instructor: Show valve. Have trainee remove screen and push foot valve open and demonstrate loss of prime by letting water run out of hose.	Demonstrate
	c. Unable to pump water even when properly primed: Pump too high above water level. Trainees will begin by using pump near water. Then they will move the pump to progressively higher elevations above the water source until suction is lost. Instructor: Stress that the nearer the pump to the water, the easier it is to get suction and the more efficient the pump is in delivering water.	
	2. Restriction on the suction screen: Examples: Moss, debris, collapsed hose. With your hand, or a piece of plastic film, gradually cover the suction screen while the engine is pumping. Have trainees listen for differences in engine speed as strainer is covered and uncovered.	Demonstrate
	3. Pressure Increase: A kinked hose or a nozzle or line being turned off may be detected by decreased engine speeds, increase in gauge pressure, pressure relief valve opening on a positive displacement pumper, or automatic shut off activating on a portable centrifugal pump. Instructor: Do this while trainees watch and listen.	Demonstrate

TIME	LESSON OUTLINE	AID CUES
	E. Drill for Skill: Instructor divides trainees into small pump or tanker crew groups, allowing each group to practice assembly of each pumping unit. Have hose team "A" induce a problem from section d (problem situations) in hose team "B"'s absence. Hose team "B" then is called in to find and correct the problem and get water flowing. If feasible, two or more groups could be working on problems induced by each other simultaneously. Make sure each group gets a crack at each type of problem.	
	III. <u>SUMMARY</u>	
	We've discussed both the equipment and techniques in drafting water from a source below the pumps. We've looked at some of the common problems that might be encountered and how to correct them. We've practiced correcting these problems, and in so doing have practiced doing the pumping job itself. Our ultimate goal is for you to do this job safely and efficiently; and this lesson has been one of the steps toward that goal.	

INSTRUCTOR'S LESSON PLAN I B

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Drafting Water from a Pressurized Source	Date:
TYPE: Lecture, discussion, practical exercises	Instructor:
TOTAL TIME:	
TRAINING AIDS: Visual aids of water equipment used in your area or the actual items, easel or chalkboard; overhead projector, screen	Assistant(s):
	Training Location:

OBJECTIVES: Trainees will be able to draft from pressurized source and be able to recognize and correct common problems (specified by instructor).

INSTRUCTOR REFERENCES:

STUDENT REFERENCES: "Water vs Fire"

TIME	LESSON OUTLINE	AID CUES
	I. <u>Introduction</u> Suppose your water supply source is higher than your pump. Gravity pressure will make it easier to get water into the pump, but even in "easy" situations there still can be problems. This lesson will show you how to get water from a pressurized source into your pump and how to recognize certain problems. By practicing the field exercises of this lesson, you will become proficient in this phase of water use.	
	II. <u>Presentation</u>	
	A. What possible situations might you encounter where your water source would be under some pressure, either great or small, and you were operating a mobile pumper of some type? 1. Fire hydrant 2. Standpipe from large tank 3. Portable tank on another truck parked higher than you 4. Stream above you (gravity sock) 5. Other?	Ask trainees and list
	B. What pressurized water sources might you encounter with a portable pump? (Same general list as in A.)	Ask trainees
	C. Potential Problems - What problems might you run into if water source is under pressure? 1. Too much pressure and volume 2. Too little pressure and volume What can you do to overcome these problems?	Ask and list some of the problems

TIME	LESSON OUTLINE	AID CUES
	a. Too much pressure and volume (1) Run water into pumper tank through filler hole or into a portable tank and draft from the tank. (2) Put pressure reduction valve in supply line. b. Too little pressure and volume (1) Run into pumper tank, as above. (2) Draft only while tank has water in it, and keep eye on water supply. Review what has been covered. D. <u>Exercises</u> Now is the time to see what actually happens when we operate under the conditions we've been discussing. (The following series of exercises can be used for demonstration and practice, using the previously discussed situations and the equipment trainees will be expected to use.)	
	1. <u>Exercise Setup</u>: From a hydrant under pressure, you are to hook up your pump or tanker (whichever applies) and draft from the hydrant. a. Procedure (1) Determine hydrant pressure. (2) Examine available hardware.	You provide vu-graphs or slides of: Hydrant to piezometer or line gauge, available water equipment, and the equipment needed.

TIME	LESSON OUTLINE	AID CUES
	(3) Arrange and select needed hardware. (4) Hook up. (5) Test to check. b. Equipment needed (1) One length of soft suction hose NS thread, 1 double female adapters. (2) One combination hydrant and adjustable spanner wrench. <u>Note to instructor</u>: Vu-graphs are only for classroom exercise. Use actual equipment in field when possible. 2. <u>Collapsed Suction Hose Situation</u>: You have checked your hydrant pressure and capacity with your piezometer (in line gauge) and examined and selected the needed hardware. You have completed your hookup and check it. Everything appears to work fine. After a short time, your suction hose collapses, your engine increases speed and shuts off. What did you forget to do? (Answer). Determine volume of pump. Your pump was taking water away faster than the hydrant could supply it. <u>Note to instructor</u>: As a field exercise, you must try this in advance, using hydrant pressure and pump capacities that will react this way. As a paper exercise, provide all data except pump capacity.	

TIME	LESSON OUTLINE	AID CUES
	3. Gradual Loss of Water Situation: You have set up as in problem #1, except you used hard instead of soft suction hose, and the pump volumes have been checked as adequate. After a short period of pumping, you have less volume than you had initially, and soon you have no water at all. What has happened? a. You used hard suction hose and likely collapsed the feed pipe to the hydrant. (A potentially serious problem to domestic water users on the same line.) b. The pressure and volume calculated for your hydrant was incorrect (possibly faulty gauge or calculations) and was too low. <u>Note to instructor</u>: As a paper exercise, this can be handled by <u>saying</u> hard suction hose was used. Again, make sure any data provided would cause this reaction. As a practical exercise, this will be difficult to do because of the possibility of damage to the feed line, as noted in the exercise. c. Conclusion: What good rule is suggested as a result of this exercise? Answer - Use only soft suction hose when drafting from hydrants. (The hose will collapse instead of the feed line.)	

TIME	LESSON OUTLINE	AID CUES
	III. <u>Summary</u> There are situations where at least part of the drafting job may be handled by gravity. However, this doesn't relieve you from taking certain precautions to be sure the gravity help is properly utilized.	

INSTRUCTOR'S LESSON PLAN I C

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Troubleshooting through gauge readings	Date:
TYPE: Lecture and exercise	Instructor:
TOTAL TIME:	
TRAINING AIDS: Fire tanker with tachometer, pressure and vacuum gauges, or slides, slide projector, screen, or vu-graphs and overhead projector.	Assistant(s):
	Training Location:

OBJECTIVES: Trainees will know the correct or normal readings for pumper instruments, and will be able to identify probably causes of problems indicated by variations in these readings.

INSTRUCTOR REFERENCES:

STUDENT REFERENCES:

TIME	LESSON OUTLINE	AID CUES
	I. INTRODUCTION In order to be proficient at any job, one must be able to foresee the problems that may come up and be able to devise ways to overcome them. If all goes well when learning to pump water, you really have accomplished only part of your education. You must have faced and overcome the inherent problems in the operation to become fully proficient. The various gauges or instruments visible on certain tankers show what the pump is doing. Variations from normal readings can indicate not only that there is a problem, but also what that problem might be. This lesson will show how to troubleshoot through recognizing these variations. (Although we still are in the "Supply" phase of water use, some of this material concerns the "Delivery" phase. Since this action will take place at the pump, we'll discuss it here.) II. PRESENTATION A. The pressure gauge and its readings. 1. Pressure gauge shows the pump pressure in pounds per square inch at the gauge location on the discharge side of the pump.	
	2. A pressure gauge on a centrifugal pump will change with the engine rpm climbing higher when the engine speed increases and dropping lower with a corresponding decrease in engine speed. 3. A pressure gauge on a centrifugal pump may change even though the engine rpm does not change under certain conditions. If there is pressure on the intake side of the	Slide I C-1

TIME	LESSON OUTLINE	AID CUES
	pump, such as when pumping from tank to fire, the pressure gauge will not change without an engine rpm change. The pressure reading will change when the intake is restricted below the capacity of the discharge. For instance, even if a hose breaks, the discharge still is well within the capability of the gpm rate of the pump, and no pressure fluctuation will show on the pressure gauge. However, if there are three hoses being used at the same time, there may be a noticeable reduction of pump pressure because the intake side of the pump can't supply the required water that the pump is trying to discharge. This situation would be the same in principle as a "Restriction/Suction Side."	Slide I C-2
	4. Exercise -	
	To test this principle, set up the fire tanker to pump out three discharges. The operation objectives will be to test the effect of a restriction on the suction side of the pump to see what pressure variation occurs, and to see if the pressure gauge changes when a hose breaks.	
	a. Put a 1/4" tip on the two hardlines and prepare to discharge water.	
	b. Put a 3/8" tip on a 1" cotton jacket hose and prepare to discharge the water.	
	c. Set tanker valves to pump from tank to fire.	
	d. Start pump and discharge water. Note if there was any pressure change from static to working pressure.	

TIME	LESSON OUTLINE	AID CUES
	e. Note the rpm and pressure readings.	
	f. Open a 1-1/2" line to simulate a broken hose. Note the pressure and engine rpm readings.	
	g. Return to pumping out the three lines as above.	
	h. Slowly close the #1 valve until the vacuum gauge starts to indicate a vacuum reading. This stimulates a "Restriction/Suction Side" problem like ice in the intake line or a clogged rock trap.	Slide I C-3
	i. Open a #3 valve to simulate a broken hose as before, and note the pressure reading, rpm and vacuum gauge readings.	
	(Instructor note: Discuss the situations which will cause restrictions on the suction side of the pump. Use experiences and cover all of the situations which could cause this variation in the pressure gauge reading.)	
	B. <u>The vacuum gauge and its readings</u>.	
	1. The vacuum gauge shows the vacuum reading in inches on the suction or intake side of the pump at the location of the gauge tap.	
	2. The vacuum gauge on a centrifugal pump will change as the engine rpm changes. The more water the pump moves where suction is required, the more inches and the higher the reading on the gauge. Water volume pumped is dependent on the speed of the pump.	
	3. The vacuum gauge will fluctuate when pump speed is constant under certain conditions:	

TIME	LESSON OUTLINE	AID CUES
	When pumping from tank to fire, we have seen that if we restrict the suction side enough, the gauge will show a vacuum reading. This vacuum reading is the result of a restriction on the suction side relative to the discharge side and the gallon per minute discharge. This means that under stream-to-tank or stream-to-fire operations, any restriction on the suction side relative to the gallons per minute discharge will cause an increase in the vacuum reading on the gauge. The fluctuation of readings on the vacuum gauge will be caused, usually, by changing restrictions on the suction side of the pump.	
	When drafting from stream to tank, there is no restriction on the discharge side of the pump; therefore, a vacuum reading will show on the vacuum gauge. That reading will depend upon how much water you're moving more than the height of the lift. The pump normally will pump capacity of 1,000 rpm and the reading will show around 20 inches.	Rule of thumb: 1" vacuum will raise water 1 foot. Slide I C-4
	When drafting from stream to fire, there is a restriction on the discharge side of the pump. There will be a pressure register on the pressure gauge depending upon the speed of the pump. There is less water being moved, so, therefore, there will be less vacuum register on the vacuum gauge.	
	"Restriction discharge side."	Slide I C-5
	The vacuum will change as the pump moves more or less water. Under these conditions, it is easy to detect broken hoses and changing restrictions on the discharge side of the pump.	

TIME	LESSON OUTLINE	AID CUES
	Another pumping variation would be to pump from stream-to-tank and stream-to-fire at the same time. This requires that there be a change of pressure and vacuum readings from the readings established when pumping tank-to-fire or stream-to-tank. There will be less restriction on the discharge side than when pumping stream to fire. Therefore, the vacuum gauge should read higher in inches than on the stream-to-fire operation, but lower than stream-to-tank because there is less water moving through the system than during stream-to-tank operations.	Slide I C-5 Repeat stream-to-fire
	By opening the #2 valve (pump to tank) there will be less restriction on the discharge side. The volume the pump moves will increase. Note change of both gauge readings in between the tank-to-fire and the stream-to-tank operations.	Slide I C-6
	C. <u>Relationships between vacuum and pressure gauge readings</u>.	
	1. Low pressure is the same as low restriction discharge side.	
	2. High pressure is the same as increasing the restriction on the discharge side.	
	3. At constant pump speed, high volumes will be attained at lower pressures.	
	4. At constant pump speed, high pressure is attained at lower volume.	Slides I C-7 and I C-8
	<u>Exercise a</u>.	
	Set up tanker for drafting from stream-to-fire. Pump water on	

TIME	LESSON OUTLINE	AID CUES
	stream-to-fire setting. Note pressure and vacuum readings. Change nozzle sizes and volumes used and note the changing readings on the gauges.	
	Discuss with class the cause and effect. Discuss the malfunctions that would cause similar variations in the readings. (Basically, any clogging of the suction side will cause a problem and can be recognized by a drop in pressure.	
	<u>Exercise b</u>.	
	Set pump up on drafting from stream-to-tank operation.	
	Start pump and note gauge readings. Pressure should be zero and vacuum should be maximum for the elevation and pump efficiency. Simulate a restriction on the suction side such as clogging the suction strainer. Note the readings on the vacuum gauge. The restriction will allow less water to be moved through the system and the vacuum gauge reading will drop toward zero.	
	<u>Exercise c</u>.	
	Set up pump for drafting from stream-to-fire. Start pump, note gauge readings. Induce a restriction on the discharge side in the internal piping such as debris or partly frozen lines would. To do this simulation, slowly close the pump-to-tank valve (#2) until there is a definite change in gauge readings. Note the readings on the gauges. The vacuum reading will decrease because there is less water moving through the system.	Slide I C-9

TIME	LESSON OUTLINE	AID CUES
	Note to instructor: Keep going over the gauge readings until the trainee can identify the readings that are normal for all pumping operations. Work with him until he can identify an abnormal reading for the pumping phase in progress and can isolate and correct the problem. III. <u>SUMMARY</u> Pumper instrument readings provide a constant interpretation of what that pumper is doing. Knowing what readings to expect under certain pumping conditions, and knowing what any variations from these readings indicate are a vital part of the pumper operator's knowledge.	

INSTRUCTOR'S LESSON PLAN I D

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Use of ejectors	Date:
TYPE: Lecture, discussion and practical exercise	Instructor:
TOTAL TIME: 6 hours	
TRAINING AIDS: Typical tankers and portable pumps used in your area, ejector, 500 feet 1 1/2" CJRL hose, 300 ft. 1" CJRL hose, Gated "Y", 2-1 1/2" to 1" reducers, 2 nozzles with various tips	Assistant(s):
	Training Location:

OBJECTIVES: Trainees will be able to connect an ejector system to selected pumps, activate the system and deliver water in specified amounts determined by instructor. They will be able to diagnose and correct common problems.

INSTRUCTOR REFERENCES: Water vs Fire. Instructor's Guide for Standard Types of Pumping Equipment, Western Fire Equipment Catalog, Water Handling Equipment Guide

STUDENT REFERENCES: Water vs Fire, Page 17

TIME	LESSON OUTLINE	AID CUES
	I. <u>Introduction</u>	
	No firefighter's training is complete until he can skillfully use all the equipment available to him. Some play it safe by using only that which is familiar to them and avoid learning to use something different, even though it may be an improvement. One such piece of equipment is the water ejector. This lesson will show how and why it can help do a better job.	
	II. <u>Presentation</u>	
	A. <u>Principles</u>. If water sources cannot be used because of excessive suction lift or off-road conditions, a hydraulic ejector may be the answer. This small, inexpensive device has no moving parts and employs a simple engineering principle. Water is pumped in a conventional manner from a tanker to the water inlet of the ejector, where it passes through a nozzle restriction as a high-velocity stream, as shown in the straight type ejector illustrated. This jet stream then picks up additional water through the suction port and delivers the combined flow through the diffuser chamber and out the discharge port under lower pressure.	Vu-graph I D-1
	B. <u>Uses</u>. The ejector can be used advantageously in situations where drafting becomes critical, such as on lifts of 18 or 20 feet, from deep cisterns, or off comparatively high bridges. In other situations, where lift is not the factor, but where the tanker or portable pumper cannot be located within easy drafting hose reach, an ejector can be used up to several hundred feet from the pumper. As you can see from this chart, it's possible to pick up about a gallon for each gallon that flows through the ejector.	Vu-graph I D-2 Vu-graph I D-3 Vu-graph I D-4

TIME	LESSON OUTLINE	AID CUES
	Incidentally, a few small leaks in the hose are not critical, because the entire hose lay to and from the ejector is under pressure, rather than vacuum.	
	Although we're still working on the SUPPLY section of our water use course, let's mention the DELIVERY use of the ejector. If there is available water that's too dirty for your pump, it still can be utilized. The ejector lets you pick up this water by adding it to your own, but <u>without</u> running it through your pump or into your tank. Of course, this illustrated supply will last only as long as the clean water in your tank lasts.	Vu-graph I D-5
	C. Practice. In order to know whether equipment actually functions as specifications state, let's try some practical exercises. These exercises also will provide practice in using the equipment and illustrate some of the problems that might be encountered:	
	1. <u>Hookup Exercise and Drill</u>:	
	a. Instruct the class to position pump or tanker between 150 and 200 ft. from a water source.	
	b. Hook up to the ejector system required to fill the pumper tank:	
	(1) Lay 1" hose to ejector at water source.	
	(2) Hook up to 1" intake on ejector.	
	(3) Lay 1-1/2" hose from discharge side of ejector to tanker and put open end in tank.	

TIME	LESSON OUTLINE	AID CUES
	(4) Make sure foot valve is on ejector and place ejector in water.	
	(5) Start pump.	
	(6) Observe for proper operation.	
	Note - Step (3) can be done by laying hose from tanker to ejector instead. Make sure reverse lay is made so threaded fittings match.	
	(7) Discuss how the job was done and how it might be improved.	
	(8) Practice for efficiency.	
	2. <u>Operating Capabilities Exercise</u>:	
	We want to identify and determine the operating capabilities of the ejector we have available.	Hand out copies of Vu-graph I D-4
	a. Separate into groups of 3 or 4 and study the chart entitled REPRESENTATIVE EJECTOR SELECTIONS FOR FOREST SERVICE TANKERS.	
	b. Identify the ejector we will be working with.	
	c. Have each trainee make a data card which lists the operating limits of the ejector used in this exercise.	
	d. Compare the cards, and have the class select the best card as the one to use for future exercises.	

TIME	LESSON OUTLINE	AID CUES

Note to instructor: Let the trainees ask questions, but have them study the reference sheet.

The data card for the ejector should be similar to this sample:

Ejector: Penberthy 63A

Pump: Mod. 20 tanker with Pacific Pumper WA-7

Max Lift: 155 ft.

Psi at ejector: 67

Max flow at ejector:
pick up: 20 gpm

Combined max flow discharge: 38 gpm

Pump requirement: 18 gpm to ejector

3. Ejector Efficiency Exercise:

Here is a sample test for the ejector lay, using the specifications shown in the sample card from Exercise 2:

a. For this test, you will need two trash cans, or other large containers for water. Mark the cans in five-gallon graduations (use masking tape, or grease pencil). Fill can A with 36 gallons of water. This is double the 18 gpm listed on the card as the pump requirement. Put the suction hose into can A and hook up to the pump. Set valves to pump from stream to fire.

TIME	LESSON OUTLINE	AID CUES
	b. Fill can B with 40 gallons of water (double the 20 gallons listed on the card at maximum flow for the ejector intake). Put ejector in this can after hooking up to the system. c. Add enough water to can A to offset the extra water required to fill the suction hose. d. Start pump and record time required to empty one can. If can A empties first, the system is less efficient than the estimate shown on the card. (You may wish to use a third can which will fill to overflowing if the system works properly.) If can B empties first, the ejector is more efficient than the estimate shown on the card. If both cans empty in the same time, all estimates were correct. Note: Discharge water from a 1-1/2" hose without nozzle. 4. <u>Results List</u>: Have the class list the results of the field tests. Their lists should contain the following information: a. Pump pressure used duing test. b. Length of hose in system.	

TIME	LESSON OUTLINE	AID CUES

c. Nozzle opening on discharge side of system.

d. gpm into ejector and out.

e. Ratio of gallons-in to gallons-out.

5. Engine Pressure Test:

Using the same setup outlined in exercise #3, have the class test the ejector system to determine the most efficient engine pressure. (Can A and B should empty at equal rates.)

Have the class make a chart showing the most efficient point and the rate of decay with change of pressures, both higher and lower than optional.

6. Nozzle Tip Test:

a. Using the same setup as exercise #3, have the class test the ejector system with decreasing nozzle sizes from 1-1/2" hose with no nozzle to 1/4" tips. The efficiency will change, due to the effect of changing friction loss.

b. Have the class note and record on a card the following information:

(1) gpm ratio between volume-in at ejector and volume-out at outlet, using open 1-1/2" hose.

(2) gpm ratio using 3/8" tip.

TIME	LESSON OUTLINE	AID CUES
	(3) gpm ratio using 1/4" tip. 7. Nozzle Elevator Test: Using the same calibrating setup as in exercise #6, raise the discharge side of the system (the nozzle) to vertical height of 50 ft. above the ejector. Using a 1/4" tip, a 3/8" tip and a 1-1/2" hose without nozzle, determine the most efficient pump pressure and the ratio of gallons used for gallons delivered to fire. Make data cards showing this information. 8. Vertical Lift Test: Using a calibrating system as developed earlier with cans, test to determine the most efficient pump pressures to use when the vertical lift is 100 ft. above the ejector. Have the class estimate these pump pressures and list them for comparison after the field tests. Use the same variation of tip sizes as in exercise #7. Have the class make a reference card of the test results. 9. Reference Card Preparation: Have the class make a reference chart, organizing all information gathered in the field testing. Place this card with the pumping equipment for future use. 10. Trainee Test Preparation: a. Ask the class to design an exercise for the ejector system, using a different specified pump and suitable ejector. The test should	

TIME	LESSON OUTLINE	AID CUES
	provide answers to the following questions: (1) How much pressure should we have at the pump for maximum efficiency? (2) How much difference in elevation can we work with, and when has this elevation overtaxed the ejector system? (3) How much water are we pumping into the ejector compared to the total water we are getting out of discharge side? (4) What things will change the ejector's efficiency? (5) How much will the efficiency of the ejector change as compared to the maximum test rated figures? b. In this exercise, the class should prepare a data card showing estimates of the ejector's capabilities, and then write a field test to verify the estimates listed on the card. (Note to instructor: Let the class work with as little help as possible in order for them to apply the principles in their own way. Encourage free discussion, and try to respond to their questions with additional questions that stimulate their thinking. Avoid giving direct answers.)	

TIME	LESSON OUTLINE	AID CUES
	11. <u>Practical Exercise</u>: a. Situation: Tanker being used to fight fire, using water supply in its tank and two 1/4" tips. The condition of the fire requires constant water streams, if possible. A water source 250 ft. behind the tanker is suitable for drafting or ejector use. You have some options: (1) Move the tanker from the fire to the draft source and lay hose to the fire. (2) Fill the tank at the source, and return to the fire. (3) Leave the tanker where it is and supply it with an ejector. From previous exercises, you know how much water in gallons per minute the lines will require and how much you need for ejector use. b. As a paper exercise, have trainees figure and explain what will happen in each of the three situations. c. As a field exercise, try to lay the ejector system in time to keep the two 1/4" tips going without interruption. (Note to instructor: This drill will build manipulative skills by requiring speed under pressure, and also will show how the class reacts to pressure situations.	

INSTRUCTOR'S LESSON PLAN II A

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Delivery Equipment	Date:
TYPE: Lecture with Discussion	Instructor:
TOTAL TIME:	
TRAINING AIDS: Actual samples, vu-graphs, slides, or a combination of these of equipment discussed. Overhead projector, slide projector, screen	Assistant(s):
	Training Location:

OBJECTIVES: Trainees will be able to identify and state the use for the common equipment used in water delivery systems.

INSTRUCTOR REFERENCES: "Water Handling Equipment Guide" (WHEG) USFS
"Western Fire Equipment Catalog"

STUDENT REFERENCES: "Water vs Fire"

TIME	LESSON OUTLINE	AID CUES
	I. <u>Introduction</u> We know how to get water <u>started</u> from a source to the fire. The next logical step is to learn how to <u>deliver</u> it. This is the middle step in the water use system of SUPPLY - DELIVERY - APPLICATION and it's vital to the water use job. Knowledge of how to do a job starts with being able to identify and know the uses of various pieces of equipment used in doing the job. This lesson will deal with the equipment involved in getting water from the pump to the fire. II. <u>Presentation</u> Delivery Equipment: The instructor will show and discuss common equipment used in his area. The following is a representative sample, but additional items may be added: A. <u>Hose</u> -	
	1. <u>Single-Cotton-Jacket, Rubber-Lined</u> - Standard cotton jackets working pressures (300 psi) are required. All-cotton is less liable to heat and flame damage than synthetic fibers. Hot embers, however, may cause small pinhole damage.	Show sample
	2. <u>Double-Jacket, - Lined</u> - Double-jacketed hose is heavier and more costly than single-jacketed hose. In Forest Service practice, Model 60 Tankers carry one or two lengths of double-jacketed hose for the first lengths in the lay, thus reducing excessive losses from bursts close to the tanker. (a limited amount of 2-1/2" also is used at airtanker bases for loading fire retardants.)	Show sample

TIME	LESSON OUTLINE	AID CUES
	3. Unlined (Linen) -	Show sample
	Unlined hose originally was designed for indoor standpipe use. Because of its light weight, flexibility when dry, and relatively inexpensive construction, unlined hose is used where water is readily available. Unlined linen is stiff when wet, is subject to abrasion, seeps through the jacket and must be thoroughly washed and dried after use. Linen also requires protection from mildew. Because of seepage and friction of the tube, the hydraulic efficiency is inherently lower than lined hose, so friction loss factors are higher. However, the water seepage through the jacket at working pressures offers good protection to the jacket from exposure to fire embers or coals.	
	Linen often is used with portable pumpers and in gravity systems for control and mopup. It is not suitable for use on tankers or practical for drills.	
	4. Unlined (Synthetic) -	
	Evaluations were conducted on 1-1/2" fire hose that has an unlined, synthetic jacket in place of linen (flax). The results:	Show sample
	Advantages:	
	a. Washing and drying were simplified.	
	b. Handling was easier.	
	c. Flexibility was better than linen.	
	d. Washing pressure, proof pressure and burst pressure were raised.	

TIME	LESSON OUTLINE	AID CUES
	e. Leakage rates showed reduction.	
	f. Friction loss was reduced.	
	g. Synthetic jackets were mildew proof.	
	h. Weight reductions were substantial.	
	i. Evaluation users stated a strong preference over linen.	
	Disadvantages:	
	a. Dry hose was subject to damage from hot sparks, embers and coals.	
	b. Abrasion, or jacket wear, from dragging over road surfaces, stream bottoms and glaciated or volcanic soils caused severe damage to single-jacket-synthetic hose when wet or dry. Like linen, the synthetic hose does not lend itself to general tanker use. The heat and abrasion limitations of unlined, synthetic jackets tend to limit use of this construction.	
	5. High Pressure -	Show sample
	Rubber-lined, rubber-covered, high-pressure hose (also called booster hose) is used as "hardline" on tanker live reels. Forest Service Specification 185 requires a heavy-duty non-collapsible water hose of braided and molded construction. This hose is designed for use on hot firelines with little possibility of damage. The hose can be wiped off with a dry rag after use. Abrasion resistance is high, and the exterior covering is not readily damaged by usual solvents.	
	A 3/4" ID high-pressure hose is available in 50' coupled lengths. Lengths of 100' are available through commercial fire supply houses.	

TIME	LESSON OUTLINE	AID CUES
	If flows above 35 gpm are planned, a 1" ID hose should be used.	
	6. Garden Hose -	Show sample
	Garden hose is not recommended for general fire use even though it is used in some areas. Difficulty in maintaining standard working pressures and the uncertainty of buying premium products make this use hazardous. When garden hose is pressurized, a "scissor-like" condition occurs that increases the diameter and shortens the hose significantly. This can cause coupling failures, and when on hose reels, damage in and around the reel hub attachment, and failure of some reel hubs.	
	7. Hose Mender -	Show sample
	A broken fire hose mender is available for installation on certain lightweight, unlined jackets. The mender is designed for field repair.	
	B. Nozzles -	
	1. Combination	
	a. Low Volume -	
	Forester Fog-Stream (Twin Tip) Nozzle	
	Type - Twin tip combination shutoff; twin threaded tip with solid cone spray, straight-steam (S-S), and shutoff positions.	Vu-graph II A-1
	Description - This nozzle is equipped with a three-position valve and two parallel outlets so that a straight-stream or a finely divided spray can be used. Six S-S tips and eight	

TIME	LESSON OUTLINE	AID CUES
	spray tips are available. Tested up to 600 psi. Outlet threads for tips are 3/4" G.H. threads.	
	All water passing through the fog-spray tips goes through a self-cleaning Monel strainer.	
	b. <u>Medium Volume</u> -	
	<u>Wilco Plastic Combination Nozzle</u>	
	Adjustable combination barrel with shutoff.	Vu-graph II A-2
	Sequence is from shutoff to straight-stream to spray in one full turn of the barrel.	
	GSA stocks only the 17 to 20 gpm flow at 100 psi. However, the manufacturer also provides a larger flow at 33 to 35 gpm. The cone angle is adjustable from a wide angle to a straight-stream.	
	Lightweight feature makes this nozzle ideal for hose pack use. Corrosion proof, except for brass spindle and nut. Low cost makes this nozzle attractive where losses may be high.	
	2. <u>Straight Stream</u>	Vu-graph II A-3
	<u>Plain Screw Tip Nozzle</u>	
	One and one-half inch plain nozzle with spare tip carrier on side of body. Outlet end threaded for G.H.T. tips as provided under F.S.	
	Furnished by Federal Supply Service with 1/4", 3/16" and 3/8" tips. The plain-nozzle body discharge-end with-	

TIME	LESSON OUTLINE	AID CUES
	out a tip provides an accurately machined 1/2" bore opening.	
	3. <u>Others</u>	
	There is a variety of other nozzles available and in use. (Instructor--show actual model or illustrations and discuss specs.)	
	4. <u>Applicator Pipe</u>	
	An applicator pipe, or wand, is available for reaching fuels. It can be used in deep duff, peat and sawdust. The applicator is 48" long, has a 45-degree bend near the end, and is equipped with 3/4" Garden Hose Threads at the inlet. The discharge end has 3/4" G.H.T. male threads to accommodate a special low-flow spray tip (3 gpm with a 60 degree pattern.)	Vu-graph II A-4
	C. <u>Nozzle Tips</u> -	
	The tips commonly have 3/4" garden hose thread and are for attaching to forester, straight stream nozzles or wands.	
	1. <u>Straight stream tips</u> -	Vu-graph II A-5 (same as IIID-2)

Tip size	Min. stream length at 100 psi	Ave. flow rate at 100 psi
1/8"	29'	5 gpm
3/16"	34'	10 gpm
1/4"	40'	20 gpm
5/16"	41'	30 gpm
3/8"	41'	40 gpm

TIME	LESSON OUTLINE	AID CUES
	2. Spray tips -	

Tip number gpm at 100 psi	Discharge angle in degrees
3	20
6	20
8	20
9	28
12	28
15	28
18	28
24	28

D. Fittings -

1. Adapters -

Most fire protection agencies, including the Forest Service, use National Standard Thread, abbreviated N.S. or N.S.T., for 1-1/2" hose connections. This standard connection has 9 threads per inch. Other thread patterns may be encountered on a fire such as Iron Pipe Thread (I.P.T.) with 11-1/2 threads per inch or "Quick Couple" which only requires 1/4 turn to lock. If nonstandardization is a problem in your area, it is desirable to carry adapters. One very common use is on 1-1/2" I.P. Thread hydrants furnished by some water companies and ranches so N.S. Thread fire hose can be attached.

Vu-graph II A-6

2. Double Female Coupling -

This connects two male sections having the same diameters and threads. It may be used to hook portable fire pumps in tandem.

Vu-graph II A-7

TIME	LESSON OUTLINE	AID CUES
	3. Double Male Coupling -	
	This connects two female sections having the same diameters and threads. Could be used to hook into a line that had the wrong direction or if it became necessary to pump water the opposite direction.	Vu-graph II A-8
	4. Increaser -	
	This connects a male outlet end to a female inlet of a larger diameter but of the same thread standard. The male end of an increaser always is the larger, since the increase is in the direction of flow, from left to right. An example: Female 1" I.P. Thread to male 1-1/2" I.P. Thread. Commonly used to attach a 1" fire nozzle to a 3/4" hose.	Vu-graph II A-9
	5. Reducers -	
	This connects the outlet end of any fire service to the inlet side of a smaller fitting, generally in the same thread standard. The male side of all reducers is smaller than the female, since the reduction is with the flow.	Vu-graph II A-10
	(Since 1-1/2" N.S. Thread and 1" I.P. Thread are standard for FS use, this fitting need not be called a reducer-adapter.)	
	6. Gravity Sock -	Vu-graph II A-11
	When water is available from a stream or spring above the fire, a gravity sock sometimes is used as a water pickup device. The sock is secured by stakes, rocks or ropes; and the line then is run down to the fire. The opening usually is 8" to 15" in diameter, and the sock	

TIME	LESSON OUTLINE	AID CUES
	is 3' to 4' long. Usually, it is furnished with 1-1/2" threads.	
	7. Hose Line Tee -	
	A 1-1/2" main line connection with a 1" I.P. Thread or 3/4" G.H. Thread male outlet. A brass hose cap protects the threads on the branch outlet. Commonly used to lay a 1" lateral line from a 1-1/2" main line. May be used also with 3/4" bailer cock valve and 3/4" garden hose for a lateral.	Vu-Graph II A-12
	8. Hose Line Tee Valve -	
	Place intermittently in 1-1/2" main hose lines to offer a 1" valved male branch outlet. A matching brass hose cap with rocker lugs protects the outlet threads. Used similar to hose line tee.	Vu-graph II A-13
	9. Gated Wye -	
	Wyes also are called wye valves, wye connections, wye control valves, etc. Wye connections often are confused with siamese connections. They are not the same. A wye divides one line into two, whereas the siamese unites two lines into one.	Vu-graph II A-14
	Both male outlets are gated (with valves) to permit the control of each line independently. The 1-1/2" size is most commonly used, but 1" wyes are available.	
	(Plain Wyes are used for a similar connection, except they are without the shutoff valves.)	
	10. Fire Hose Shutoff Clamp -	
	Lightweight pocket-size shutoff clamps are available for squeezing	Vu-graph II A-15

TIME	LESSON OUTLINE	AID CUES
	off hose lines. The term "hose strangler" also is used. These clamps can be used when replacing burst hose, to extend the line, to exchange nozzles, or to insert wyes and tees. The shutoff clamp will save time, conserve water and reduce the number of shutdowns.	
	The pocket-size clamps in forestry use are designed for 1" and 1-1/2" single-jacket, lined hose up to 200 to 250 psi.	
	11. <u>Six-Man Mopup Outfit</u> -	
	Designed for the Pacific Northwest Region (R-6) of the Forest Service for use in deep ground litter and duff where extensive mopup is required. A six-man mopup crew can effectively cover a wide area of fireline with water from a small diameter hose line off a 1-1/2" main lay. The outfit is composed of small hose connections, water applicators with fog and straight-stream tips, and shutoff valves.	Vu-graph II A-16
	12. <u>Lateral Line Mopup Kit (One Man)</u> -	
	This kit is prepackaged in a cardboard box with carrying straps, and contains all the necessary equipment for one man to carry to the lateral take off location and begin using a 3/4" garden hose lateral for mopup.	Vu-graph II A-17
	13. <u>Fire Hose Roller</u> -	
	A time-saving device designed and used by the California Division of Forestry to handle 50- or 100-foot lengths of 1" or 1-1/2" lined or linen hose in either single or double rolls. A supporting bracket allows vertical mounting on a post, wall or tanker panel. Extra sup-	

TIME	LESSON OUTLINE	AID CUES
	porting brackets may be hung on various wall faces and trucks in work areas. A rocker lug nut secures the hose rollers. Several versions of the basic design are available from supply houses.	
	14. Collapsible and Folding Water Storage Tanks -	
	Several designs of commercial storage tanks are available, including pillow shapes, pyramid shapes and rectangular shapes with folding metal frames. Metal stock troughs and portable wading or swimming pools also work well. Another common practice is to dig or scrape a depression in the ground and line it with plastic sheeting.	Vu-graph II A-19
	15. Goggles -	
	Nozzle men shall be equipped with goggles available thru GSA or other fire equipment supply organizations.	Show goggles
	16. Wetting Agents -	
	These are chemical additives used to modify the characteristics of water used for firefighting. They reduce surface tension, permitting better dispersal and greater penetration. This reduces mopup time, and permits better water utilization. Water to which a wetting agent has been introduced is called "wet water". Of the many commercial brands available, one should be selected that is non-toxic, non-corrosive, water-soluble, requires a minimum concentration, and gives a minimum cost per 1,000 gallons treated. (An evaluation of wetting agents is available from the Southern Forest Fire Laboratory at Macon, Georgia.)	

TIME	LESSON OUTLINE	AID CUES
	III. SUMMARY There are many pieces of equipment that make up a water delivery system. Each has its use and logical place in the system. Knowing this will help make the rest of these lessons easier to understand and use.	

INSTRUCTOR'S LESSON PLAN II B

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Hose Lay Systems	Date:
TYPE: Lecture and Demonstration	Instructor:
TOTAL TIME:	
TRAINING AIDS: Film - "Ground Equipment Hose Lay", R-5 16mm film projector Slide projector Overhead projector Vu-graphs	Assistant(s): Training Location:

OBJECTIVES: Trainees will be able to describe the basic elements of simple and progressive hose lays.

INSTRUCTOR REFERENCES: "OJAI Progressive Hose Lays" Instructions, R-5
"Cleveland Progressive Hose Lay" Inst., R-5
"Water vs Fire", USFS
"Water-Handling Equipment Guide" (WHEG), USFS 5162
"Hose Box Pack" Instructions, R-6

STUDENT REFERENCES: Firefighter Basic Training Course "Using Water in Fire Suppression" USFS TT-87 (5100)
"Water vs Fire" USFS

TIME	LESSON OUTLINE	AID CUES
	I. INTRODUCTION We know that water delivery systems require certain components of hose and fittings. Let's start putting these components together. This lesson will show the methods and techniques used in doing this part of the water delivery job with hose lay systems. A hose lay is simply a hose, or series of hoses and accessories used to deliver water from the pump to the fire. Now, let's talk about what does into the making of a hose lay.	
	II. PRESENTATION A. Hose Distribution 1. Live Reel -	
	The live reel probably is the simplest method of laying hose. It usually involves approximately 250 feet of hose, depending on the type of tanker involved. The live reel usually is charged at all times, and the nozzle already will be attached. To lay the hose, one or more men just pull and unreel from the pump to the fire: It's fast and limited to the amount of hose on the reel.	Vu-graph II B-1 & II B-2
	2. Hose Basket -	
	Used similar to a live reel, but preferred over a live reel by some organizations. (This will be cotton jacket hose, rather than the live reel's hard rubber line.)	Vu-graph II B-3
	3. Folded Hose (Accordion Lay) -	
	Where the fire occurs beyond the reach of a live reel or live hose	Vu-graph II B-4

TIME	LESSON OUTLINE	AID CUES
	basket, various methods of storing and laying hose are used. One of these methods involves hose folded in an according-like manner in a basket or bay on the tanker. It is played out by pulling the nozzle end of the hose and one man per each 100 ft. helping pull. In open country, this can be put out rapidly.	
	4. Rolled Hose -	
	Dragging hose can be hard work. If long distances are anticipated, it will be easier to carry lengths of hose in some manner. Rolled hose probably is the most common method of carrying and laying hose. It can be carried in knapsacks, on pack boards, or by some type of harness.	Vu-graph II B-5
	5. Pre-packed Backpack Hose - By packaging hose in some manner, a hose lay can be more quickly and efficiently extended any practical distance. There is no one standard or preferred method, but many effective systems have been devised by crews throughout the country.	
	a. Cleveland N.F. Hose Pack -	
	As presently used, this system combines 100' of 1-1/2" main line, a double gated WYE valve, 100' of 1" lateral line and a Forester Combination nozzle, all pre-connected on a packboard to form a progressive hose lay. The number of "packs" used will be	Vu-graph II B-6

TIME	LESSON OUTLINE	AID CUES
	determined by the distance to be covered. (If instructor chooses to demonstrate the system, use Cleveland text.)	
	b. Ojai Progressive Hose Lay -	
	This pack is very similar to the Cleveland, but does not use a packboard. Instead, the fire hose itself serves as shoulder straps. An experienced 4-man tanker crew can place a 550' hose lay with 4-50' laterals, all with nozzles, in two to four minutes. (If instructor chooses to demonstrate this system, use Ojai text.)	Vu-graph II B-7
	c. Hose Box Pack -	
	This system uses either CJRL, linen or synthetic hose, pre-coupled and folded accordion fashion in a disposable cardboard box with shoulder straps or a conventional packsack. Up to 400' is carried. The system is convenient for long mainlines and may be dispensed from a pick-up or be backpacked.	Vu-graph II B-5 again
	d. Ground Equipment Hose Lay -	
	A system of rolling, coupling and packaging hose to make rapid hose lays from the back of a moving tanker or tractor. Good for long supply lines to a fire.	Show film "Ground Equipment Hose Lays"
	B. Making Connections	
	1. One of the most important skills in hose lay work is being able to connect hoses and threaded fittings rapidly and effectively.	

TIME	LESSON OUTLINE	AID CUES
	a. Hold the hose in position with three fingers of each hand.	Vu-graph II B-8
	b. Use the thumb and index finger to turn the female collar.	
	c. Connect hand tight.	
	2. For "Quick Connect" (1/4 turn) couplings show best way to do.	Demonstrate and practice
	C. <u>Hose Lay Principles</u>	
	1. Water always should flow from the female end of the hose to the male end. In other words, the male end always should be away from the pump.	
	Notice that with siamese, gated wyes, and nozzles, the water enters through female end and leaves through the male end.	
	2. The largest hose (1-1/2") should be used first. (Near the pump.)	
	a. Supplies larger volume.	
	b. Is less likely to burst and cause line to drain. (Particularly double jacketed hose.)	
	3. When using tankers, it is common practice to install a siamese valve in the first fifty foot length out from the pump. This permits the hook-up of a second unit to:	
	a. Supply more volume and pressure.	
	b. Assure a continuous flow of water by permitting tankers to alternate going for refill as tankers become empty.	
	4. When the hose lay reaches the fire, a gated wye should be installed.	Vu-graph II B-11

TIME	LESSON OUTLINE	AID CUES
	a. Provides place to fill backpack pumps. b. As safety factor, should fire flare up behind extended line and lateral is needed. c. Enables a lateral line to work while the main line is being extended or during later mopup. 5. An extra amount of hose of 50-100' always should be on hand <u>AT THE LEADING NOZZLE</u>. a. In case of hose breakage. b. In case of flare up out of reach of leading nozzle. 6. All hose should be kept out of the burned area until area is cooled by water. D. <u>Hose Lay Configuration</u> Hose lays are put together to meet the situation and demands of the fire.	
	1. <u>Simple Hose Lay</u> - A simple hose lay may be no more than enough hose to reach the fire plus a nozzle to regulate the flow and application of water. It may vary from the live reel hard line to cotton jacket rubber lined hose set out with fittings ready for a second pumper or laterals. It is considered a single nozzle application setup.	Vu-graph II B-12
	2. <u>Progressive Hose Lays</u> -	
	The progressive hose lay was designed for speed and safety on a hot, fast running fire.	Vu-graph II B-13

TIME	LESSON OUTLINE	AID CUES
	a. A number of "gated wyes" are used in the main lay every 2 or 3 lengths. b. At each of these valves, a hose team will hook into a wye and run a 1-1/2" line with nozzle to the fire perimeter. (Smaller laterals might be utilized.) A direct attack with water can be made at several points in the fire and allows the hose lay to grow without interrupting the flow at other nozzles. (If left in place, the hose lay may be utilized later for mopup.) III. <u>SUMMARY</u> A simple hose lay is any method which will get water from a pump on to the fire through a single nozzle. It can be done with a charged live reel or by connecting lengths of hose and a single nozzle. A progressive hose lay permits attacking the fire with multiple nozzles even as the hose lay is being extended by adding hose and fittings. There are various methods of making progressive hose lays, depending on the situation as affected by terrain, type of fire and available equipment.	

INSTRUCTOR'S LESSON PLAN II C

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Planning water delivery systems for mop up	Date:
TYPE: Lecture and exercises	Instructor:
TOTAL TIME:	
TRAINING AIDS: Vu-graphs, overhead projector, handouts	Assistant(s):
	Training Location:

OBJECTIVES: Trainees will be able to describe pumping and hose lay hydraulics that must be considered when delivering water over a long distance. They will demonstrate their knowledge by solving sample exercise problems.

INSTRUCTOR REFERENCES:
- Fire Service Hydraulics (Sheppard)
- Water Handling Equipment Guide
- BIFC Delivery of Water to a Fire - Lesson Plan
- CDF - Lesson Plan
- Fire Academy - Basic Fire Control Training Manual - 1970

STUDENT REFERENCES:
- Instructor's Guide for Standard Types of Pumping Equipment - USFS - R-5
- Water vs Fire

TIME	LESSON OUTLINE	AID CUES

I. INTRODUCTION

The principles to be discussed here apply just as much to initial attack as they do to mop up. They are discussed as part of mop up because it is more likely that long distance water delivery systems will be put in during this phase of the fire. At this time it also is likely that more time and choice of equipment will be available to set up such a system.

Hydraulics is the study of fluids at rest or in motion and the forces necessary to keep them at rest or in motion. A knowledge of certain basic hydraulics will be a big help in determining what can be accomplished with available equipment, or what equipment is needed to get the job done.

II. PRESENTATION

A. Let's discuss a few fire hydraulics definitions which are necessary for a better understanding of water delivery.

1. Suction lift is the vertical lift of water by suction. What a pump actually does when lifting water by suction is to create a partial vacuum within the pump chamber. Atmospheric pressure on the water surface then forces the water up through the suction hose into the pump.

The maximum theoretical lift of a pump is 34 ft. (33.8688) based on the atmospheric pressure at sea level. However, due to mechanical deficiencies of pumps and fittings and the effects of friction loss on suction hose, a practical suction lift would be more likely less than 25 ft. And when we add changes due to working in areas considerably above sea level the practical lift may become only 10 to 12 feet.

TIME	LESSON OUTLINE	AID CUES
	2. Head is the vertical depth of water measured in pounds per square inch (psi) or feet of head. A column of water 100 feet high exerts a pressure of 43.4 psi or roughly 5 psi for every 12 feet change in elevation. Head will affect the pumping operation whether it is above or below the pump. If it is above the pump, head must be added to the pump pressure to obtain effective nozzle pressure.	
	If it is below the pump, it must be subtracted from the pump pressure or the nozzleman may experience difficulty in handling the hose. A good rule of thumb to use in relating pressure loss due to elevation is a 2 to 1 approach in that for every 2 feet gain in elevation, you have a 1 pound loss in nozzle pressure. (And remember, the reverse is true in applying pressure gain when elevation of the nozzle is lower than the pump!)	Stress 2 ft. = 1 lb.
	3. Water hammer is a series of shock waves produced in a water line where a valve or nozzle has been closed abruptly. These shock waves travel back along the length of the water line at high speeds, producing rapid vibrations which may be violet and destructive. Water hammer produced in a hose lay may cause the hose to burst.	Explain that valves and nozzles should be shut off smoothly for this reason.
	4. Friction loss is the resistance resulting as water moves along the inside wall of the hose. It varies according to both volume of water moving through hose and hose size. Friction loss in hoses can be calculated from the following table. However, a quick rule of thumb to use when calculating friction loss	Vu-graph II C-1

TIME	LESSON OUTLINE	AID CUES
	for extended hose lays is 4 psi per 100' of 1-1/2" linen hose and 2 psi per 100' of 1-1/2" CJRL hose. For 1" hose, either linen or CJRL, figure five times the friction loss of 1-1/2". For 1" CJRL hose, use as a rule of thumb that pressure loss with a 1/4-inch nozzle will be 10 psi per 100 foot length.	Use easel or overhead projector. Trainees to copy.
	5. <u>Nozzle pressure</u> is the pressure of water as it leaves the tip of the nozzle. For tankers, it may range from 20 lbs. to over 100 lbs., however, a good working nozzle pressure is usually between 50 and 70 psi.	
	6. <u>Nozzle volumes</u> will vary according to tip size, design and water pressure. Here are a couple of general rules that will help you calculate volumes with different tip sizes: - Doubling tip size will quadruple discharge rate. - For every 10 psi increase of nozzle pressure over 50 psi, discharge rate will increase by 10%. (But remember, larger volumes also will affect engine pressure needed, as larger volumes increase friction loss in the line.)	Vu-graph II C-2 C-3 C-4 C-5
	B. <u>Exercises</u> Using the rules of thumb given earlier for head gain or loss, friction loss and nozzle pressures, let's work the following exercises:	
	(Instructor's note: These exercises may be done with both handouts and vu-graphs for a review of the exercises with the class.) Simple formula for calculating pump pressures necessary to work a hose lay.	Provide a handout or put on easel or chalkboard to copy from.

TIME	LESSON OUTLINE	AID CUES
	$EP = NP + FL \pm H$ EP = Engine Pressure or Pump Pressure NP = Nozzle Pressure FL = Friction Loss in Hose H = Head loss or gain	
	<u>Exercise #1</u>	
	What engine pressure is necessary to give 50 psi nozzle pressure on a 500 ft. uphill hose lay using 1 inch CJRL hose with a 1/4-inch tip, 60 feet above the pump?	Use easel or handout question.
	$EP = NP + FL \pm H$ NP = 50 psi = 50 + 50 + 30 FL = 10x5 = 50 psi = <u>130</u> psi at pump H = 60÷2 = 30 psi	Show computations on easel or overhead projector when all complete.
	Head is added because the nozzle is above the pump. If it was below the pump head would be subtracted. Head (rule of thumb) is 1 psi per 2 feet height. Friction loss per 100 feet of 1-inch CJRL hose is 10 psi, and with five lengths it equals 50 psi.	
	<u>Exercise #2</u>	
	Substitute 1-1/2-inch CJRL for the 1-inch CJRL and what would the desired engine pressure be? $EP = NP + FL \pm H$ NP = 50 psi = 50 + 10 + 30 FL = 2x5 = 10 psi = <u>90</u> psi at pump H = 30 psi	
	<u>Exercise #3</u>	
	Using 1-inch CJRL hose and changing the elevation to a 60-foot drop, what would 50 psi at the nozzle call for in Engine Pressure?	

TIME	LESSON OUTLINE	AID CUES

$EP = NP + FL \pm H$	$NP = 50$ psi
$= 50 + 50 - 30$	$FL = 50$ psi
$= \underline{70}$ psi	$H = -30$ psi

Exercise #4

Using 1-1/2 inch CJRL hose and a 60 ft. drop to the nozzle, what would 50 psi at the nozzle need in Engine Pressure?

$EP = NP + FL \pm H$	$NP = 50$ psi
$= 50 + 10 - 30$	$FL = 10$ psi
$= 30$ psi at pump	$H = -30$ psi

Exercise #5

Double the Head Pressure in #4 by increasing the drop to 120 feet. What happens?

$EP = NP + FL \pm H$	$NP = 50$ psi
$= 50 + 10 - 60$	$FL = 10$ psi
$= 0$ psi	$H = -60$ psi

(This might indicate that a gravity sock could be substituted for the pump.)

Exercise #6

Using a 1-inch CJRL hose, a 2000-foot hose lay, and a rise of 60 feet to the nozzle, what Engine Pressure is indicated for a psi of 50 at the nozzle?

$EP = NP + FL \pm H$	$NP = 50$ psi
$= 50 + 200 + 30$	$FL = 10 \times 20 = 200$ psi
$= \underline{280}$ psi	$H = 60 \div 2 = 30$ psi

TIME	LESSON OUTLINE	AID CUES
	Using the performance data for these three pumps, what can we assume? Answer: Gorman Rupp and Pacific Mark 26 can't handle it. Pacific Mark 3 comes close, but may have problem getting enough water to nozzle or may have hose breakage problems at pump.	Vu-graph II C-6
	What action is recommended?	
	Possible answers: - Change pump type - Use relay - Use booster - Use larger hose	Discuss with trainees
	<u>Exercise #7</u>	
	Substitute 1-1/2 inch CJRL hose for the 1-inch hose in #6 and what will the EP be?	
	$EP = NP + FL \pm H$ $NP = 50$ psi $= 50 + 40 + 30$ $FL = 2x20 = 40$ psi $= \underline{120}$ psi $H = 30$ psi	
	Using the three pumps compared in #6, what can we assume?	Vu-graph II C-6 again
	Answer: All three can handle it with Mark 3 giving best flow.	Discuss
	As a result of these exercises and from looking at friction loss factors in hose what general assumption can we make regarding use of 1-inch and 1-1/2 inch hose? Answer: Downhill lays should be made with 1-inch hose and uphill lays with 1-1/2 inch hose. The reason being that friction loss in downhill lays can be used to advantage to prevent pressure buildups and that uphill lays will benefit from the lower friction loss shown for the larger hose.	

TIME	LESSON OUTLINE	AID CUES

(Note to instructor: Any or all of the previous exercises, or some version of them, can be performed in the field to reinforce, dramatize or revise the anticipated results.)

C. Review

The four primary factors that influence water delivery from the pump to the nozzle are:

1. Engine Pressure (or pump pressure) which is the pressure the selected or available pump must be capable of producing to move water.

2. Nozzle Pressure which is the pressure resulting at the nozzle where the water is to be applied.

3. Friction Loss which is the loss of pressure caused by friction in the hose lines.

4. Head which is the increase or decrease in pressure caused by the nozzle being higher or lower than the pump.

When these factors are combined in the formula $EP = NP + FL \pm H$ available equipment capabilities can be measured to see how they fit existing situations or suitable equipment can be ordered to meet a measured situation.

The rules of thumb utilized in the sample exercises are suitable for quick computations. More accurate charts and tables are available which can and should be utilized when possible.

D. Relays and Booster Systems

Having completed the previous exercises, you now are acquainted with some of the

TIME	LESSON OUTLINE	AID CUES
	problems you may encounter when using extended hose lays. Also, you realize that you may exceed the capabilities of the pump. When you reach this point, it's time to go to a booster or a relay system.	
	1. <u>Relays and Sumps</u>	
	a. First Stage	
	(1) The pump is set up at the water supply with the drafting hose lifting water from the supply.	Vu-graph II C-7
	(2) A pressure relief valve and check valve is installed at the pump.	
	(3) A hose line, usually 1-1/2" is laid uphill where it empties into a sump. This sump may be a canvas tank, or a hole dug in the ground, lined with plastic, and used as a reservoir.	
	b. Second Stage	
	(1) A second pump is set up at this point.	
	(2) Suction hose drafts water from the sump.	
	(3) A discharge line carries the water on up to the fire or to another relay.	
	(4) A pressure relief valve and check valve is installed in this line also.	
	c. Additional stages can be added as necessary to reach the fire or to extend the lay.	

TIME	LESSON OUTLINE	AID CUES
	2. <u>Boosters</u> a. Instead of using a sump, the discharge line of the first pump sometimes can be hooked up directly to the suction inlet of the second pump. b. Since the second pump is receiving water from the first pump, the volume will remain the same. c. It will, however, add more pressure to the pressure already developed by the first pump. d. This will force the water to a higher elevation. e. The operator must exercise caution in this operation. (The increase of pressure may damage equipment if the second pump is placed too close to the first and excessive pressures result.) f. It is recommended that this system be used <u>only</u> when a sump is not available. 3. <u>Review Relays and Boosters</u> 4. <u>Relay Exercise</u>:	
	This exercise is a theoretical problem in moving water from a source progressively around a fire line back to the point of origin. For this problem, one Pacific Marine MK 3 and two Gorman Rupp pumps are available plus an adequate supply of 1-1/2" linen hose. Friction and head rules of thumb plus pump and nozzle specifications discussed previously will be used. Disregard laterals for time being.	Show or hand out "Rules of Thumb", Vu-graph II C-3 (Tip Specs) Vu-graph II C-4 (Pump Specs) and Vu-graph II C-6 (sketch)

TIME	LESSON OUTLINE	AID CUES
	a. Make a hose lay which will go from point A to point D, where a relay sump will be installed by using one of the three pumps available. What EP will be required at B, C and D if a Nozzle Pressure of 50 psi is requested? What size nozzle could be used at each point if hose lay was to stop there? Why was the selected pump used at this time?	Discuss results.
	b. Continue hose lay from relay at point D to point H, where another relay will be installed. Use the second pump and estimate EP needed at each point to provide a 50 psi NP. Why did lay stop at point H?	Discuss results.
	c. Continue hose lay from point H back to point A. (It's not likely that such a situation would result, but let's just say the ridge in the sketch makes it that way!)	Discuss results.
	<u>School Solution</u>, part a: $EP = FL \pm H + NP$ (Point B) $EP = 40 + 50 + 50 = 140$ psi (Point C) $EP = 80 + 50 + 50 = 180$ psi (Point D) $EP = 120 + 75 + 50 = 245$ psi The charts indicate that 140 psi at point B will produce about 60 gpm which is capable of supplying up to a 1/2" nozzle at 50 psi NP. Point C should show about 40 gpm and up to a 3/8" nozzle. Point D should show about 29 gpm and up to 3/8" nozzle also.	

TIME	LESSON OUTLINE	AID CUES
	The Mark 3 pump was used because indicated EP at point D of 245 psi would have exceeded capabilities of Gorman Rupp's 190 psi limitation.	
	School Solution, part b:	
	$EP = FL \pm H + NP$	
	(Point E) $EP = 40 - 50 + 50 = 40$ psi	
	(Point F) $EP = 80 - 100 + 50 = 30$ psi	
	(Point G) $EP = 120 - 100 + 50 = 70$ psi	
	(Point H) $EP = 160 - 50 + 50 = 160$ psi	
	Point E should show about 50 gpm at 50 psi NP and up to a 3/8" tip could be used.	
	Point F should show about the same.	
	Point G should show about 45 gpm and up to a 3/8" tip could be used.	
	Point H should show about 24 gpm and up to a 5/16" tip could be used.	
	The lay was stopped at this point because indicated EP at point I (180 - 25 + 50 = 205 psi) would exceed capabilities of Gorman Rupp pump used for this section.	

TIME	LESSON OUTLINE	AID CUES

School Solution, part c:

$$EP = FL \pm H + NP$$

(Point I) EP = 40 + 25 + 50 = 115 psi

(Point J) EP = 80 + 25 + 50 = 155 psi

(Point A) EP = 120 - 25 + 50 = 145 psi

Point I should show about 27 gpm and up to a 5/16" tip.

Point J should show about 25 gpm and up to a 5/16" tip.

Point A should show about 30 gpm and up to a 3/8" tip.

School Solution, discussion:

Q. What water saving measures could be used to assure adequate supply at each point, particularly beyond the first relay?

A. Shut off when moving about. Replace larger nozzles with smaller tips or fog nozzles.

Q. What effect will the use of 1" laterals at each point have?

A. Will increase the needed EP for adequate Nozzle Pressure due to increased friction loss in smaller hose added plus possible Head change. Also increase total water demand.

Note to Instructor. This exercise can be done in various ways:

1. Use various pumps and/or hoses.

TIME	LESSON OUTLINE	AID CUES
	2. Use the pumps and hoses standard to your area. 3. Provide specifications and ask for most efficient set up. 4. Provide equipment and specify two hose lays at opposite sides of designated area. 5. Interject use of laterals while hose lay progresses. 6. Specify elevation changes to fit your area. <u>SUMMARY</u>: By now you have a pretty good idea of what pressures can be obtained when making hose lays with certain equipment under certain conditions. Also, it has been obvious that some types of equipment perform better than others in specified situations. With an unlimited choice of pumps and hose from various specified lists, we realize that the performance characteristics of certain pumps combined with certain hose do the most efficient job. However, real life seldom provides an unlimited choice, and we must do the job with the equipment available. By now you should be able to calculate your needs based on just such a condition for any real life situation. Better yet, take your equipment into the field. Make your calculations. Run the equipment and see what actually happens.	

INSTRUCTOR'S LESSON PLAN II D

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Water Use Hand Signals	Date:
TYPE: Lecture with demonstration	Instructor:
TOTAL TIME:	
TRAINING AIDS: Overhead Projector, Vu-graphs	Assistant(s):
	Training Location:

OBJECTIVES:

Trainees will be able to communicate water use information, using standard hand signals.

INSTRUCTOR REFERENCES:

Water vs Fire

STUDENT REFERENCES:

Water vs Fire

TIME	LESSON OUTLINE	AID CUES
	I. <u>Introduction</u> When working around equipment on fire operations, it sometimes is necessary to use hand signals. Equipment often is noisy, and verbal communication becomes unreliable. Hand signals improve communications when noise or distance prevent the use of verbal signals.	
	II. <u>Presentation</u>	
	A. Four hand signals are used to communicate concerning how much water is in the tanker. These signals are used to indicate how close the water is to the top when filling the tanker, or how much water is left when using water from the tanker. Notice that the first signal asks the question, and the next three provide the answer. (Instructor: Have an assistant face the class and demonstrate these and subsequent signals.)	Vu-graph II D-1
	B. Three signals are used to inform the pump operator, from some distance away on a hose lay, either to start delivering water to the nozzle or to change the present pressure. (Care must be taken to stand correctly and signal properly. For instance, "deliver water at nozzle" may be mistaken for "increase pressure.")	Vu-graph II D-2
	C. The next two signals concern hose. The "more hose" signal means to reel out or carry forward more hose. The broken hose signal can be used as a request for water control, as a warning to men beyond the break, or as a notification that repair is needed.	Vu-graph II D-3
	D. The "shut down" signal can be used two ways. When filling a tanker, it would indicate that the tank is full and drafting should stop. If it followed a broken hose signal, it would mean that the water should be shut off while repairs are being made.	Vu-graph II D-4

TIME	LESSON OUTLINE	AID CUES
	"Roll up hose" means to retrieve hose either from hose lays or on a live reel. When used with the "shut down" signal, "roll up hose" means the operation is complete, and gathering equipment can begin. Note to instructor: Your personal experience showing how hand signals have been used, both good and bad, in actual fire situations will help liven this session. E. Have trainees practice the hand signals until they know and can give each one. Use the hand signals in all future drills as appropriate. III. SUMMARY An accepted "code" of easily understood hand signals will permit you to do this part of your job safely and efficiently when the usual verbal communications are difficult or impossible. Your skill in knowing and using these signals should become common practice.	

INSTRUCTOR'S LESSON PLAN II E

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Care of hose and fittings	Date:
TYPE: Lecture	Instructor:
TOTAL TIME:	
TRAINING AIDS: Damaged hose and fittings or slides of same	Assistant(s):
	Training Location:

OBJECTIVES:

The trainee will be able to identify important types of damage to hose and fittings. He will be able to tell how such damage was caused and how it can be avoided.

INSTRUCTOR REFERENCES:

STUDENT REFERENCES:

TIME	LESSON OUTLINE	AID CUES
	I. INTRODUCTION There have been times when ordered hose and fittings have arrived at the fire but can't be used because of already damaged components. There have been times when good hose and fittings have become unusable because of careless handling during the fire. This lesson will enable you to identify bad gear, show you how it got that way, and show you how to avoid damaging hose and fittings.	
	II. PRESENTATION	
	A. Care of threads	
	1. Male threads are exposed and easily damaged. Don't drop, drag or bang them. Damaged male threads make it difficult, or impossible, to screw two parts together. (Demonstrate)	Show slide or sample
	2. Female threads are not exposed, but dropping the fitting may slightly flatten one edge or make the fitting egg shaped. This likely will create difficult or impossible coupling. Also, it may cause the swivel to bind. (Demonstrate)	Show slide or sample
	3. Dragging female fittings can get dirt in the threads, which may cause damage when coupling. Make sure fittings are clean before coupling.	Show slide or sample
	4. (Pass samples of damaged items around so trainees can see and touch.)	
	B. Charged hose.	
	1. Avoid bending at sharp angle, as high pressure may break the hose that is kinked. Hose clamps should be used to control water where necessary.	

TIME	LESSON OUTLINE	AID CUES
	2. Don't drive over charged hose. It may cause a break, damage a jacket or damage the lining.	Show slide or sample
	3. Avoid laying hose where it might be driven over. Push through culverts, or otherwise protect.	Show slide or sample
	4. Don't step on charged hose with your caulked boots.	
	5. Don't use a charged hose line for a climbing rope. It may pull apart at a coupling, and you'll lose both your balance and your water supply simultaneously!	
	6. If possible, lay charged hose out of the hot area to avoid burning it.	
	7. Lay hose out of the way of the followup hand crew to avoid getting it cut. Dirty hose may look like just another root or branch to some guys.	
	C. How can you mark or identify damaged hose or couplings so faulty gear won't be used mistakenly? (Tie a knot in the end of the hose nearest the damaged fitting or section.)	Ask for suggestions.
	D. <u>Storage of hose</u>	
	1. Drain and dry hose according to your policy for the type of hose before storing.	
	2. Roll and store in the same manner that your warehouse is storing it.	
	3. Rolling up in a watermelon roll as hose is retrieved from the fire line is a good way to help dry it before it is returned to the station. Also, it indicates that it has been used, and is not new or unchecked.	

TIME	LESSON OUTLINE	AID CUES
	III. SUMMARY Certain types of damage to hose and fittings can be expected. By knowing what causes it, such damage can be better prevented.	

INSTRUCTOR'S LESSON PLAN II F

COURSE: Water in Fire Control	File No.
TYPE: Drill TOTAL TIME:	Instructor:
TRAINING AIDS: 1", 1-1/2" hose with couplings, fittings, such as gated Ys, reducers, suction hose, tips, adapters, increasers, etc., all fittings normally used.	Assistant(s): Training Location:

OBJECTIVES:

Trainees will be able to connect hose and fittings under specified performance conditions determined by the instructor.

INSTRUCTOR REFERENCES:

STUDENT REFERENCES:

TIME	LESSON OUTLINE	AID CUES
	I. INTRODUCTION Coupling hose and fittings seems so simple it sometimes is overlooked in training firefighters. During fire operations, we often lay many lengths of hose and use dozens of fittings in getting water to the fire. No single coupling operation usually is critical for time, but in the aggregate coupling can take a significant amount of time. The skill of crewmen in coupling operations can be important, especially in initial attack. Here's an example: If we start to lay hose on the flank of a fire and need 10 lengths plus laterals, we may have 18 coupling jobs which might average about 10 seconds each. The total time required amounts to three minutes. If we can reduce this to five seconds for each coupling, we will save a minute and a half in this operation. That minute and a half may be the difference between stopping the fire or watching it get away. II. PRESENTATION A. Lay out coupling jobs for the class. Fitting combinations: Gated Y to hoses, hose to hose, nozzle to hose, ejectors to hoses, etc. B. Each trainee is given the task of coupling each combination of hose and fittings with enough trials to become proficient. Notes to Instructor: 1. These skills need to be fully developed, and you may not want to spend the time necessary in only one session. It is common practice to do this part of the drill two or three times a week in hourly sessions, rather than a three or four hour single session. Those who become proficient quickly can be tested any time you feel they are ready.	

TIME	LESSON OUTLINE	AID CUES
	2. When proficient, the trainee is asked to couple fittings to establish his own speed. Time each trial with a stopwatch	
	3. When the trainee has established and tested his speed and skills under practice conditions, test him under conditions where there is pressure. He needs to be able to couple hose and fittings in the face of advancing fire, when hose is about to be charged, or where other conditions might distract him. One test is to have him couple fittings and hoses using the time he established when not under pressure, but inform him that during this test a backpack pump spray will be directed at his head starting at the end of the time previously established and will be continued until the coupling job is completed. (A water stream played on his hard had will make a lot of noise without getting him overly wet. Any sediment in the water won't get in his eyes, either.)	Ask if he can do this "for real.' Good for hot days!
	His reactions will be directly related to how he reacts under fire. If he becomes confused, disorganized or cannot remain calm when threatened by a small stream of water, would you expect him to keep his cool on a fire?	
	At the point where the trainee is not finished with his coupling job and his time has run out, give him a squirt and don't stop until he completes the task! (For competition, let crew members time and "test" each other under these conditions.)	
	III. SUMMARY	
	Practice makes perfect. Maybe. But practice does develop skills, which enable the firefighter to do a better job under pressure conditions.	

INSTRUCTOR'S LESSON PLAN II G

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: The Broken Hose Situation	Date
TYPE: Drill	Instructor:
TOTAL TIME:	
TRAINING AIDS: Simple hose lay and nozzle Extra lengths of hose Expendable lengths of hose Hose shut-off clamp	Assistant(s): Training Location:

OBJECTIVES:

A hose lay team will be able to solve broken hose problems safely, quickly and with minimum water loss.

INSTRUCTOR REFERENCES:

STUDENT REFERENCES:

TIME	LESSON OUTLINE	AID CUES

I. INTRODUCTION

Every firefighter needs to be ready to act in unforeseen situations. There are too many opportunities for failure of hose under hose lay conditions to ignore the probability that hoses may break. If one breaks during training, it should be used as a training opportunity. The following drill is designed to prepare you to react correctly and quickly in case of a hose break.

II. PRESENTATION

A. A break in a hose lay presents certain problems. Men beyond the break are immediately out of water, if they are on the uphill side. If on the downhill side of the break, they will be out of water shortly. There are times when this situation would be a safety threat. And there's the obvious problem of delay in putting out the fire.

B. Actions

1. The first step on each break should be to warn others on the crew that hose is broken so that they can protect themselves by retreating to a safe location.

2. The next thing to do is to control the water flow into the hose. This can be done with a hose clamp, by closing a gated valve, or by signalling the pump operator. Your situation will determine which method is best at the time.

3. Then repair the hose lay by replacing the damaged length.

4. The final action is to reactivate the hose lay by recharging the line.

TIME	LESSON OUTLINE	AID CUES
	C. Instructor should have the trainee crew start any hose lay they are trained to lay. At a selected time, he is to simulate that a hose has ruptured at a particular place. The trainee crew is to repair the hose lay in an approved manner. The standards of operation are set by the instructor. Timing one broken hose drill over and over is less valuable than creating the problem under varying conditions. The operation should be critiqued after each drill, to make sure the best procedure for the particular situation was used.	
	D. After crew has become proficient under simulated conditions, substitute an actual break, using a length of expendable hose in a charged hose lay. Puncture the hose and let the crew correct the situation with all the factors of engine noise, water spraying, pressure drops and related confusion present.	
	III. <u>SUMMARY</u>	
	The unexpected doesn't happen often. But it does happen! Being ready and having experienced what to do under such conditions is a necessary part of a firefighter's background.	

INSTRUCTOR'S LESSON PLAN II H

COURSE: Water in Fire Control

File No.

TITLE OF LESSON: Finding the Fitting

Date:

TYPE: Drill

Instructor:

TOTAL TIME:

TRAINING AIDS:

Fully equipped fire tanker or slipon unit normally used by crew being trained.

Assistant(s):

Training Location:

OBJECTIVES:

Trainees will be able to retrieve a specified (by name) fitting or other equipment within time limit established by instructor.

INSTRUCTOR REFERENCES:

STUDENT REFERENCES:

TIME	LESSON OUTLINE	AID CUES

I. INTRODUCTION

All fittings have specific names, and usually are stored in a particular place on the vehicle normally used to transport them to a fire. Each crew member should know what each fitting is called and where it is located on the vehicle he usually works with.

Being able to quickly locate the various fittings needed when requested is just as important as being able to use them effectively.

The following drill program is designed to overcome potential problems by facing up to simulated problems.

II. PRESENTATION

A. Make cards with a task involving specific equipment written on each. Language used should be that used in a fire situation. Cards can be used over again for additional drills. It is assumed that trainees already are familiar with the equipment in question.

Drill #1 - Give card to trainee and time his completion of the task.

Sample card:

1. Get out enough inch and a half to lay to--- (indicate point 200' away.)
2. Get out a "Y". Hook up and Y off in two lines.
3. Bring me a 1" reducer, 50' lateral, and 1/4" nozzle.
4. Get hose clamp.
5. Get a shovel.

TIME	LESSON OUTLINE	AID CUES
	Drill #2 - Blindfold trainee. Simulated night problem. Read first item on card to trainee.	Blindfold trainee in cab of vehicle.
	1. Get a head lamp and hook it up on your hard hat. When it is turned on, you may remove the blindfold.	Give card to trainee now.
	2. Need the box of hose gaskets.	
	3. Bring the extra headlamp batteries.	
	4. Break out the first aid kit.	
	5. Need a file.	
	B. Make additional cards to cover situations you may encounter on fires. Plan on some of the drills to be done with your verbal requests either directly or by radio.	
	C. Continue drills until you are satisfied that trainees can quickly locate all the needed equipment. (Make sure your orders are not any better than they are in fire situations, but don't deliberately slip into poor communications habits just to make the problem more difficult.)	
	III. <u>SUMMARY</u>	
	Sometimes the little things of the job can create big problems or cause aggravations. Knowing where everything is kept should become second nature to the fire crewman.	

INSTRUCTOR'S LESSON PLAN III A

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Principles of Water Application	Date:
TYPE: Lecture	Instructor:
TOTAL TIME:	
TRAINING AIDS: Overhead projector and transparencies or slide projector and slides. Screen.	Assistant(s);
	Training Location:

OBJECTIVES: Trainees will be able to describe the basic principles of how and why water suppresses fire, basic techniques of water application and basic fire control strategy using water. This knowledge will be prerequisite to further lessons in this course.

INSTRUCTOR REFERENCES: "Water vs Fire"

STUDENT REFERENCES: Firefighter Basic Training "Use of Water", USFS TT-87
Booklet - "Water vs Fire"
Film - "Water vs Fire"

TIME	LESSON OUTLINE	AID CUES
	I. INTRODUCTION We've spent time learning how to get water from a source to the fire itself. All these steps were necessary, otherwise we'd have no water with which to stop the fire. Now it's time to take a look at just what water can do to fire, and how to apply it. This lesson will be a general review of basic water use. Other lessons will go into more detail. II. PRESENTATION A. Fire Triangle FIRE DOESN'T LIKE WATER MUCH. Water can be a mighty formidable enemy of fire, if you consider the fire triangle. There is usually plenty of fuel around. There's plenty of oxygen too - if there weren't, you'd be gasping like a goldfish on dry land by now. The heat bar of the triangle is brought in by a smoker who didn't believe in signs, or by lightning, or some other firebrand; but once it's there, the three, FUEL OXYGEN HEAT form a closed Triangle Corporation called FIRE. One of the best ways to break it down is to C-O-O-O-O-L THE FUEL.	Vu-graph III A-1 Vu-graph III A-2
	Water has been the A-1 cooler since the world began. It acts on the fire triangle by breaking the heat bar and diluting the oxygen with vapor at the same time. There's one more thing about that triangle to remember - and that is important. It has a way of getting back together again - and that's why it <u>always</u> is a good idea after you've knocked FIRE down with any cooler - to <u>put a line around</u> it and keep it down.	Vu-graph III A-3

TIME	LESSON OUTLINE	AID CUES
	B. <u>Effectiveness of Water</u>	Vu-graph III A-4
	YOU GET 100% if you can do the trick shown here. Although these represent perfection, they give you an idea of what a big job a little water can do.	
	You wouldn't use a bucket full of water to douse a match flame. The smallest of drops will do it. Try it and see.	Vu-graph III A-5 GO AHEAD - TRY IT!
	The flame will burn merrily on unless the water spreads over the fuel and cools it down below kindling point.	
	The same is true on the fireline. It'll take <u>very little water</u> to cover volumes of fuel - especially if you break the water up into a spray - because then many single droplets can cool many units of fuel - simultaneously.	
	If your weapon is water and you have a limited supply, use it sparingly, but effectively!	
	Remember: Burning litter, grass or duff, NOT TOO LITTLE - JUST ENOUGH Logs that smoulder, trees and such, NOT TOO LITTLE - NOT TOO MUCH	
	C. <u>General Principles of Water Conservation</u>	
	1. A LITTLE SPRAY GOES A LONG WAY toward knocking down a lot of flame, <u>if</u> you put it where it will do the most good. The tiny drop of water put out the burning match because it hit the <u>base</u> of the flame. Where there's smoke there's fire; where there's fire there's burning fuel, and it's <u>always</u> at the root of the trouble.	Vu-graph III A-6

TIME	LESSON OUTLINE	AID CUES
	Whether water knocks the flame Depends a lot on how you aim. If it's a bush burning, hit the base - if it's a tree or snag, hit the bottom first - then work up the trunk. As you spray water on the fire edge, remember to work in close with the finest spray that will do the job - not too much, but just enough - making sure that every drop finds a piece of hot fuel.	Vu-graph III A-7
	2. <u>Know Your Equipment</u> Whenever your water supply is limited, there are three gadgets you must be master of - your <u>pressure gauge</u>, your <u>nozzle</u> and your <u>shut-off</u>.	Vu-graph III A-8
	It's easy to see that if you step pressure up as high as it will go and open your nozzle at the same time, your water won't last long - the time you'll have to use it will be short. High discharge rates, then, mean short use-time. By lowering pressure and reducing the nozzle opening, you can keep your water from escaping so fast. Low discharge rates - longer use-time - more fire caught - more fuel cooled.	
	Learn to handle your nozzle. Learn the effects pressure has on water at the nozzle. Practice with combinations of <u>nozzle</u> <u>openings</u> and <u>pressures</u>. A little water will go a long way - kill a lot of flame - cool a lot of fuel - last a long time - do a big job well - save a lot of work - cost a lot less - if you're expert enough to see that it does. MORE FIRE TAKES MORE WATER - less fire, less water. Simple, huh?	Vu-graph III A-9

TIME	LESSON OUTLINE	AID CUES
	But if you're the kind of guy who's slow to change, you're going to waste a lot of water on a little fire, or a big fire will get bigger for want of enough water - adjust as you spray. Make your water match your fire.	
	a. <u>The straight stream nozzle</u>:	
	Use that straight stream reach <u>only</u> when you neet it:	
	- to cool a hot fire in order to get at it,	Vu-graph III A-10
	- to knock fire out of snags or trees,	Vu-graph III A-11 & III A-12
	- to hit dangerous hot spots ahead of you.	
	b. <u>Use your shut-off</u>:	
	Don't waste water on cold ground. If you're moving from one hot spot to another - <u>shut-off</u> the water.	Vu-graph III A-13
	"If you would water use with care; Spray the fuel and not the air."	
	There's an "on-again-off-again Finnigan" technique that pays high dividends in water saved. On the fire line, squirt a little water at the base of the flame - shut it off - or move along. If the flame bounces back, give it more - but squirting water <u>intermittently on and off</u> gives you a better chance to use the least amount needed for the job. Practice this one on fire until you get the "feel" of it.	

TIME	LESSON OUTLINE	AID CUES
	c. Select proper pressures:	
	Some nozzles at high pressures actually deliver air as well as water on the fire - which has the effect of fanning the flame into action instead of knocking it down. When that happens, lower pressure.	Vu-graph III A-14
	D. Initial Attack with a Backpack Pump:	
	1. Valuable things sometimes are heavy. Gold, for instance. A backpump full of water can be worth its weight, too - if you're alone on initial attack, especially.	Vu-graph III A-15
	2. After water line - hand-tool line - at your leisure - hottest edge first You've broken the fire triangle heat bar. Now, go after the fuel bar, and you've got it licked.	Vu-graph III A-16
	3. Popularity is not always a matter of personality. On a hot fire, the cool-headed fellow with the back-pump often is sought after. As a member of a firefighting TEAM, you can make it possible for hand-tool men to work in closer to the fire. Watch for hot spots. Cool them down. Be where you're needed. Make your water last.	Vu-graph III A-17
	E. Initial Attack with a Tanker:	Vu-graph III A-18
	1. As nozzleman, backed up with plenty of water + power on wheels, you often can hit the head of a hot fire. When you do, make every drop of water count - and you'd better know every minute how much is in the tank. Running out of water on a head attack is more than embarrassing - it's downright dangerous! At all times -	

TIME	LESSON OUTLINE	AID CUES
	2. Sometimes the fuel is light and there's little risk to tires or hose - smoke and heat being what they are, it's more comfortable to go in the back way and sneak up on the fire head from inside.	Vu-graph III A-19
	3. A hot fast fire in heavy fuel can be put to sleep with water - <u>but only to sleep</u>. Knock it out faster than it can run ahead in order to pinch it off and stop it. Watch your water supply - and <u>watch behind</u>. Hot fires come awake fast - ready to run and overtake <u>you</u>. (Burning up tankers lowers their efficiency - and raises the cost of water a bit, too.) Remember - all hands to the fire line with hand tools as soon as the water job is done - or the race may still be lost.	Vu-graph III A-20
	4. You should know how much water you have and how to make it last. Fire can take all you'll give it - but don't give more than is needed. Hands that hold a nozzle fit a shovel handle too - but the work is harder on your back. The job of catching the fire is still there to do if you run out of water - but it's hotter and takes longer. Meter your water - make every drop count.	Vu-graph III A-21
	5. <u>Know too</u>, how much fire your water can kill - what pressures and discharge rates are necessary to knock it down faster than the head is traveling - and have water left over if you can!	
	6. IF YOU DO RUN OUT OF WATER - you shouldn't - but if you do before the fire is stopped - for gosh sake, don't just stand there! The most elegant of water rigs are equipped with hand tools for just such emergencies. Go on with an indirect attack as near your original plan as possible. If you've been working	Vu-graph III A-22

TIME	LESSON OUTLINE	AID CUES
	with a hand-tool crew - grab a shovel and take your place on the fire line - or go back for more water, if you have the crew boss's O.K.	
	Some people are surprised when they come to the end of the hose. "We almost got it, but the hose wasn't long enough!" should rate as "famous last words" before leaving for another job.	
	"Disaster" is a word used to describe what happens sometimes if you run out of water at a critical moment. Disasters cost lives and cause misery, and can be a mighty heavy weight on a man's conscience.	
	F. <u>Small Fire Suppression Tips</u>:	
	1. IF THE FIRE IS SMALL AND - you have water, you're lucky - because with water you often can hit the fire head (1), which is the fastest way to stop it.	Vu-graph III A-23
	2. Sometimes in light fuel you can avoid heat and smoke by going in at the heel and attacking the head from inside the burn (2).	Vu-graph III A-24
	3. But most often the best strategy is a flank attack (3). Start at the rear, knocking down the burning flank as you go. Encircle the head and keep going down the opposite flank back to the point of first attack.	Vu-graph III A-25
	4. Or - do the same thing on the inside (4) where the heat and smoke often are less if the fuel is light. These diagrams demonstrate points of attack on a small fire. They do not tell you when or why they're used.	Vu-graph III A-26

TIME	LESSON OUTLINE	AID CUES
	Nice simple fires are rare - usually they behave according to a combination of wind, weather, fuel, slope and general cussedness. It's up to you to size up a fire and then <u>stop it</u>. Remember - no two fires ever are alike. Your choice of strategy must fit the fire - but using any of these diagrammed approaches, you can stop fire faster with water <u>if</u> you've aimed one at the other often enough in practice sessions to know what happens when they meet. Be sure you keep your water where it will do the most good - unless you <u>like</u> mopup work.	
	5. <u>TO GET IN AND GET AT IT</u> when the fire is hot - reach with a straight stream-aim for the base of the hot spot. If you keep your water low, bouncing some of it off the ground in a fan, you'll cool more fuel at one time.	Vu-graph III A-27
	6. Keep moving in fast and - <u>CHANGE TO A SPRAY OR FOG</u> as soon as you're close enough to cover burning fuel - the spray or fog will make a protecting water shield for you. Keep the flame knocked down. Fog in dense fine fuels such as grass is most efficient because of the higher rate of vaporization. The idea is to cool just enough area at the fire edge to give you a place to stand so that you can turn and -	Vu-graph III A-28
	7. <u>SPRAY DOWN AND PARALLEL</u> to the fire's edge. Working that way, you can cool more fuel ahead of you and waste less water doing it, at the same time making full speed forward. Make a good water scratch-line as you go - <u>don't drown</u> the fire but - make sure the flame is knocked down.	Vu-graph III A-29

TIME	LESSON OUTLINE	AID CUES
	G. Large Fire Suppression Tips:	
	1. As a spot fire trouble shooter - back pump equipped - you can keep a big fire from getting bigger with a little water. Alert back pump teams on large fires can hold a lot of fire within bounds.	Vu-graph III A-30
	2. WATER MAKES SMALL CREWS SEEM LARGER-- On fires in light fuels, a 5-man water hand tool unit working as a well coordinated team can conquer more fire faster than a 15-man hand tool crew without water. The 5 men are safer than the 15 - and cooler too.	
	3. Burning out "fingers" or "islands" inside a fire keeps them from being future fuel beds. A back pump and you can guarantee that the burning stays where it's wanted. "Hose-happy-Harrys" have been known to create "fingers" and "islands". Be sure you keep your water where it will do the most good - unless you <u>like</u> mopup work.	Vu-graph III A-31
	4. WATER IN THE RIGHT PLACE AT THE RIGHT TIME can save hours of work - your neck - various people's tempers - money - timber - watershed - the day - in fact, the list of possible savings is endless. But before you start dreaming of yourself as a future hero - make sure of the efficiency of your performance with a nozzle. Practice your water techniques. Spot fires make good practice targets. Size them up - match your water to the fire. Knock it out. Did you use more water than you needed? Could you have done it with less? How was your aim? Did you cool down <u>all</u> the hot fuel? Will it stay that way?	Vu-graph III A-32

TIME	LESSON OUTLINE	AID CUES
	5. Attacks with stationary tankers and hoselays are made when terrain or dense cover make it impossible to drive close enough to use the live-reel hose. As pumper operator, you are responsible for keeping water going to the fire. Keep in touch with the hose crew, too. They <u>must</u> know how much water is available at all times.	Vu-graph III A-33
	H. <u>Mopup</u>	
	1. IT'S HEAT YOU'RE AFTER in mopup - and it's hard to see because often there isn't much flame or smoke. There will be glowing and smouldering, but you'll have to look for hidden hot stuff. Find it - dig it, turn it - spray it with cooooling water.	Vu-graph III A-34
	2. If all the cooled fuel that a good water man can mopup with low pressure - fine spray, and one tank of water, was piled in one place - its volume would be several hundred times that of a truck. (Do you remember this proportion?)	Vu-graph III A-35
	3. A long tank of water makes short work of mopup - so you and your water can star in this show. The final cooling job will cost less - take less time - if you know and use <u>all</u> of your water stretching tricks. Intermittent squirts in the right place - not too little - not too much. Where water is scarce, don't waste it on hydraulic digging.	Vu-graph III A-36 III A-37 III A-38 III A-39
	4. Water and hand tool men working together are double threat fire teams on mopup, too. This time, the shovel men make the water job faster and easier. They rake -	Vu-graph III A-40

TIME	LESSON OUTLINE	AID CUES
	scrape - chop - dig out the hot fuel and expose it to the air - so you can spray it. Air is a goof pre-cooler - let it help you save water.	
	III. <u>SUMMARY</u>	
	A. Water can break the fire triangle by cooling.	
	B. A little water is capable of putting out a lot of fire.	
	C. Wise use of water, not just the amount, determines how effective water will be.	

INSTRUCTOR'S LESSON PLAN III B

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Initial Attack with Water	Date:
TYPE: Lecture with discussion TOTAL TIME:	Instructor:
TRAINING AIDS: Easel or chalkboard	Assistant(s):
	Training Location:

OBJECTIVES: Trainees will be able to describe the effective use of water as illustrated by the Deluge, Containment, Hotspotting and Exposure Protection methods of initial attack. Their knowledge will be tested by relating the appropriate method to hypothetical or actual situations.

INSTRUCTOR REFERENCES:

STUDENT REFERENCES:

TIME	LESSON OUTLINE	AID CUES
	I. INTRODUCTION Throughout the various water use lessons, films and other training media, we have stressed water conservation. Let's regroup for a moment to emphasize that by conservation we do not mean the miserly use of water -- we mean the wise use of water. Just as the miser may starve to death, even though he has adequate funds, so may the "water miser" lose the fire in spite of an adequate water supply for the job at hand. Wise use very well may mean rapid use, particularly in certain attack situations. If proper rapid use exhausts the water supply, but stops the fire, then it has not been wasteful use. In this lesson, we'll discuss four methods of water use and determine the situations and equipment involved in the selection of each. We'll call these methods: DELUGE, CONTAINMENT, HOTSPOTTING AND EXPOSURE PROTECTION	
	II. PRESENTATION	
	A. Deluge Method: 1. Water is applied in large volumes. 2. Entire fire area is covered, if possible. 3. Objective is to completely and rapidly extinguish the fire with little, if any, other help.	List on easel
	B. Containment Method 1. Water may be applied in as large volumes as necessary to knock down fire and stop spread. 2. Perimeter of fire is completely covered; but containment, rather than extinguishment, is objective.	List on easel

TIME	LESSON OUTLINE	AID CUES
	3. Hand tools and/or mechanized equipment likely to be used also.	
	4. Most often used method, probably.	
	C. <u>Hotspotting Method</u>	List on easel
	1. Water use is intermittent and confined to knocking down head of fire, cooling hot spots and flare ups, preventing runs, hitting spots ahead of fire front.	
	2. Objective is to slow or hold the fire until adequate help arrives.	
	D. <u>Exposure Protection</u>	List on easel
	1. Priority is given to keeping fire out of high hazard fuel areas, away from high value property and equipment, away from public danger area.	
	2. Water may be used to cool fuels or property ahead of, or adjacent to, fire.	
	3. Objective is protection of values and exposures when fire fighting resources abviously are inadequate to stop spread of fire.	
	E. <u>Factors to Consider</u>	Ask trainee for the factors in each category
	1. <u>Fire Behavior</u>	
	a. Intensity - hot and wide front or not so hot and narrow front, - how close can you get?	
	b. Rate of spread - fast or slow.	
	c. Fuels - those burning now and those ahead of the front, - light and flashy, but easy to stop - heavy and slow, but hard to extinguish.	

TIME	LESSON OUTLINE	AID CUES

d. Topography - uphill, downhill, flat - changes ahead of fire.

e. Weather - present and predicted moisture and winds.

2. <u>Values threatened</u>

   a. Public safety

   b. Homes, industries, resorts, equipment, recreation areas

   c. Timber

   d. Watersheds

   e. Aesthetic areas

   f. Fish and wildlife habitat

   g. Crops

3. <u>Firefighting capabilities</u>

   a. Amount of water available - backpack tanker, stream, pond, etc.

   b. Types of pumps, hoses and nozzles available

   c. Application speed - moving vehicle vs hose lay

   d. Additives - "wet water", foam, retardants

   e. Other fire fighting units and crewmen on hand

   f. Amount and time help expected - water units, line building equipment, manpower

TIME	LESSON OUTLINE	AID CUES
	F. Situation Exercises By considering the factors we have discussed, what likely would be the means of attack indicated, that is; Deluge, Containment, Hotspotting, or Exposure Protection; for the following situations: 1. A two acre fire is contained by gravel roads on three sides. It is running in weeds and dry grass and periodically gets into piled, dry slash where trees have been cut to expand a scout camp athletic area. The apread is toward the wooden, one story buildings on the fringe of the camp area. As the slash piles ignite, they spot ahead and further spread the fire. A drainage ditch 50 feet from the buildings blocks vehicle access to the fire head, and will also prevent ground fire from spreading into the camp. You are equipped with a 125 gallon slip-on tanker with live reel, 2 backpack pumps, hand tools for 6 men, and are accompanied by 2 experienced crewmen. The only water supply nearby is a low volume standpipe at the other end of the camp. Additional tankers are scheduled to arrive in 20 minutes; but fire likely will be at the drainage ditch in 15 minutes. What method of water attack appears indicated? (Answer - Exposure protection. Although the drainage ditch will stop the ground fire, the slash piles likely will put embers on the roofs of the scout camp buildings. Since you do not have enough hose or water to stop the main fire, then efforts should be made to protect the roofs and grounds in the camp area with the slip-on pump and backpacks until other tankers arrive.)	Discuss possible answers

TIME	LESSON OUTLINE	AID CUES
	2. You have arrived at a half-acre fire just west of the Blanco Experimental Forest. A few hundred yards north of the fire is a 20 year old pine plantation of 500 acres. Topography slopes rapidly upward just beyond the plantation and in the experimental forest. There is a small stockpond beside the road ahead of the fire. Fire is advancing in brush and weeds. Fire danger is very high and is predicted to continue. Winds are from the west at 5-10 mph and predicted to increase to 10-15 mph within 2 hours. Time is noon. You have 300 gallon tanker fully equipped with live reels, 1-1/2 CJRL hose, assorted nozzles, fittings, etc., plus a 5-man crew. There are otherfires on your unit; and all help is tied up indefinitely. What appears to be your indicated method of water attack?	Discuss possible answers
	(Answer - Deluge method. With the values and exposures near or ahead of the fire, the continued high fire danger, the apparent lack of reinforcements, plus the availability of water and the capability of applying it, a fast and complete extinguishment is indicated. This also would permit this equipment being available for reassignment as soon as possible.)	
	3. Additional exercises:	
	a. Instructor prepare exercises to illustrate Containment and Hot-spotting methods of water attack.	
	b. Instructor prepare substitute exercises for Exposure Protection and Deluge methods. The use of simulated conditions in <u>your</u> area and specifying <u>your</u> water equipment will be most effective.	

TIME	LESSON OUTLINE	AID CUES
	III. <u>SUMMARY</u>	
	There are times when a little water is indicated; there are times when a lot of water is indicated. There are times when it's best to pull all stops and hit the fire directly; there are times when it's best to lay back and react to what the fire does.	
	In this lesson, we discussed when and how to do some of these things, using four methods of water application:	
	(A) <u>Deluge</u> - a hard hitting, heavy volume, quick and complete extinguishment method.	List on easel or chalkboard
	(B) <u>Containment</u> - a progressive, stop-the-spread method.	
	(C) <u>Hotspotting</u> - a hit-and-run, try-to-hold-3m method.	
	(D) <u>Exposure Protection</u> - a protect-the-values-first method.	
	It's not just how much or how little water is used - it's how <u>wisely</u> it's used according to the situation that determines your effectiveness.	

INSTRUCTOR'S LESSON PLAN III C

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Mopup Equipment and Methods	Date:
TYPE: Lecture and demonstration	Instructor:
TOTAL TIME:	
TRAINING AIDS: Easel and felt pens. Supplies listed in drill exercise.	Assistant(s) Training Location:

OBJECTIVES:

Trainees will be able to select mopup equipment compatible with the water supply, and apply water to accomplish the mopup job efficiently.

INSTRUCTOR REFERENCES:

"Effective Wetting Agents for Forest Fire Fighting"
Southern Forest Fire Lab, Macon, Georgia

STUDENT REFERENCES:

"Use of Water, Fire Fighter Basic Training, USFS TT-87 (5100)
"Water vs Fire"

TIME	LESSON OUTLINE	AID CUES

I. INTRODUCTION

Like any good job, planning a water system for mopup should be carefully planned and used. One of the big differences between mopup and attack on wildfires is that mopup usually permits sufficient time to plan and order the equipment needed to do the job efficiently. Don't be led into the trap that mopup is a low priority job, and therefore you can afford to be less than efficient.

II. PRESENTATION

A. Sizing up the water source -

1. Backpack pumps. Transportation time may make this system slow and expensive. The limited volumes available are a handicap.

2. Air delivery of water in cans by helicopter or air drop. This also is expensive, limited in total volumes, and must be used wisely.

3. Fire Tanker delivery. Generally, these tankers deliver from 75 to 500 gallons. Depending on the size of the area and method of water use, they may be able to deliver sufficient water for the nozzle men to work at reasonable speed consistent with good water use principles and safety.

4. Nurse tanker delivery. When used in conjunction with fire tankers or portable water tanks, they may be able to keep an uninterrupted supply of water available.

5. Streams, rivers, ponds, etc. If these sources are located in or near the fire, we have an unlimited source of supply. It is limited only by the delivery system we install.

TIME	LESSON OUTLINE	AID CUES
	B. Selecting the proper equipment - If a source is running only 2 gpm, there is no sense in calling for a portable pump. If a river is handy and you have 40 acres of heavy fuel to mopup with a large crew, there is no sense in trying to do it with only one tanker or portable pump. Making the maximum utilization of the water available, consistent with good practice and safety, will be the cheapest method in the long run. C. Starting in the right place - Start your mopup in those areas that pose the greatest threat of escape, such as: a. Spot fires outside the main line. b. Hot spots inside the line, but adjacent to hazardous fuels outside the line. c. Areas where burning fuels might roll across the main line. d. All other areas adjacent to the fire line. e. Around unburned fuels inside the fire line. f. All other areas in the fire. D. Using water modifiers - Wet water is water whose surface tension has been reduced by the addition of a wetting agent. It is most helpful where penetration is needed in deep duff, heavy litter, peat and muskeg. It can be a big help in mopup. Compared with plain water: -Penetration into wood is 8 times greater. -Penetration into charcoal is 6 times greater.	

TIME	LESSON OUTLINE	AID CUES
	-Surface spread on wood is increased 2 to 8 times. Non-toxic, non-corrosive wetting agents are available, but concentrations required and cost vary greatly. (See the "Effective Wetting Agents for Forest Fire Fighting" evaluation from the Southern Forest Fire Laboratory, Macon, Georgia.) E. <u>Using the right approach for the equipment you have</u> - 1. Backpack cans - As in most mopup situations, the team approach will work best here. If water is costing a lot, such as with a long pack-in or by being air-delivered, the team should develop methods to get the best utilization of each gallon of water:	
	a. Find hot spots (with bare hands, if necessary). b. Expose hot spots - dig out roots and duff, peel logs or chip coals off with axe, shovel, etc. c. Spray light stream of water directly onto burning embers.	Instructor & assistant should demonstrate this on a small practice fire if possible.
	Sometimes it is helpful to build a small mud bath to roll small chunks in. If wetting agents are available, they should be added to the backpack. If water for the backpack is easy to obtain, such as from a small stream in the fire area, the nozzleman should feel free to use lots of it, but shouldn't ignore the principles of doing a complete job. (Don't waste water and time on areas	

TIME	LESSON OUTLINE	AID CUES

already cold!) Dig out or turn over the coals, preferably working in teams, and then put enough water on them to get them out fast. The chunks that are out should be put in a bone pile to avoid having to check them again.

2. Tanker delivery -

Here we are talking about standard 75- to 500-gallon tankers. The nozzleman can be more aggressive with his water, but must realize he still has a limitation. A wetting agent should be added, when feasible. This allows the water to penetrate better and increases its effectiveness. Use a mopup wand. If you feel you occasionally might need a straight stream nozzle also, you can use a Forester Combination Nozzle. Attach the mopup wand to the fog side of the nozzle and put the fog tip on the end of the mopup wand. Selection of tip size should allow the operator to cover the area as fast as his teammates can turn over and dig out. The nozzleman might want to carry several tips for different jobs.

a. Find the hot spots: In addition to the techniques used with back pack pumps, the nozzleman might find it helpful to put a small fog tip on the nozzle and give a large area a very light spray. Steam will tend to boil up from the hot spots, and this will help the nozzleman pick up spots not otherwise visible.

b. Expose the hot spots: Again, this is often done best with a team approach, as with the back pack pump. In addition, the nozzleman with a mopup wand is

TIME	LESSON OUTLINE	AID CUES
	able to roll some burning chunks over with the wand. Also, he can do some hydraulic digging with the wand and water stream. If a nozzleman has several hand tool men working with him, he should let them do the digging. This saves water, keeps everyone working, and the team can cover more ground. C. Extinguish the hot spots: The nozzleman should select a tip that will allow him to douse live fire and coals as fast as his team is able to expose them. 3. Unlimited water supply - Here our application is limited primarily by our delivery system. If we have a major mopup job to do, it might be worthwhile to spend all the time needed to install the correct delivery system. On the other hand, it's not worth spending many hours in putting in a 100 gpm system to mopup routine, small fire. Let's assume we have a large fire that will take several days to mopup. When working as teams in the limited water situation, we probably had several tool men working with each nozzleman so as to help conserve water. Now, we have lots of water available; so let's reorganize. Let's provide only one tool man to do the digging, turning over of chunks and helping drag hose. The nozzleman now will use a large spray or fog tip on his mopup wand. His wand will allow him to turn small chunks over and reach under logs and down root holes. The high volume nozzle will allow him to hydraulically force the tip 6 inches or more down in the duff and dirt. The larger volumes used and greater area	

TIME	LESSON OUTLINE	AID CUES
	covered means less of the mixing, chipping, scraping and digging that's needed for conserving water. This method will let us divide into more teams that are smaller but fast moving, and we'll cover more ground in less time.	
	F. <u>Doing a complete job</u> - Nothing is more frustrating than to see a smoke 100 yards away in the area you just covered. You may end up wasting time and energy dragging hose and tools back to that persistent smoke that you should have located on the first pass.	
	Make sure you get all the heat out the first time. It's a tough, dirty job checking for those last little hot spots. The method is the same, regardless of the water use techniques applied.	
	One man in each mopup team should check the ground and fuels with his bare hands. He should feel cautiously down into all the root and stump holes, under logs and along the length of logs. He should feel through the ashes on the ground or in the duff. He needs to check every foot of the mopup area for heat and smoke. This job could be assigned to a competent hand tool man, or one of the men dragging hose.	
	The heavier the fuels, the more time consuming and the more important this job becomes. It is easy to spot a good mopup crew, as they seldom leave any hot spots behind them.	
	G. <u>Wetting agent demonstration on duff</u>:	
	This demonstration is to show the relative effectiveness of a wetting agent versus plain water when used on mopup in your fuel types.	

TIME	LESSON OUTLINE	AID CUES
	1. Select a typical duff type, and gather two or more cubic feet. 2. Put the duff in two equal amounts, spread over an area in the sun. 3. Light the two duff plots. Let them burn until fully involved for maximum heat. 4. Use two backpack pumps, one with wet water and one with plain water. 5. Apply plain water to one of the piles, and count the pump strokes needed to mopup the duff. Stir as you would in a live mopup situation; and use approved application techniques. 6. Simultaneously apply wet water to the other duff pile, and count the strokes necessary to mopup this duff plot. 7. Repeat the same demonstration until results are obviously consistent. 8. The difference in water use will be apparent, as will the visual effect wet water has on the duff. H. <u>Wetting Agent Demonstration on Heavy Fuels</u>: 1. Use the same approach as in the previous demonstration, but use heavy fuels such as limbs or punky logs. 2. Use approved techniques, and note difference in time and/or water amounts. III. <u>SUMMARY</u> Mopup is the last part of the fire suppression job, but it can't be slighted.	

TIME	LESSON OUTLINE	AID CUES
	There are effective ways to do this job, and they should be used to do the job with the least time and cost.	

INSTRUCTOR'S LESSON PLAN III D

COURSE: Water in Fire Control	File No.
TITLE OF LESSON: Selecting or Outfitting a Tanker	Date:
TYPE: Lecture, exercises	Instructor:
TOTAL TIME:	
TRAINING AIDS: Overhead projector, hand-outs, flagging or spray paint, outfitted tankers (see exercises)	Assistant(s):
	Training Location:

OBJECTIVES: Trainees will be able to describe the limitations and strong points of the tankers and accessories used in their individual areas.

INSTRUCTOR REFERENCES: Water-Handling Equipment Guide

Fire Ground Hydraulics Manual,
Los Angeles County - 1968

STUDENT REFERENCES:

TIME	LESSON OUTLINE	AID CUES
	I. INTRODUCTION There are measurable standards for fire line construction by men or machines based on cover type. When structural firemen attack a fire, they can estimate flowage and nozzle requirements based on room volume and contents. What measurable standards are there for determining water use requirements in forest fire fighting? I don't think you'll really find any. For many of us, the approach has been to provide equipment that makes for easy mopup with miserly water use and minimum refill trips. Some forest fire control units now base their needs on the equipment necessary to stop a running or spotting fire. If they can stop such a fire, they assume smouldering, creeping and mopup type fires can be taken care of without much trouble. How are <u>you</u> set up? Can you stop the typical fires you are likely to be confronted with? Are you equipped only for "easy" fires and mopup? Are you set to stop the hot ones, but not to do efficient mopup jobs? In this session, we'll discuss the general characteristics of water equipment needed to do various jobs. II. PRESENTATION A. Before we even start to talk about hoses, nozzles and pumps, let's set up some <u>rough</u> <u>guidelines</u>: 1. Roughly, flow is limited to about 35 gpm for 3/4" and 1" I.D. lines (the booster reel class) and to 100 gpm for 1-1/2" lines.	 Put on easel

TIME	LESSON OUTLINE	AID CUES
	2. Let's talk of equipment using the examples on these tables for pumping equipment and nozzle tips. There are more types than shown here and some nozzle tip capacities may vary somewhat from these, but the concept is what we're most concerned with. (Instructor: You may add or substitute your equipment for listed items as appropriate.)	Vu-graphs III D-1,2 & 3 (Pass out copies)
	B. <u>Situations</u>	
	What do you think we need in the way of maximum water-handling capabilities for these initial attack situations?	
	1. Hot, fast moving fires (initial attack)	DISCUSS & LIST
	a. Equipment needs	
	(1) Pump capacity - high volume	
	(2) Nozzle capacity - high volume	
	(3) Stream reach - long distance	
	(4) Stream type - straight and heavy spray	
	(5) Supply - large tank, nurse tankers handy, drafting chance handy	
	(6) Hose - 1-1/2" plus live reel	
	b. From the pump and tip lists, what appears to be suitable for this situation?	
	(1) Model 60 and Lockheed Slip-On	

TIME	LESSON OUTLINE	AID CUES
	(2) 3/8" straight stream and #24 spray tip, or larger tip if available.	
	2. Creeping, low intensity fires (initial attack)	DISCUSS & LIST
	a. Equipment needs	
	(1) Pump capacity - low volume	
	(2) Nozzle capacity - low volume	
	(3) Stream reach - not important	
	(4) Stream type - spray preferable	
	(5) Supply - medium tank, nurse tankers, handy drafting chance	
	(6) Hose - 1" or live reel	
	b. From the pump and tip lists, what appears to be suitable for this situation?	
	(1) Either the CEDCO or EDWARDS slip-on pumps	
	(2) The #9, #12, or #15 spray tips	
	(3) Backpacks might be utilized in addition	
	3. Large area, long perimeter mopup	DISCUSS & LIST
	a. Equipment needs	
	(1) Pump capacity - high volume for supply	
	(2) Nozzle capacity - low volume	

TIME	LESSON OUTLINE	AID CUES
	(3) Stream reach - not important (4) Stream type - spray preferable (5) Supply - large tank, nurse tankers, pump chance handy, relay tanks (6) Hose - 1-1/2" b. From the pump and tip lists, what appears to be suitable for this situation:	
	(1) First choice would be the Model 60 tanker; but any of the three tankers and/or combination of the two portables would be suitable.	Why not the slip-ons? (Capacity - small)
	(2) The low volume spray tips. C. <u>Situation Conclusions and Discussions</u> As fire intensity decreased, the need for high volume application also decreased. As high volume need decreased, the need for a large water supply also decreased. Likewise, the less volume needed, the smaller the nozzle capacity needed. The need for straight stream capability diminished as fire intensity diminished. In the mopup situation, application needs were low, but pump capacities needed were high to supply initial hose lay and laterals to cover large area. D. <u>Other Water Application Accessories</u> In addition to the stream and spray tips just discussed, there are other	

TIME	LESSON OUTLINE	AID CUES
	items that should be considered. 1. Adjustable nozzles - these vary by shape and weight as well as delivery capabilities. Usually, they can be adjusted for both spray and straight streams, and are made for various volume capabilities. Some can be adjusted for both volume and stream type. Volumes may range from as low as 3 gpm to 54 gpm. One nozzle might be used to do the work of a variety of interchangeable tips. 2. Combination nozzles - usually have one straight stream and one spray tip. Some have various size tips to choose from, ranging from 3 gpm to over 40 gpm capacity. 3. Applicator pipe or mopup wand - a low volume (3 gpm) water applicator that can reach into piled fuels and also hydraulically bore into dirt, peat and duff. 4. High volume nozzles - 1/2", 5/8", 3/4", 7/8", and 1", and larger nozzles are available. By using the rule of thumb that doubling nozzle size gives approximately four times the gpm flow, you can see from the tip chart that if a 5/16" tip that puts out over 25 gpm was to be replaced by a 5/8" tip, a flow in the vicinity of 100 gpm could be expected. Flows over 100 gpm could theoretically be expected with an even larger tip, but if we stick with our rough guide that 1-1/2" lines are limited to practical flows not exceed much over 100 gpm, then any further discussion is academic. (Structural fire companies using larger hose can and do use larger nozzles.)	III D-2 & D-3 What are obvious disadvantages (exhaust limited supply)

TIME	LESSON OUTLINE	AID CUES
	5. Larger hose, 2-1/2", 3" - probably not available for most forestry units, but likely available when working with volunteer fire companies or other cooperating municipal mobile units. A factor of 4 times the flow can be used when comparing 2-1/2" and 1-1/2" capacities. When available, this would make excellent supply lines for long hose lays or for filling tankers.	Why not? (Weight) (High volume)
	E. Equipping the Tanker:	
	1. First consideration - to be able to successfully attack the type of fires most likely to occur.	
	a. Large, hot fires usually demand high volume equipment.	
	b. Small fires usually can be held with low volume equipment.	
	2. Second consideration - to be able to efficiently mopup the fires most likely to occur.	
	a. Low volume equipment usually best as it's most efficient for using small amounts of water.	
	b. High volume equipment more likely to be wasteful of water.	
	3. Other considerations - to be able to act as nurse tanker, to act as supply pump for hose lays for both suppression and mopup.	
	4. Modifying equipment and practices - Let's assume that we have a CEDCO HPZZ slip-on unit and a Model 60 PTO tanker. The CEDCO is equipped to handle small fires, and the	

TIME	LESSON OUTLINE	AID CUES
	Model 60 tanker for hot fires. What type of equipment or practices should we use so the small unit can work on large fires and the large unit work on small fires as needed?	
	a. CEDCO HPZZ Slip-on:	LIST AND DISCUSS
	1. Large hose, 1-1/2", for maximum flow. There's less friction loss in the large hose.	
	2. Larger tips or variable nozzles with capacities up to 30 gpm. (This unit can take any of the spray tips on the provided list.)	
	3. Operate at pressure for maximum volume.	
	(Note: We still must remember the obvious limitations of this "small" pumper and its usual initial water supply.)	
	b. Model 60 PTO Tanker -	
	1. Small tips and variable nozzles with low volumes. Spray tips as low as 2 gpm can be used.	
	2. Use live reel instead of 1-1/2" hose.	
	3. Operate at low volume pump pressures.	
	F. Exercises:	
	1. Low volume test:	
	a. Set up a test area by marking a 100 foot long by 2 foot wide	

TIME	LESSON OUTLINE	AID CUES
	strip on one side of a gravel road, in a warehouse parking area, or on some similar site. Plastic flagging, spray paint, or scraping lines in the gravel can be used.	
	b. Simulate extinguishing a creeping fire by wetting the 100' x 2' strip with a backpack pump can.	
	c. Record the time needed to cover the strip and the amount of water used.	
	2. Medium volume test:	
	a. Repeat the 100' test, using a small slip-on pumper and whatever nozzles you have in a rolling attack.	
	b. Record time and water amounts used.	
	3. High volume test:	
	a. Repeat the rolling test, using a high volume pumper and available nozzles.	
	b. Compare the lowest and highest volume tips for time, amount and apparent efficiency.	
	4. Variations:	
	a. Repeat tests 1-3, using wider and/or longer test strips.	
	b. Do the tests, using actual fire in grass, brush or duff fuels.	
	c. Compare use of wetting agents in live fire tests.	

TIME	LESSON OUTLINE	AID CUES
	5. Discussion and Conclusions: These tests show only the potential speed and efficiency under simulated conditions. They do give an indicator of what might be expected of certain equipment in actual use as to speed of water application and amounts used. III. SUMMARY There are many combinations of pumps, hoses and nozzles in use on tankers, or available to equip them. Different fire situations demand different combinations. The best tanker combination is the one rigged to combat the most likely fire situation, plus being able to take advantage of accessories and capabilities to do a reasonable job in a variety of situations.	

TRAINING AIDS AND REFERENCES

1. Water Handling Equipment Guide

Text - Forest Service, USDA
CENTRAL SUPPLY
South Building
12th & Independence Av., SW
Washington, D. C. 20250

2. Water vs Fire

Text - Forest Service, USDA
NA-S&PF
6816 Market Street
Upper Darby, Pennsylvania 19082

3. Instructor's Guide for Standard Types of Pumping Equipment

Text - U. S. Department of Agriculture
Forest Service - California Region
630 Sansome Street
San Francisco, California 94111

4. Pumping and Delivering Water to Fire

Text - Dept. of Land, Forest and Water Resources
British Columbia
Victoria, B. C.

5. Portable and Manual Fire Control Equipment

Text - National Fire Protection Association
470 Atlantic Avenue
Boston, Massachusetts 02210

6. Basic Forest Firefighting Training

Text - California Division of Forestry
1416 Ninth Street
Sacramento, California 95814

7. Effective Wetting Agents for Forest Fire Fighting

Text - Southern Forest Fire Laboratory
P.O. Box 5106
Macon, Georgia 31202

8. Ojai Progressive Hose Lay

Text - National Fire Training Center
Marana Air Park
Marana, Arizona 85238

9. Cleveland Packboard System

Text - National Fire Training Center
Marana Air Park
Marana, Arizona 85238

10. Hose Box Pack

Text - National Fire Training Center
Marana Air Park
Marana, Arizona 85238

11. Performance Test on Mark 26 Centrifugal Pump

Text - Forest Fire Research Institute
Canadian Forestry Service
Dept. of Fisheries & Forestry
Ottawa, Ontario
Canada

12. Basic Hydraulics

Text - State Division of Forestry
1416 Ninth Street
Sacramento, California 95814

13. Performance Test on Gorman-Rupp Backpack Portable Pump

Text - Forest Fire Research Institute
Canadian Forestry Service
Ottawa, Ontario
Canada

14. Water Delivery Equipment

Text - Dept. of Natural Resource & Conservation
Division of Forestry
Missoula, Montana 59801

15. Operating Fire Department Pumper

Text - U. S. Forest Service
Marana Air Park
Marana, Arizona 85238

16. <u>WGC-4 Pump and Maintenance</u>

Slide/Tape - Montana State Forester
Missoula, Montana 59801

17. <u>Mark 3 Mark 26 Pump Operation & Maintenance</u>

Slide/Tape - Montana State Forestry
Missoula, Montana 59801

18. <u>Ojai Progressive Hose Lays</u>

Slide/Tape - U. S. Forest Service
Marana Air Park
Marana, Arizona 85238

19. <u>Water vs Fire</u>

Film - Regional Offices

20. <u>Water on Fire</u>

Film - Boise Interagency Fire Center
3905 Vista Avenue
Boise, Idaho 83705

21. <u>Ground Equipment Hose Lay</u>

Film - U. S. Forest Service Regional Offices

22. <u>Nozzle Discharge & Friction Loss Calculation</u>

Slide Rule - Pacific Pumpers, Inc.
227 Andover Park E.
Box 88540, Tukwila Br.
Seattle, Washington 98188

CLEVELAND PACKBOARD SYSTEM

Necessary Items

1. 1 Packboard - dimensions 24" long x 18" wide
   Straps - 2 approximately 42" long each x 1½" wide
   (old 1" CJRL can be supplemented)
   4 Eye bolts with hex nuts - size ¼" x 3" (2" shank)
   3 1¼" bolts with hex nuts

   NOTE: ¼" center x 1" diameter washers to be used with both eye bolts and regular bolts (1¼"). Larger washers can be used to secure straps to packboard if tearing becomes a problem.

2. 100' of 1" CJRL lightweight hose

3. 100' of 1½" CJRL lightweight hose

4. 1 Gated Y 1½" N.S.

5. 1 Reducer 1½" N.S. to 1" P.I.P. (to be attached to gated Y, left side)

6. 1 R-5 Forester nozzle

7. 6 Thin rubber bands - approximately ½" wide (use a cross-section of a truck tire inner tube)

Fig. 1

Packing Procedures

Step #1

Connect both 1½" and 1" CJRL to Gated Y; place Y on packboard and stretch out hose parallel to each other.

NOTE: Gated Y should be turned upside down with valve handles closed and placed on packboard with the handles being on the bottom side of board and main body on top.

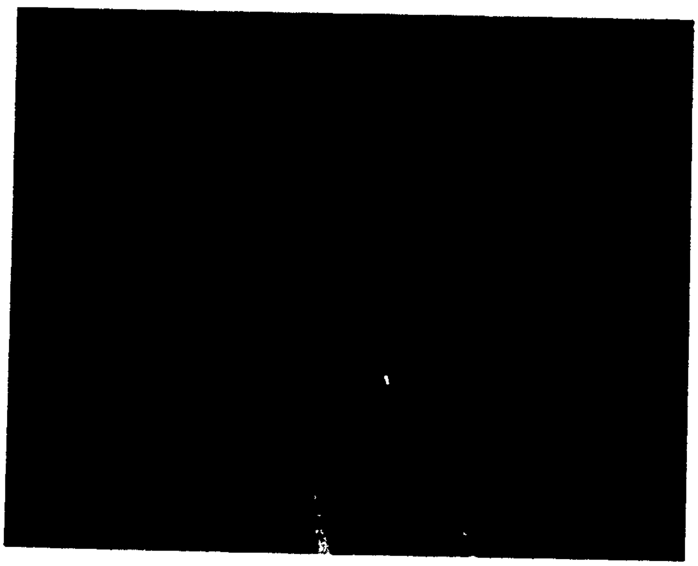


Fig. 2

Step #2

Pick up nozzle, walk back with it, and place it at the bottom of the right side of packboard. Keep hose parallel.

Tie nozzle and 1½" hose together - use flagging, etc.

Fig. 3

Step #3

Begin to more or less horseshoe both 1½" hose and 1" hose onto packboard.

NOTE: Keep the outer side of the 1" hose outside of the eye bolts in the first layer (do not band). Reason: Nozzle will fall to hip when stretched out, creating less damage to nozzle.

Band hose to packboard.

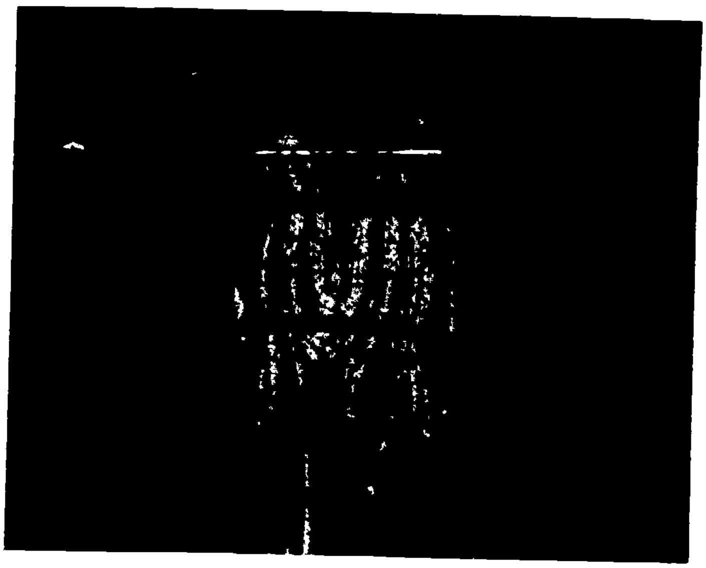


Fig. 4

Step #4

On the second layer, be sure to place hose just below the bolts in the gated Y to prevent the hose from hanging up. Horseshoe this layer on, and band.

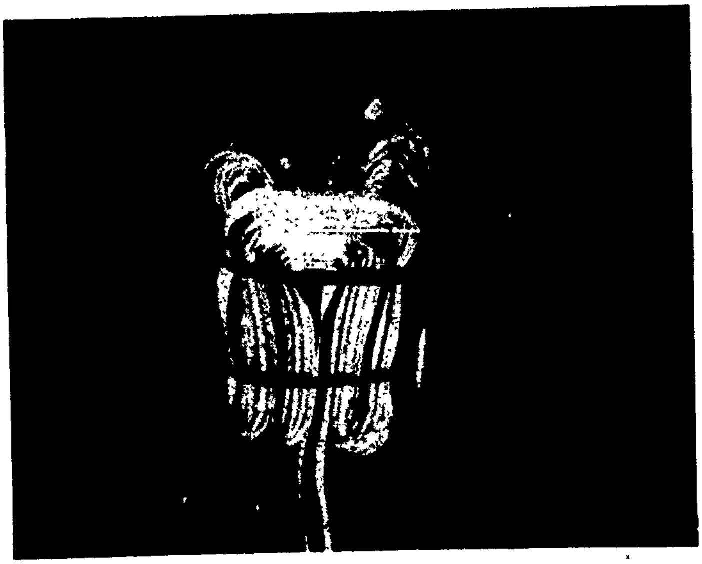


Fig. 5

Step #5

Get most of the $1\frac{1}{2}$" and 1" CJRL on the bottom two layers with only the outer edge at the top row being both $1\frac{1}{2}$" and 1" hose - the inner part of the layer should be all $1\frac{1}{2}$" CJRL on 3rd layer.

NOTE: When you get to the end of the 1" hose, tie it securely to the $1\frac{1}{2}$" hose with a rubber band - it keeps your hose coming out straight and parallel. If the band doesn't break under pressure, it will with a quick tug.

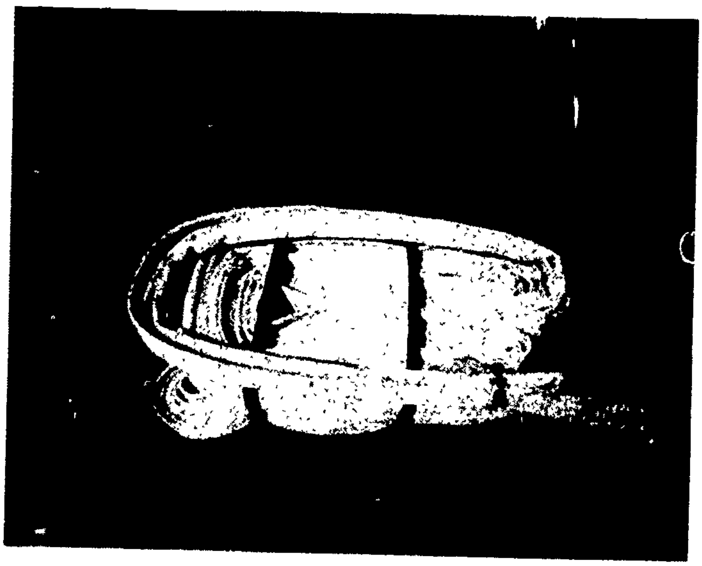


Fig. 6

Finished Product: Figs. 7&8

CLEVELAND PACKBOARD SYSTEM

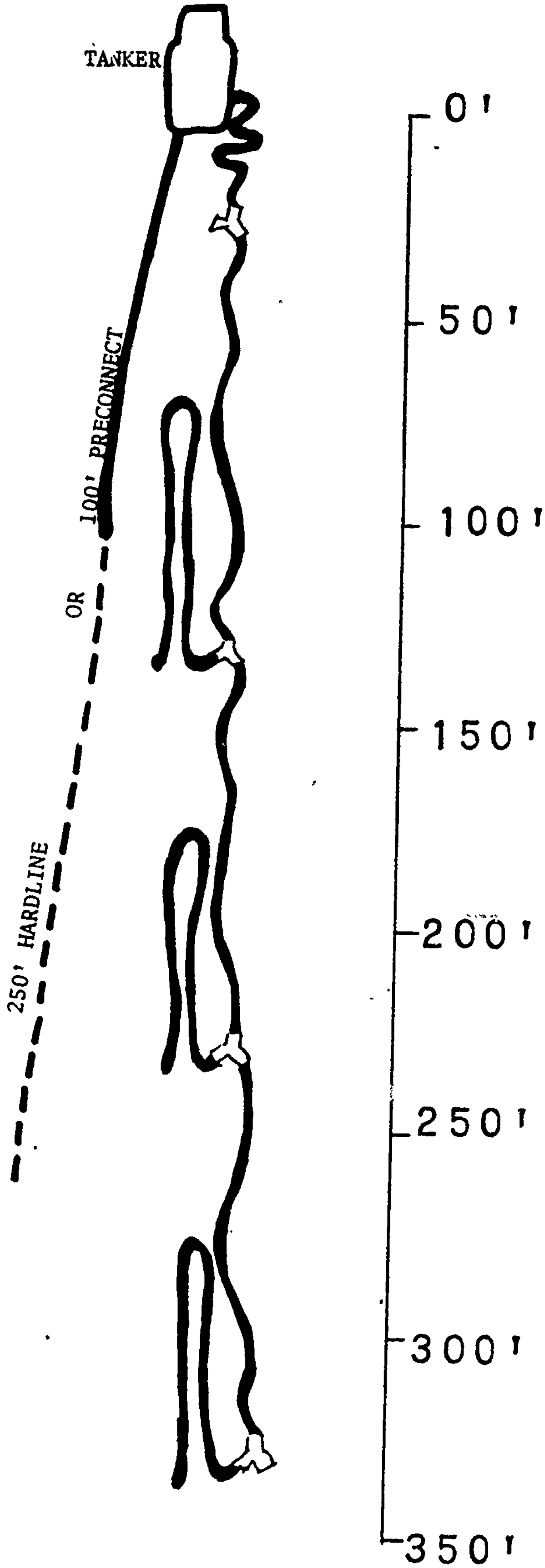
Finished Product

Fig. 7

Fig. 8

139

A PLAN FOR INITIAL ATTACK



#1 MAN-HELPS FOREMAN PULL HOSE

#2 MAN-CHOCK BLOCK, 1st PACKBOARD, SPANNER, HOSE CLAMP

#3 MAN-FILLER PIPE, SPANNER, HOSE CLAMP, SHOVEL, 2nd PACKBOARD

#4 MAN-3rd PACKBOARD

PACKBOARDS WITH 100' OF 1½" AND 100' OF 1" WITH NOZZLES ARE USED

FOREMAN ALWAYS HAS LEAD NOZZLE

THE #1 MAN HELPS PULL HOSE FOR FOREMAN

THE #3 MAN CARRIES A TOOL WITH EACH TRIP UP THE LINE

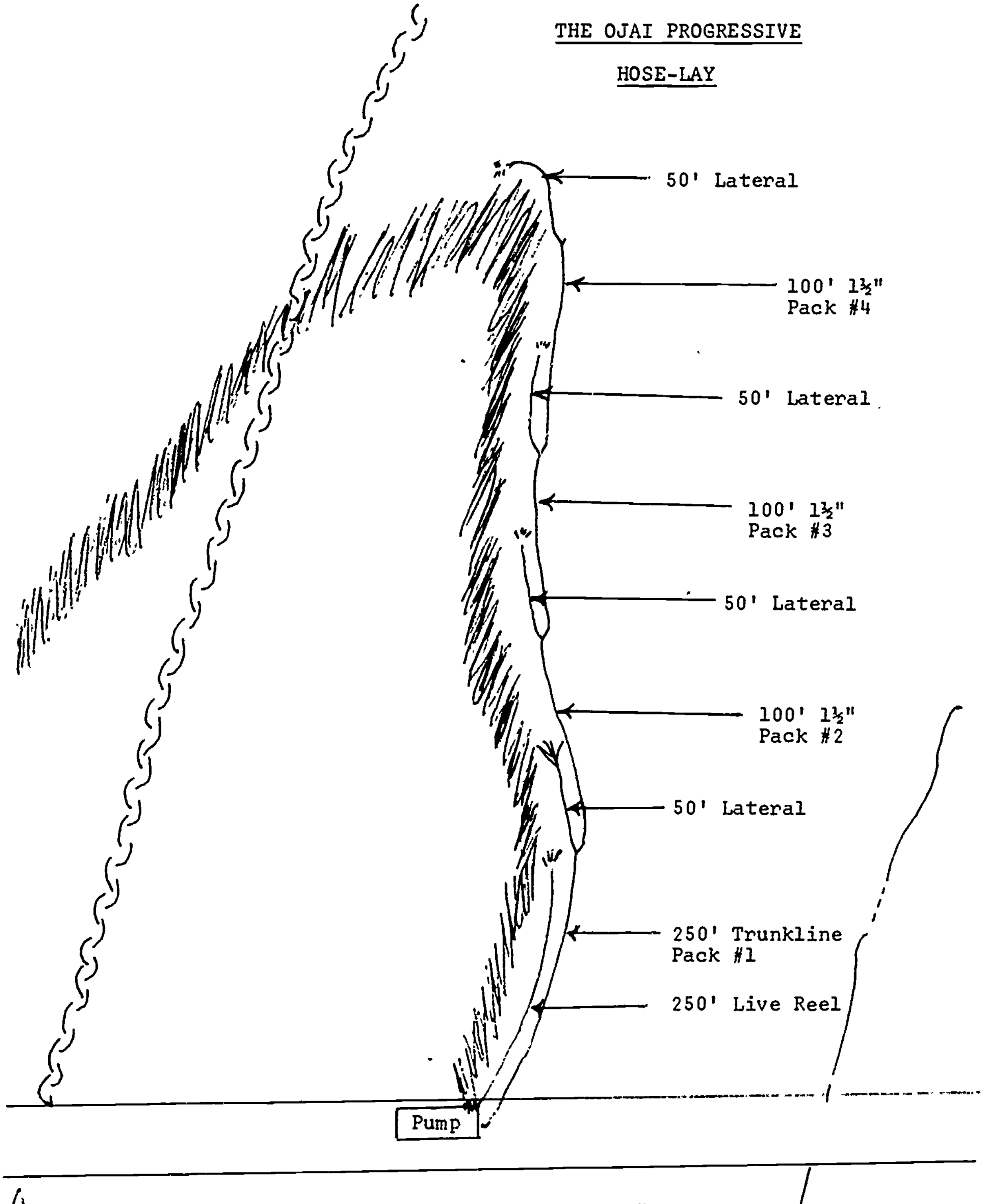
CREWMEN USE NOZZLES IF NECESSARY ON TRIPS BACK TO TRUCK

OJAI PROGRESSIVE HOSE-LAY

OBJECTIVE: To enable the tanker crew to perform the Ojai Progressive Hose-Lay in the shortest time with maximum efficiency. Standards set by four-man suppression crews are from two to four minutes for four hose packs.

INTRODUCTION: The main objective of a Forest Service tanker crew is to stop a wildfire in their initial attack area. The tanker equipment should be used to its utmost capacity. The most effective extinguishing agent available to a tanker crew is water. The "Ojai Progressive Hose-Lay" is a method which has many advantages in the transporting of water from tanker to fire. These advantages have been proven by drills and by its use in initial attack situations. Some of the outstanding advantages are: less time required for training in use of hose-lay; fewer couplings; fewer wasted movements; less time to extend; compactness of hose and fittings; hose carrying procedure allows for free use of hands and ability to carry extra equipment to fire line if needed; no extra equipment for hose-lay with which to be concerned; ability to charge packs without extending hose in order to have more water power when needed.

THE OJAI PROGRESSIVE HOSE-LAY



APPLICATION

(A) Foreman or TTO

(C-1) Crewman #1

(C-2) Crewman #2

(C-3) Crewman #3

OPERATION	KEY POINT
1. A places tanker for operation	Hose bed toward lay
2. C-1 extends live reel to full extent	Good anchor point; good heel control
3. C-2, with pack #1 on back, starts walking	
4. C-3 follows 50' behind with pack #2	50' drag is tight
5. Trunk line extended, C-2 drops pack and pulls tie-cord	Nozzle and siamese point in direction of hose-lay
6. C-2 then extends hose with nozzle and siamese	Scatter top layer of 1" hose
7. A charges trunk line when line is extended to 1st siamese	
8. C-3, with 50' drag tight, follows	
9. C-2 meets C-1 with live reel, gets o.k. to proceed	C-1 cools fire ahead for C-2
10. C-1 charges C-2's trunkline and C-3's trunkline when signaled by C-2 and C-3	
11. C-3 follows until 50' drag is extended	
12. C-3 then drops pack #2, pulls tie-cord, extends hose with nozzle and siamese	When meeting C-2 with lateral, C-3 waits for water coverage and o.k. to proceed

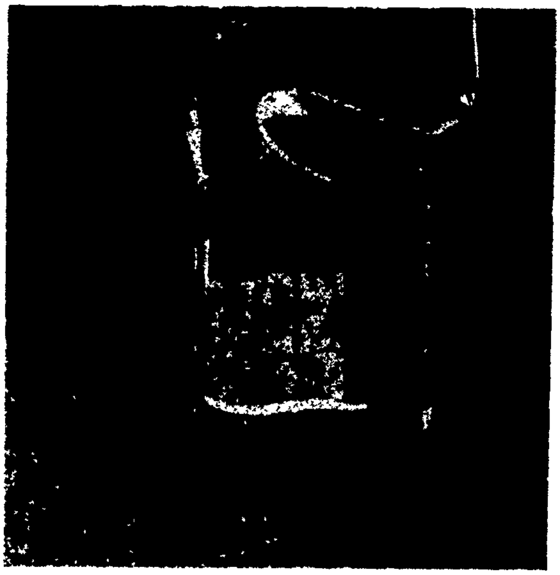
(APPLICATION - continued)

OPERATION

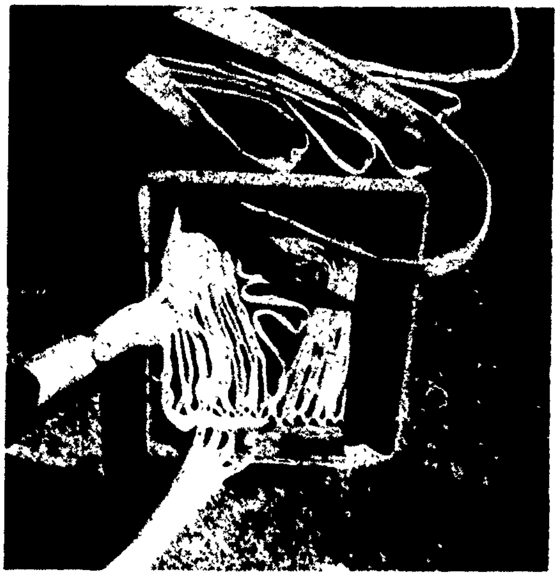
13. C-3 then fully extends his hose (If necessary, additional hose-packs may be added at this point, and hose-lay extended as needed... C-1, C-2, etc.)

The Ojai Progressive Hose-Pack slips onto the crewman's back, with no extra equipment necessary, and leaves both hands free. Utilizing a light-weight siamese and Dacron hose, the pack weighs thirty-five pounds. When CJRL hose and a regular siamese are used, the pack weighs approximately fifty pounds. The weight of the pack is evenly distributed on the crewman's back.

Due to pack construction, hose may be charged immediately after the tie-cords have been pulled. This permits the crewman to have water at the nozzle at any time during extention of the hose. This safety factor is not characteristic of previous types of hose-lays.

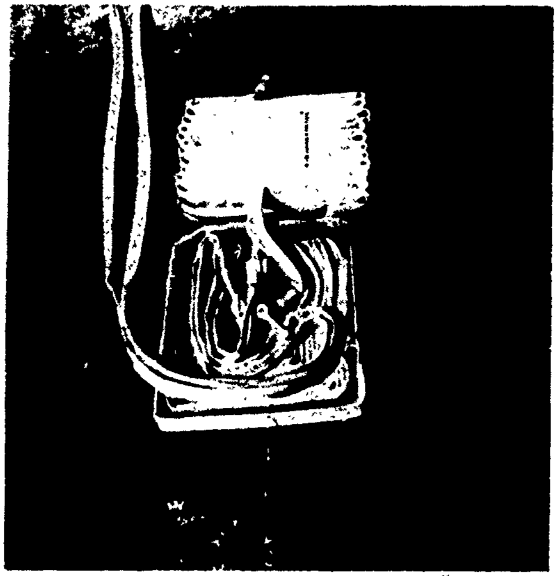


Pictured above is the first step in assembling Pack #1. Note how the bungies, or tie-cords, are laid over and under hose, allowing for arm straps. Tie-cords at the top and on the side near the female coupling go outside the hose. The other three sides go inside the hose on the first loop of the first layer. Hose is now ready to be folded correctly into the box.

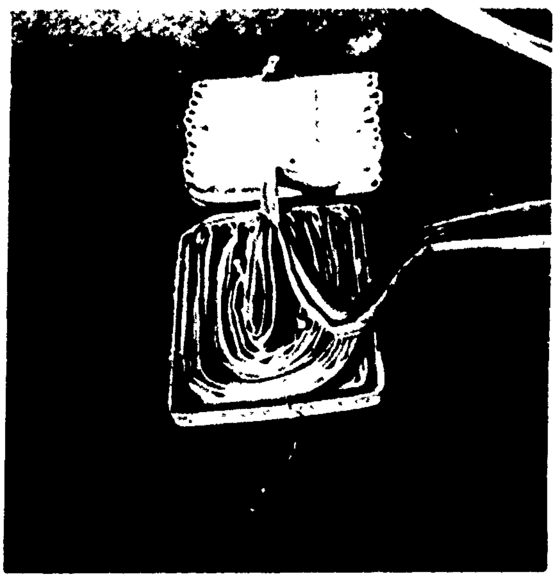


First layer of 1½" is completed. Note here method of transferring hose neatly to start second layer of 1½".

Second layer is now completed, with siamese connected and in place between coiled hose. Note that on the siamese the gate with the reducer adapter for the 1" line is open, and the other gate is closed. The reason for this will become apparent later. (Hint: As each layer is completed, adjust tie-cords.)

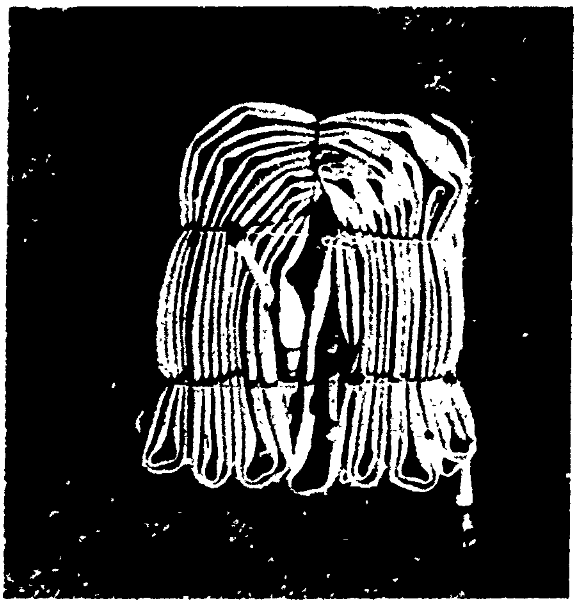


The 50' drag and 100' lateral are attached to the siamese. Note that the R--5 nozzle is positioned between the gate valves. The 1" lateral should be free of twists, and is horse-shoed around the siamese in doubled fashion as shown. (Hint: Hose should be fully collapsed to prevent ballooning and therefore achieve maximum compactness.)



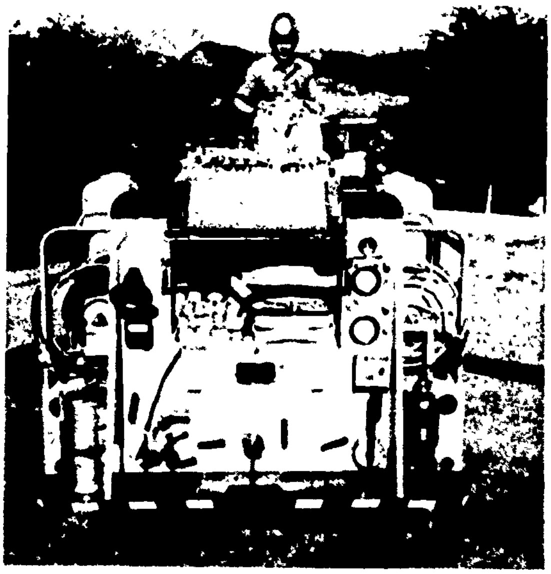
Here we have the first layer of 1" completed and are beginning the second layer. Note the 1" is coming from the side to the top center.

Pack #1 is completed. Tie-cords are tied in quick-release knots, with the loose ends tied together. The 50' drag is attached, and is now ready to be connected to Pack #2 and placed on the truck.

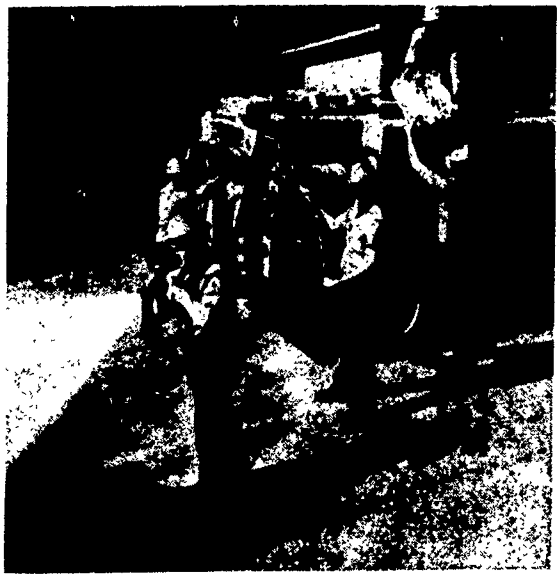


Pack #2 and all other packs are different from Pack #1 in that they contain only 50 feet of 1" lateral, thus having only one layer of 1" hose.

Pictured above is the complete trunkline with laterals that are pre-connected. When fully extended, the distance covered is 450 feet. Packs #3, #4, etc., are connected to the end of the existing hose-lay by one coupling per pack. Each pack extends trunkline 100 feet.



Initial hose-lay and additional packs may be stored on tanker where convenient.



Tanker is positioned. Crewman #1 establishes anchor point and extends live-reel, utilizing as much of it as possible.

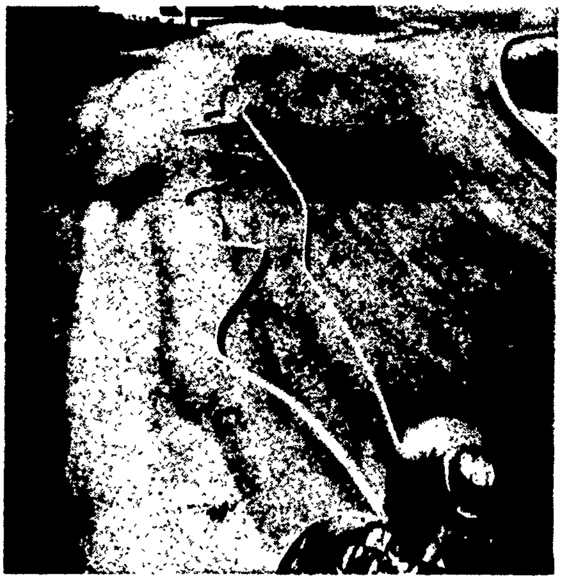
Crewman #2 with Pack #1 on his back extends the trunk line 50 feet.

Crewman #3 with Pack #2

Crewman #3 puts on second pack and stays 50 feet behind Crewman #2 until the first pack is fully extended. This prevents the 50 foot drag line from snagging brush, etc.

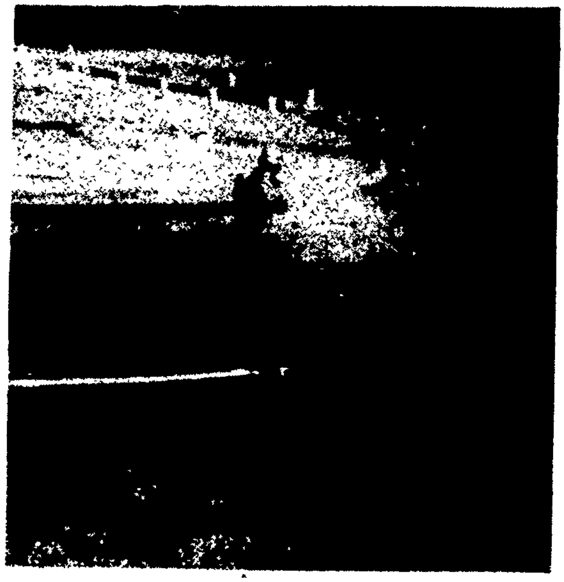
When trunk line is fully extended, crewman #2 drops the first pack and pulls the tie-cords. He then scatters the top layer of 1" lateral, and continues on with siamese and nozzle in hand.

When first pack is extended, crewman #2 signals for water and extends lateral along the fire's edge, being sure to anchor wet line with live reel's wet line.



With the 50 foot drag line fully extended, Crewman #3 drops pack #2 and continues on.

When Crewman #3 reaches crewman #2 who has first lateral, Crewman #2 signals him when it is o.k. to extend further.



When Crewman #3 has fully extended his pack, he signals Crewman #1, who is at the first siamese, to charge the line.

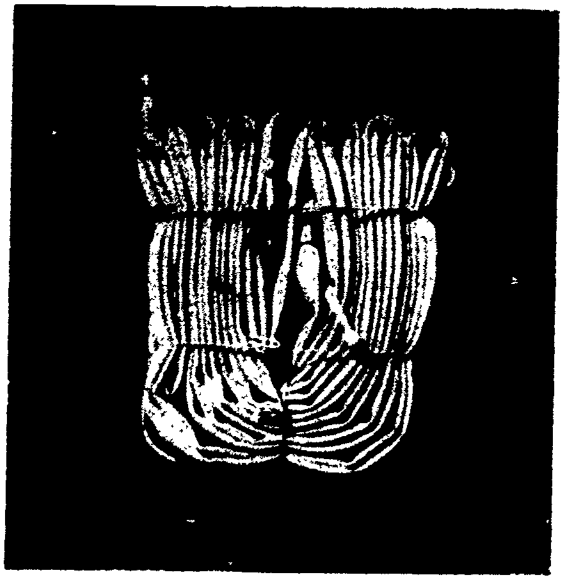
Pack #3 is coupled to the siamese and extended. For more length, additional packs may be brought up by crew members who have completed initial assignments.

SUMMARY

In review, the objective of this program is to enable the tanker crew to perform the "Ojai Progressive Hose Lay" in the shortest possible time with maximum efficiency.

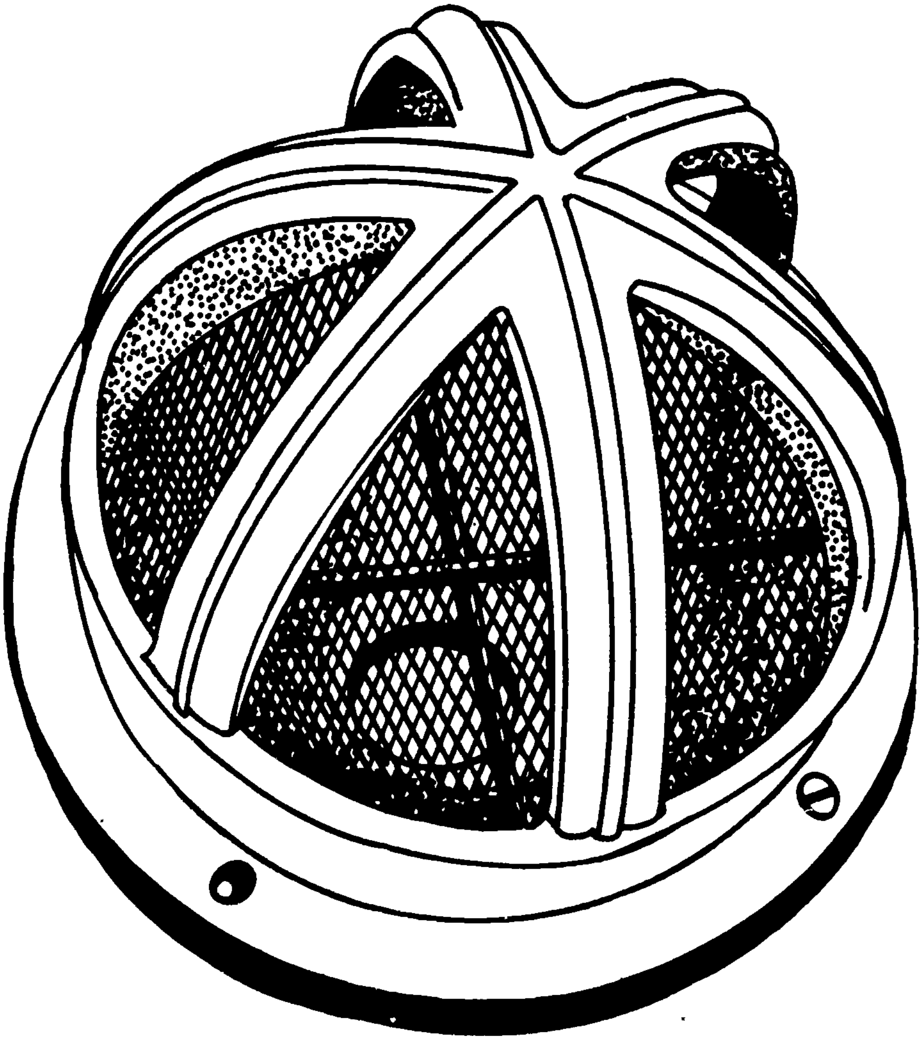
It is important while training that those who desire to meet this objective use this program as a reference while actually performing the methods discussed.

Fifty foot laterals are used in this hose lay because it was discovered that this length is more effective and easier to handle in situations where the fuel bed is predominantly Fuel Type 13. However, one hundred foot laterals may be more suitable in your situation.

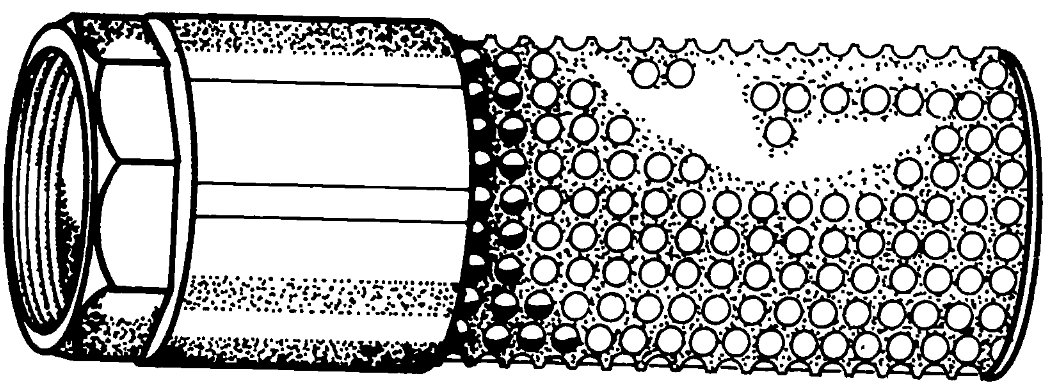


Video tape available from Marana Training Center.

IA-1



IA-2



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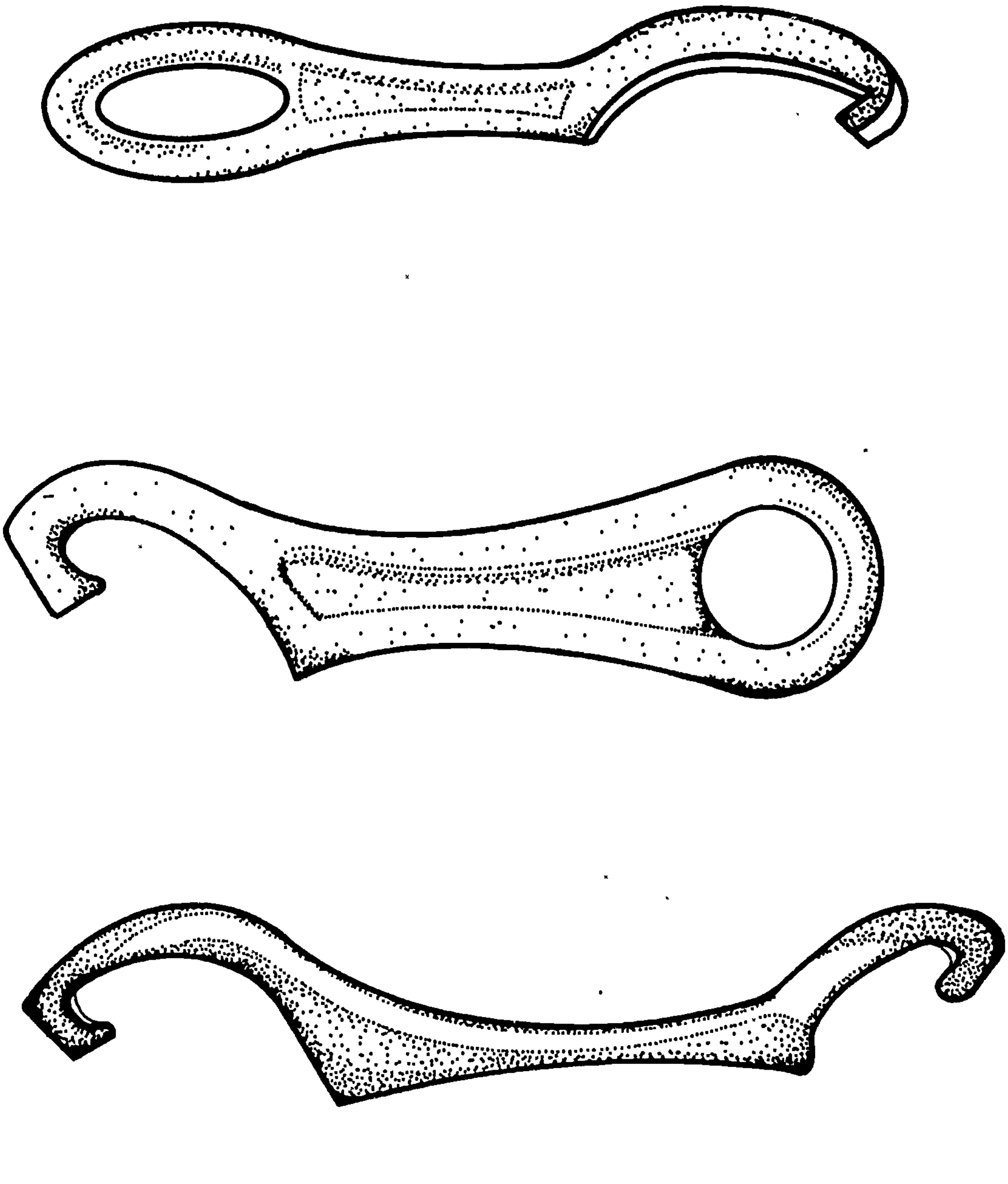
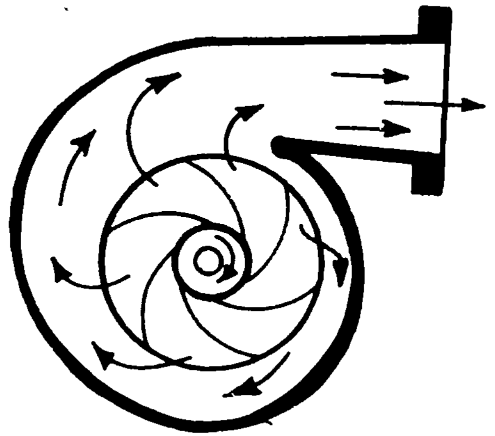
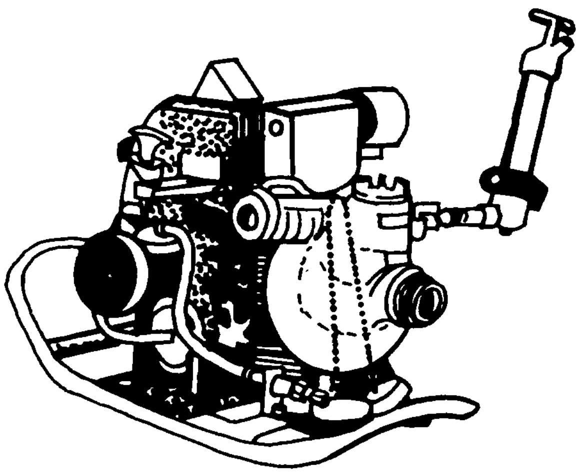
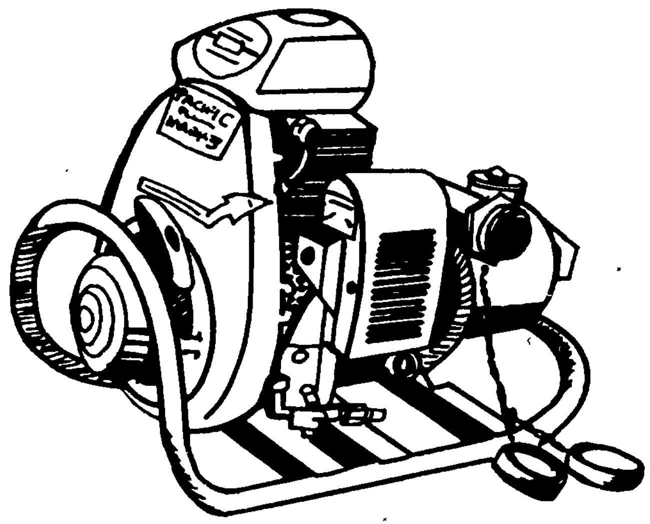


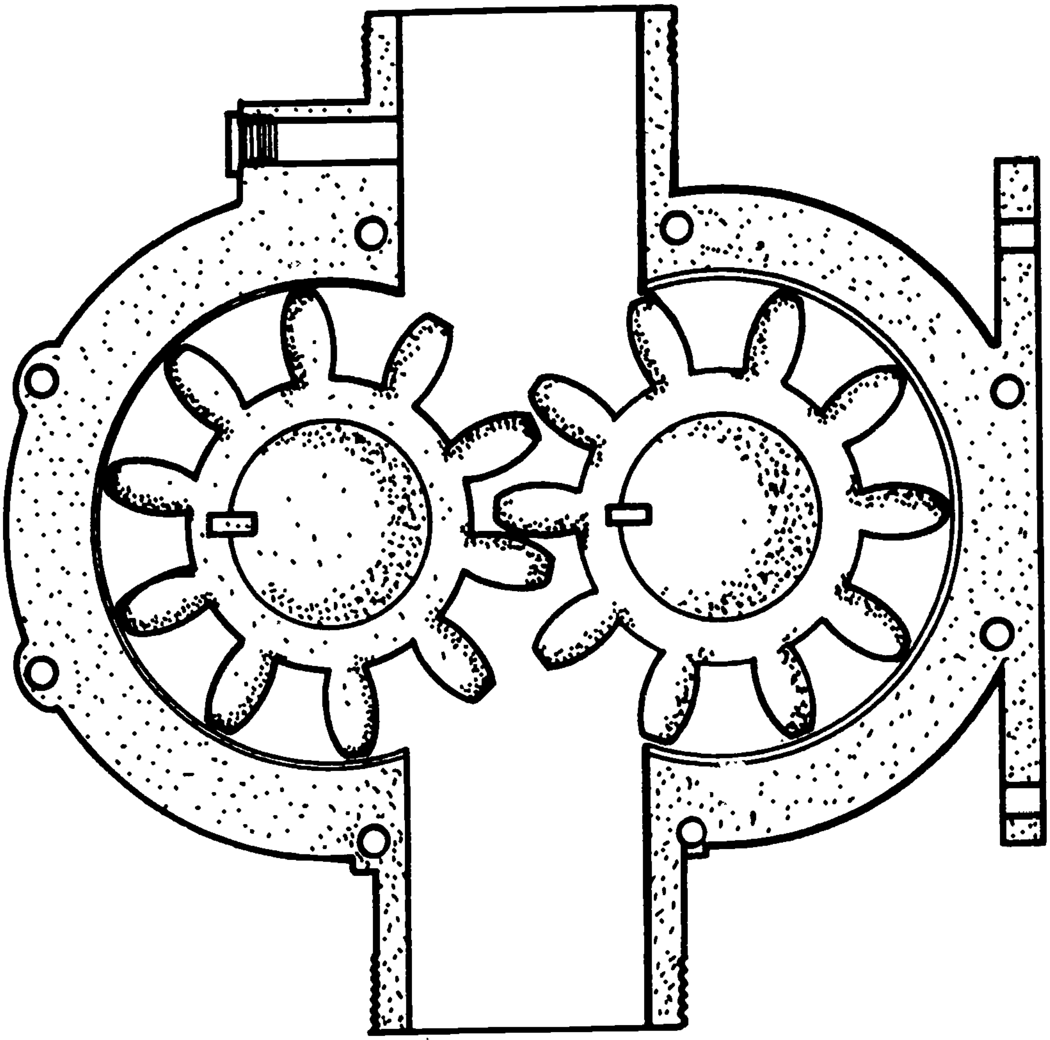


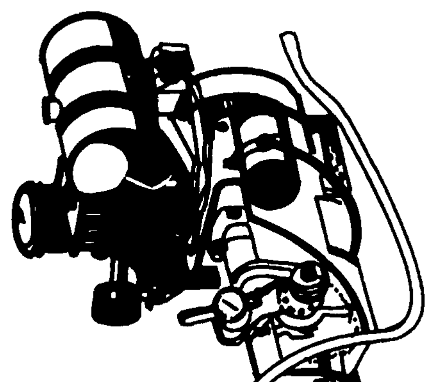




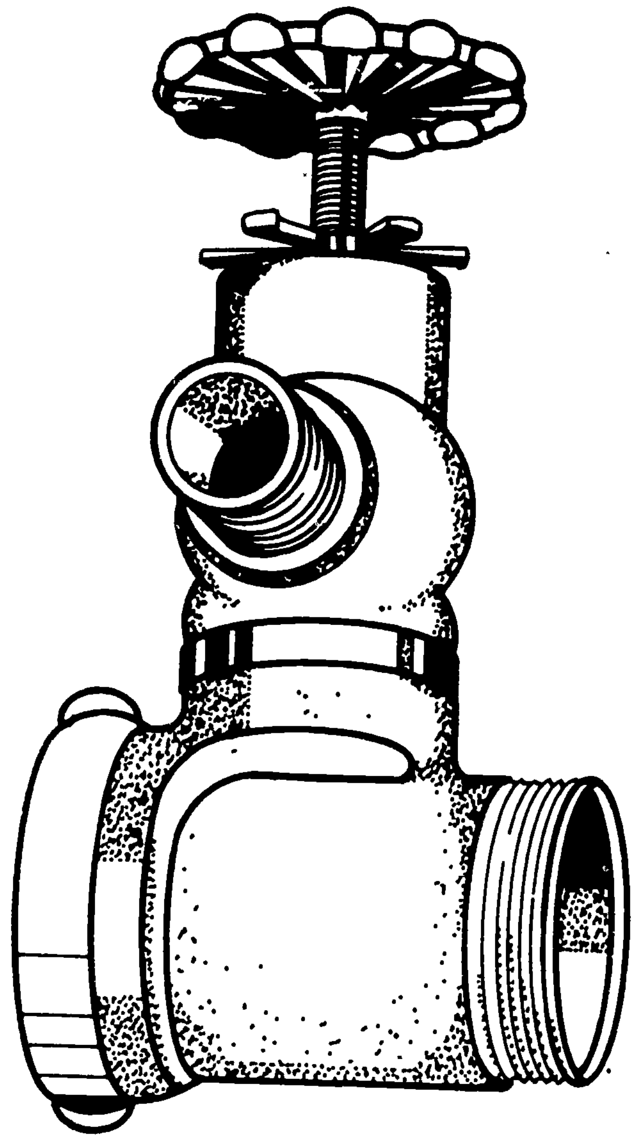
IA-4

IA-5

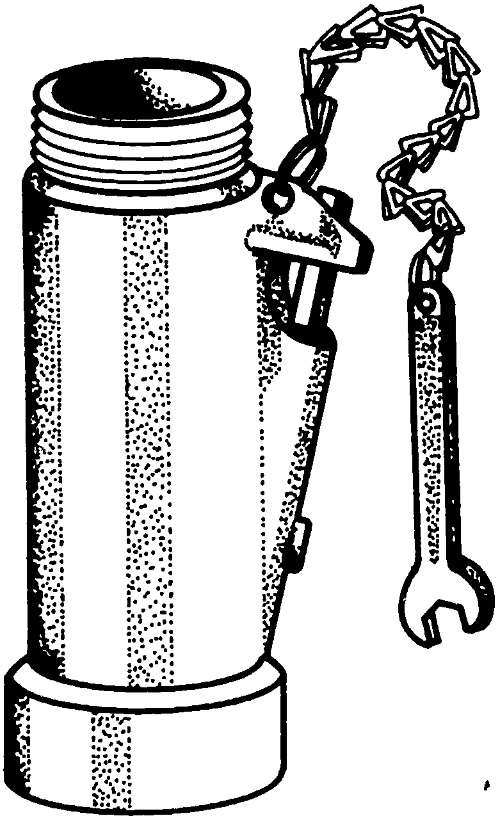


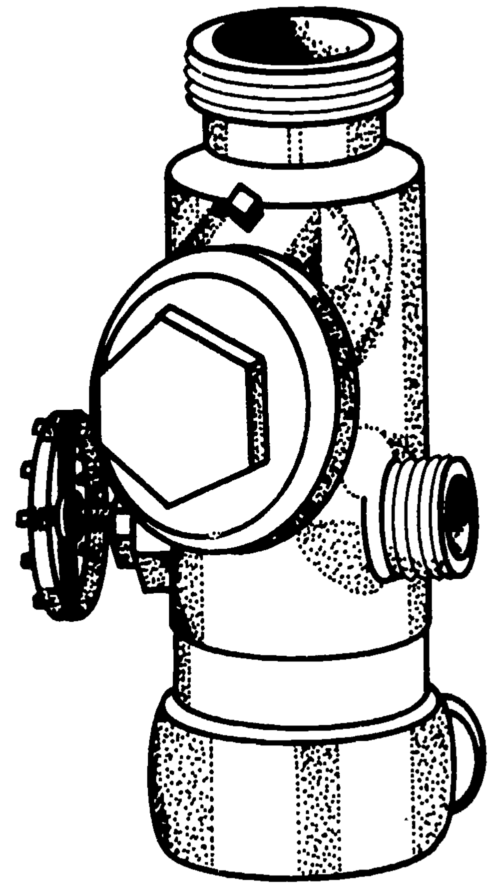


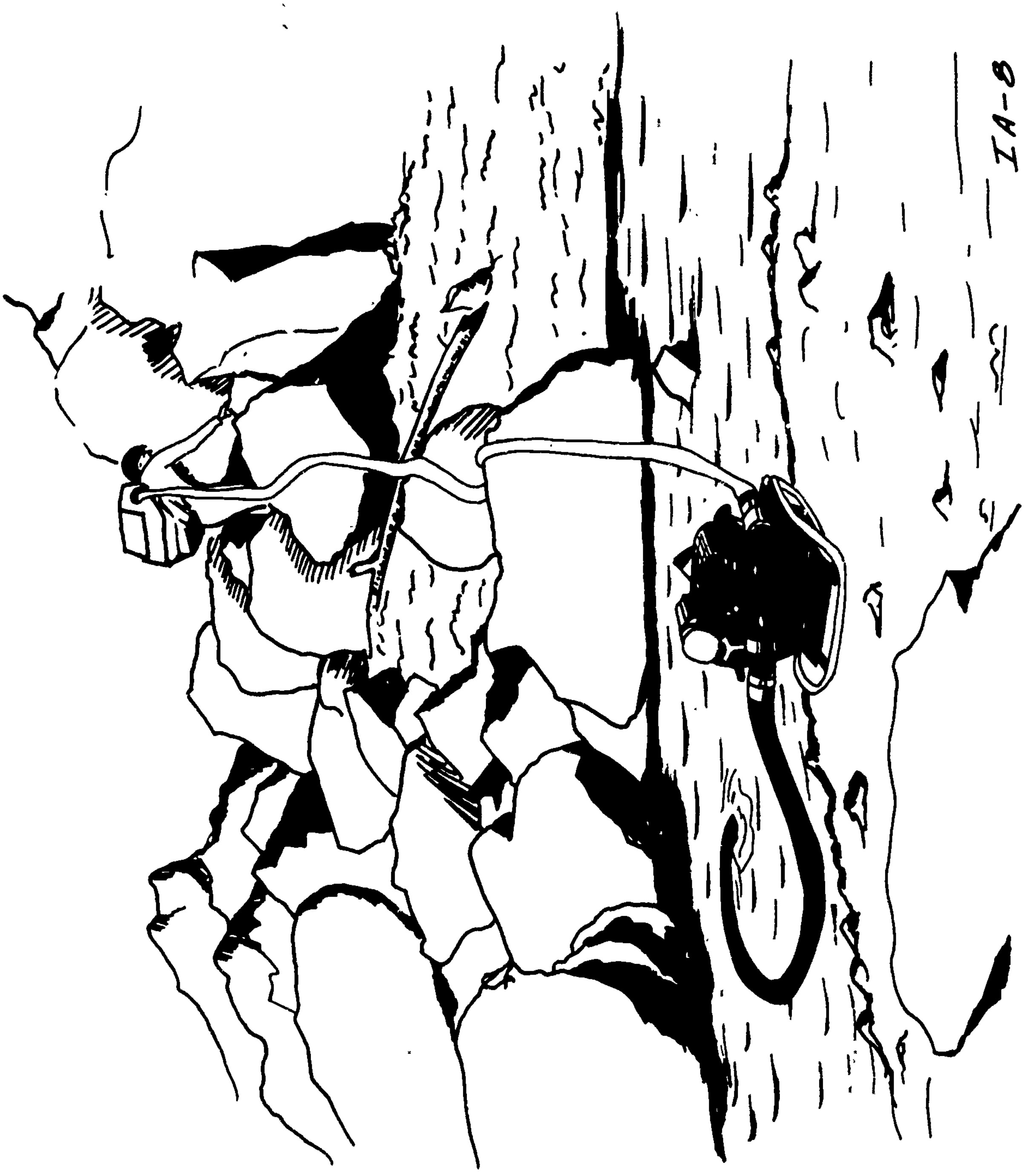
IA-6



IA-7

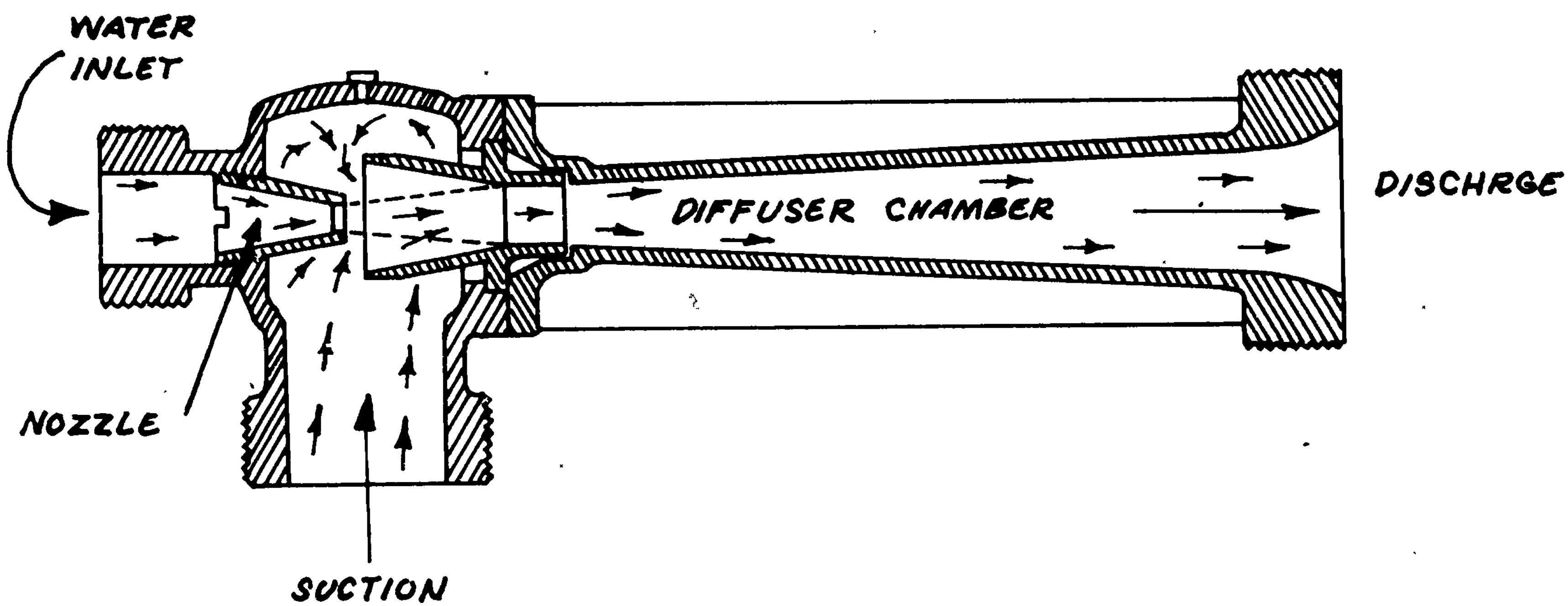




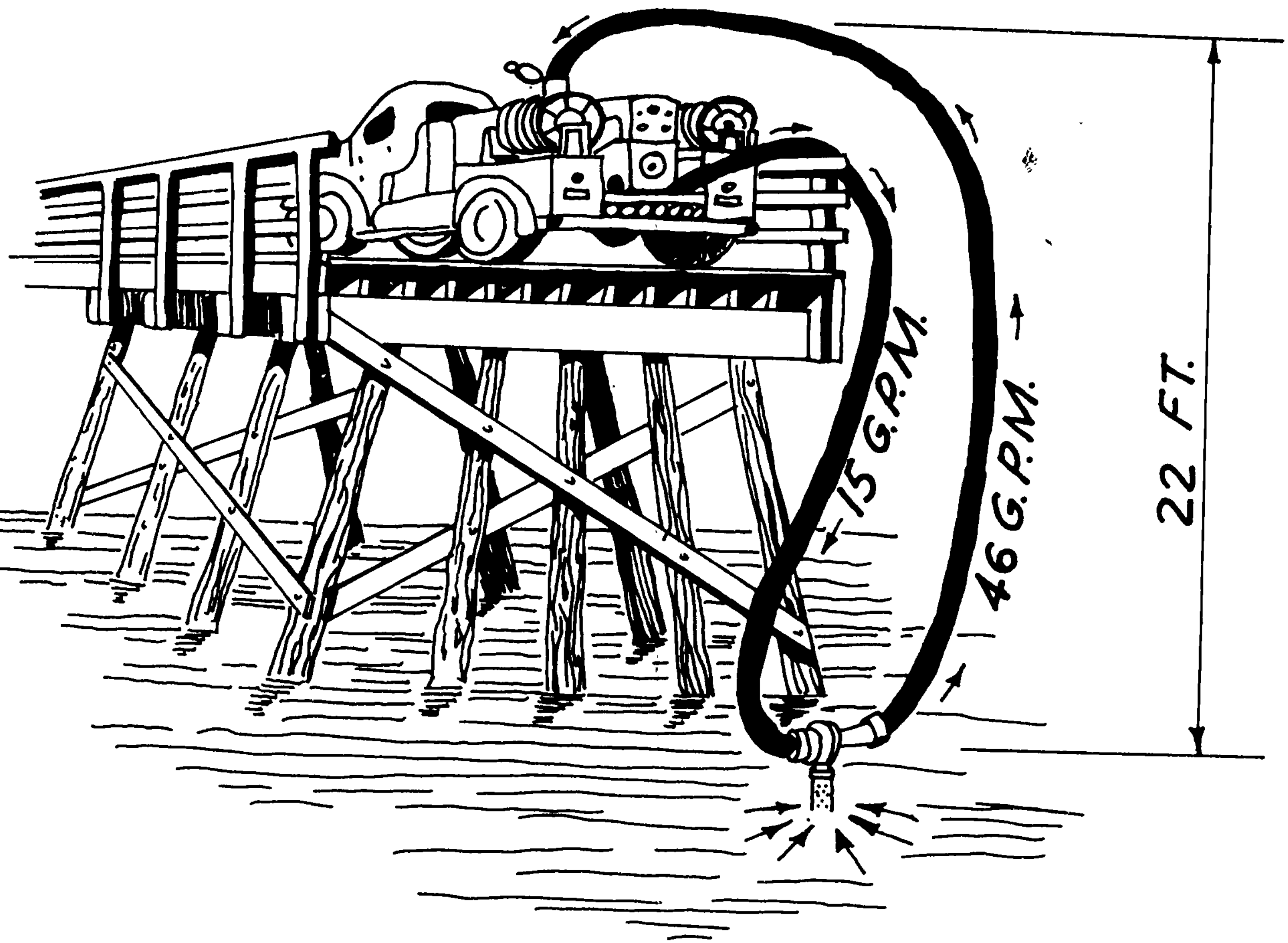


IA-8

WATER EJECTOR

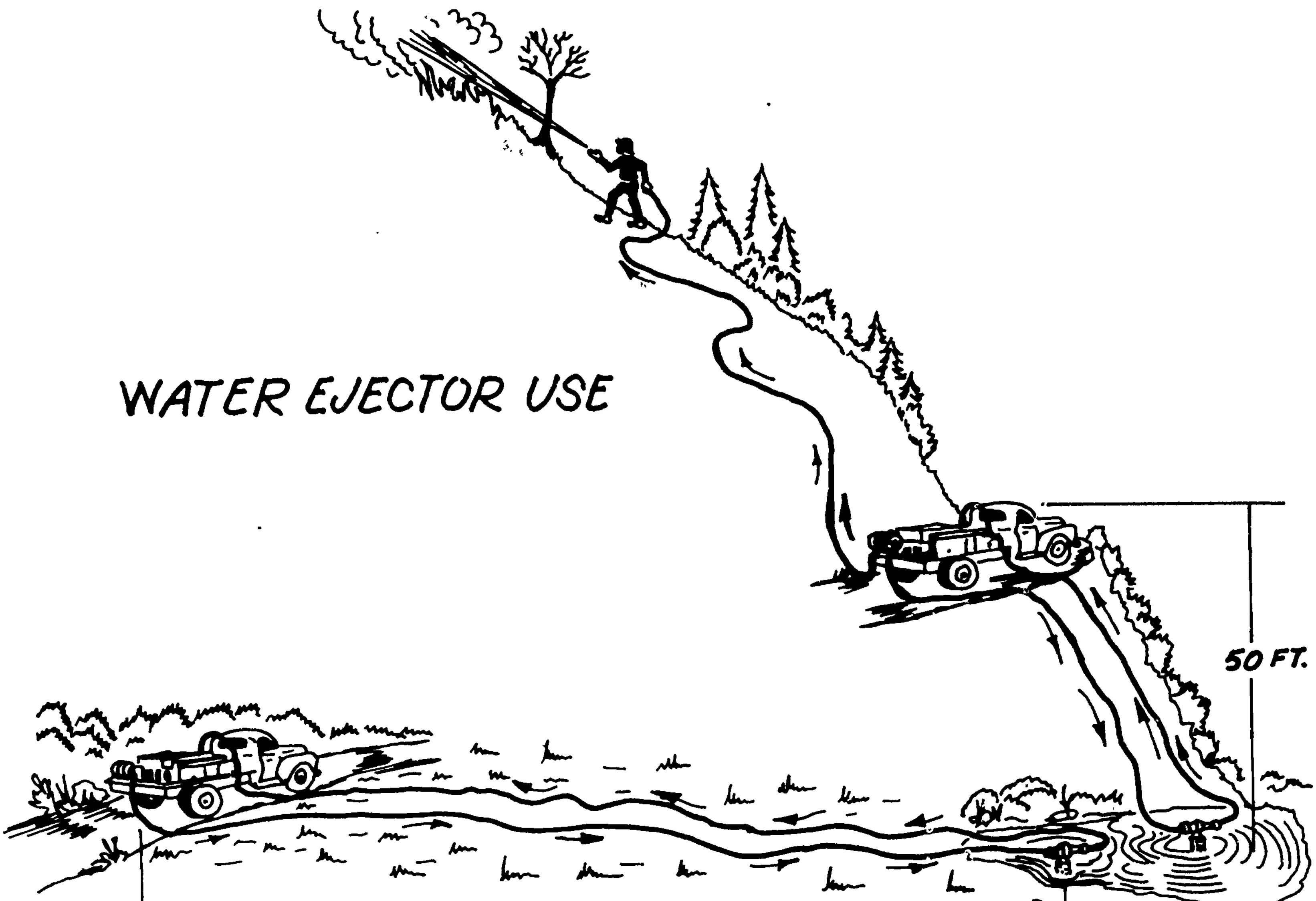


ID-1



ID-2

WATER EJECTOR USE



ID-3

REPRESENTATIVE EJECTOR SELECTIONS FOR FOREST SERVICE TANKERS

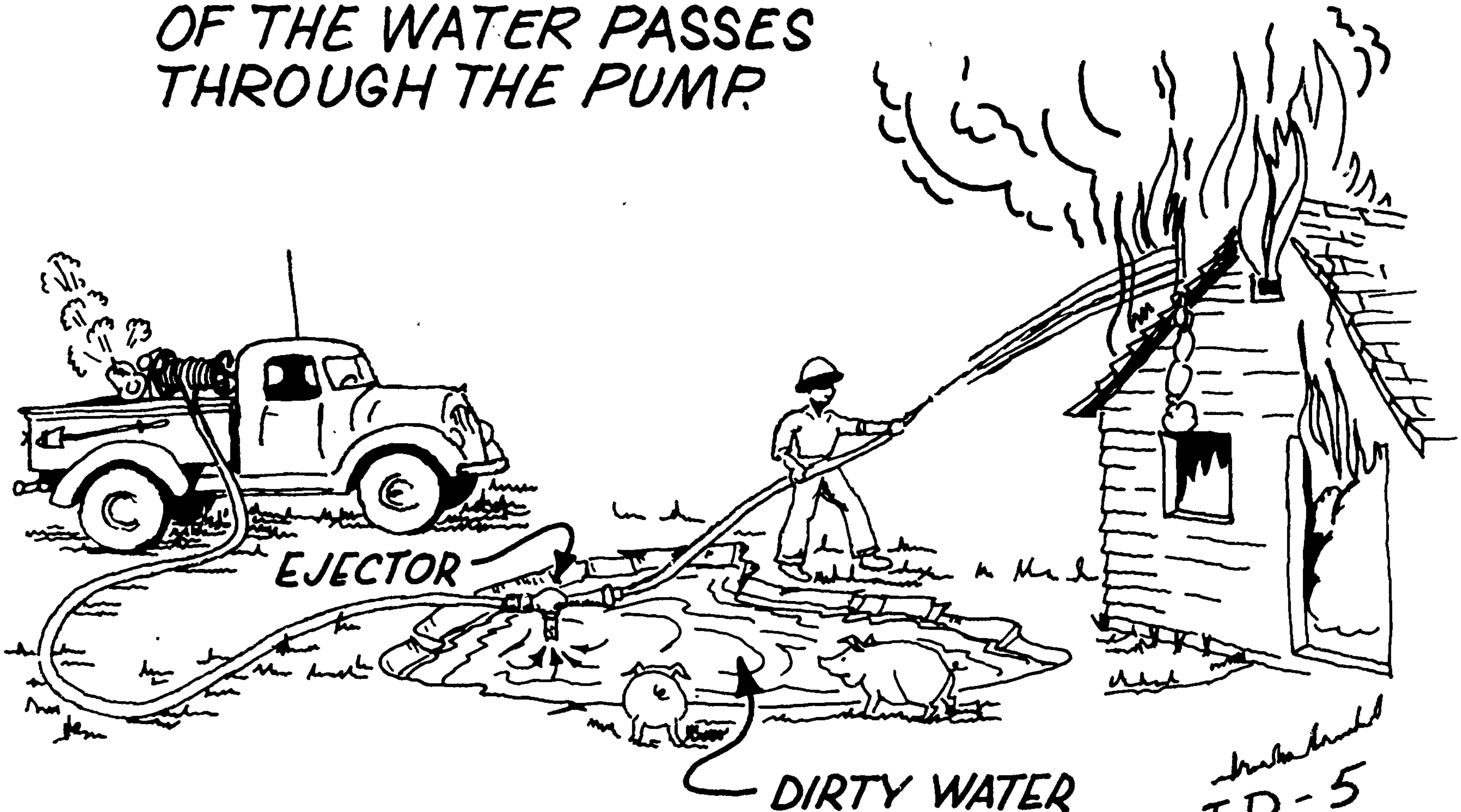
Tanker Model	Pumper Model	Ejector Model	Maximum Lift*		Ejector "Pick-up" at		Ejector Return Max. Combined Flow (GPM)
			Ft.	Psi	3/4 Max. Lift (GPM)	Max. Flow (GPM)	
10	Briggs-Eco	Penberthy 62A	101	44	7	11	20
20	Berkeley B1-1/2XQBS-10	Penberthy 64A	118	51	15	28	52
	Hale or Cedco HPZZ	Penberthy 63A	122	53	10	20	36
	Edwards L-23	Penberthy 64A	127	55	16	28	53
	Pacific Pumper WA-7	Penberthy 63A	155	67	12	20	38
	Pacific Pumper WX-10	Penberthy 64A	125	54	16	28	53
	Cedco A10-F	Penberthy 62A	127	55	8	11	21
30**							
40	Gorman Rupp 02F1-GR (at 200 psi)	Penberthy 65A	127	55	.23	45	85
50	Cedco HPZF	Penberthy 65A	148	64	30	45	88
	Berkeley B1-1/2XQBS-18	Penberthy 65A	152	66	31	45	88
60	Hale CBPD (at 400 psi)	Penberthy 65A	250	107	44	44	99

*There is no point in operating with the ejector discharge at or above the maximum lift pressure because there is no gain over the pumper flow rate (ejector "pick-up" flow is zero).

**Usually ejectors are not used with Model 30 pumpers because the pumper can be removed for drafting assignment.

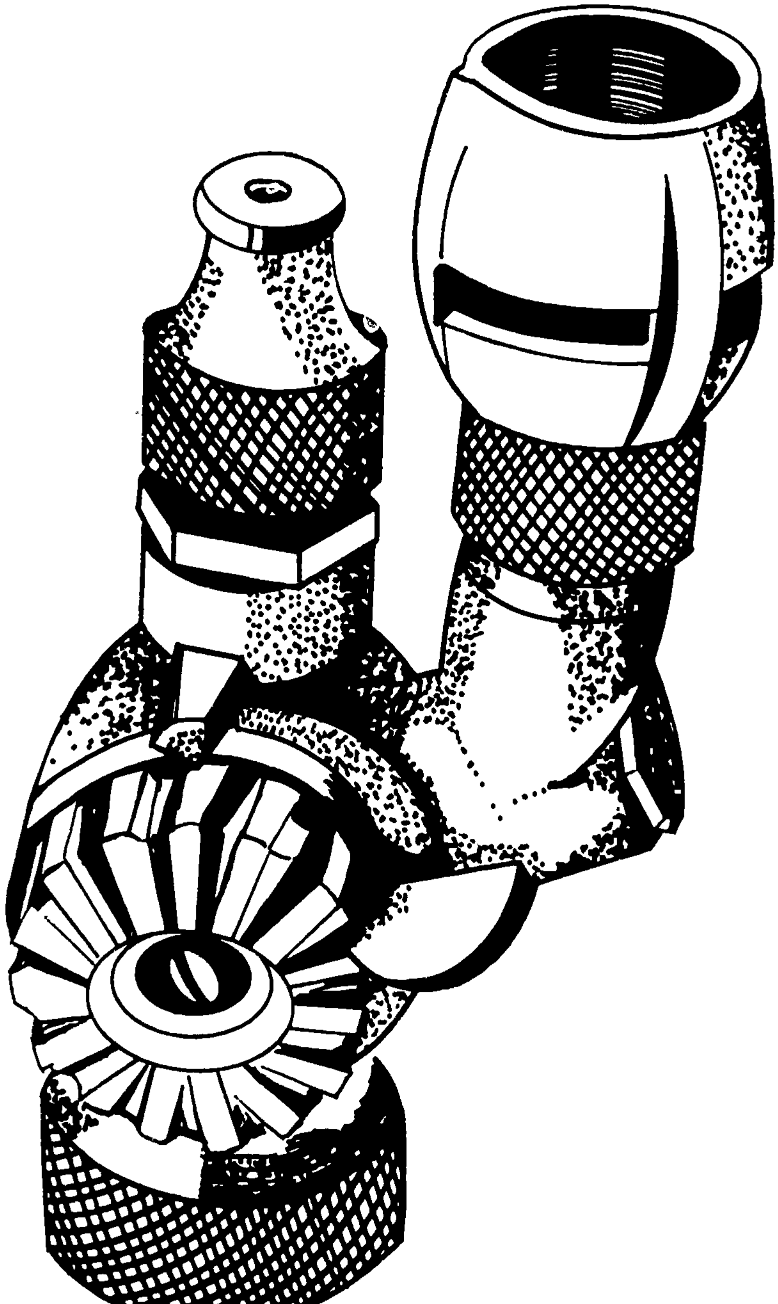
I D-4

DIRTY WATER CAN BE UTILIZED TO PUT OUT FIRES AND UP TO 3 TIMES PUMP CAPACITY CAN BE APPLIED SINCE NONE OF THE WATER PASSES THROUGH THE PUMP.

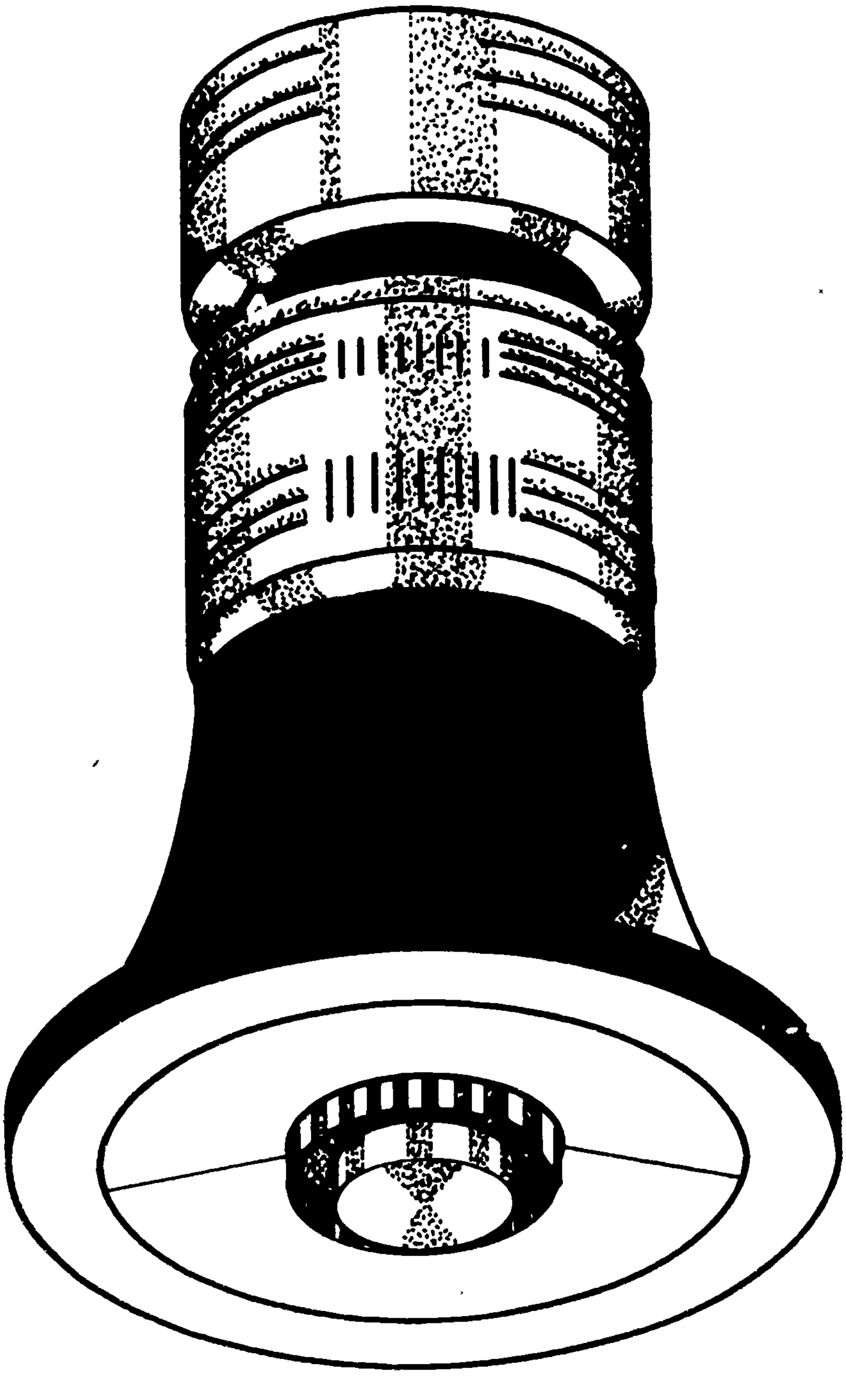


ID-5

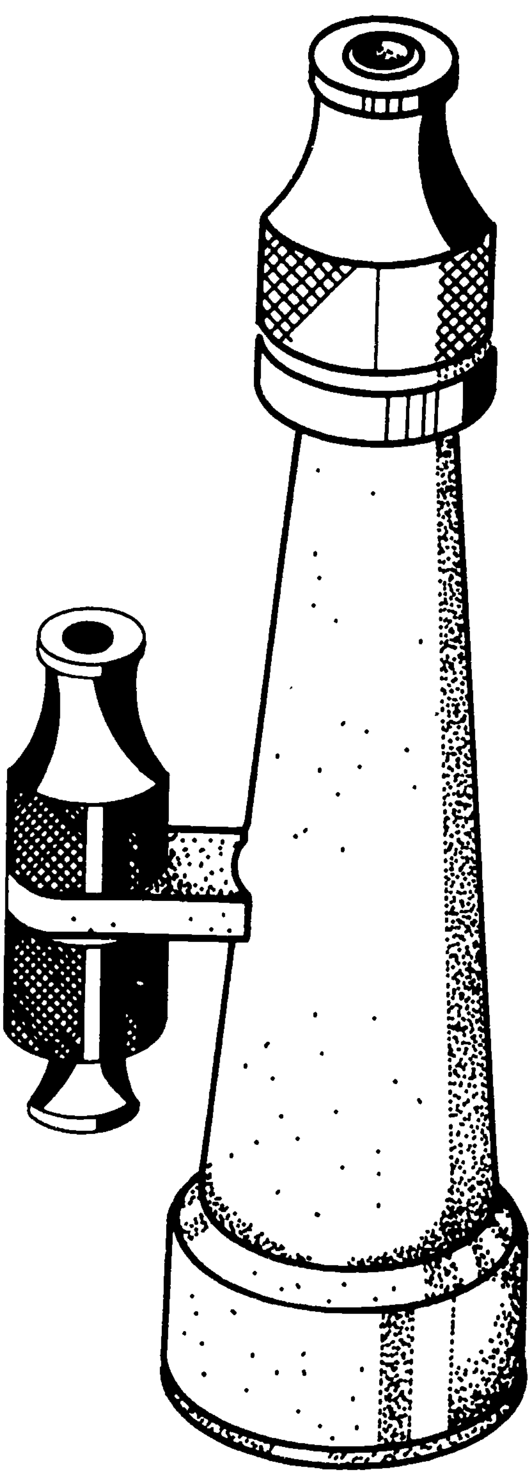
II A-1



IIA-2



II-1-3



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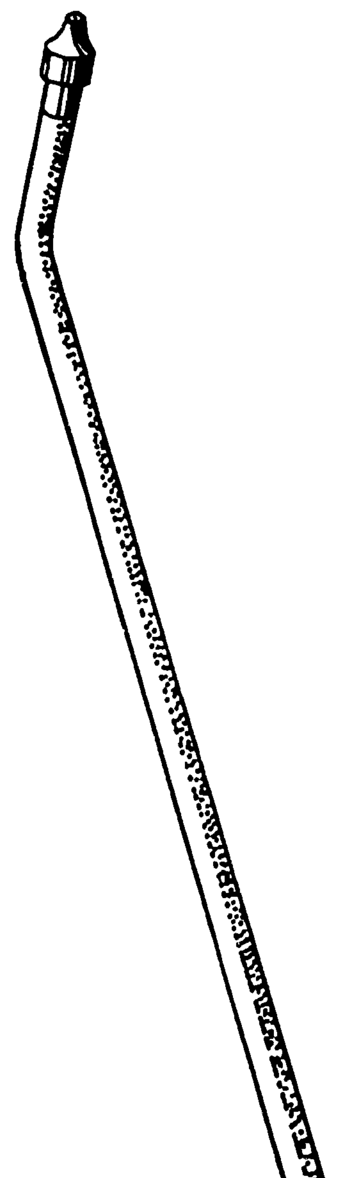

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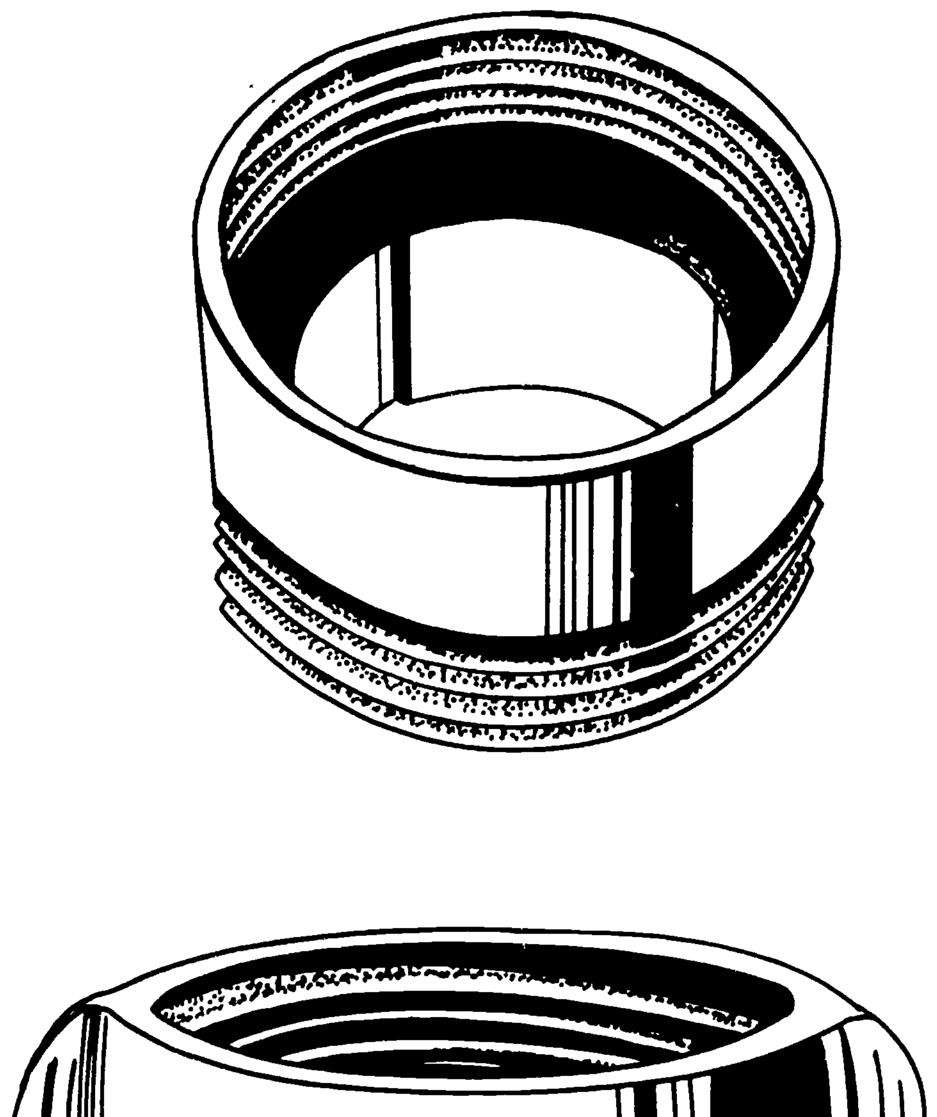

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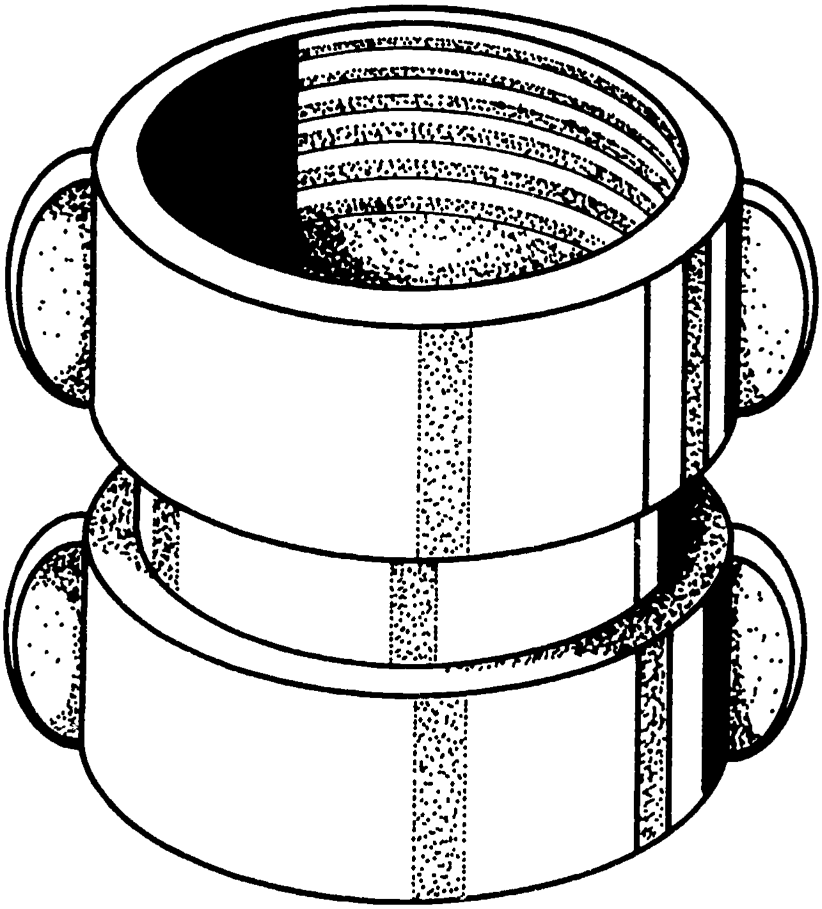

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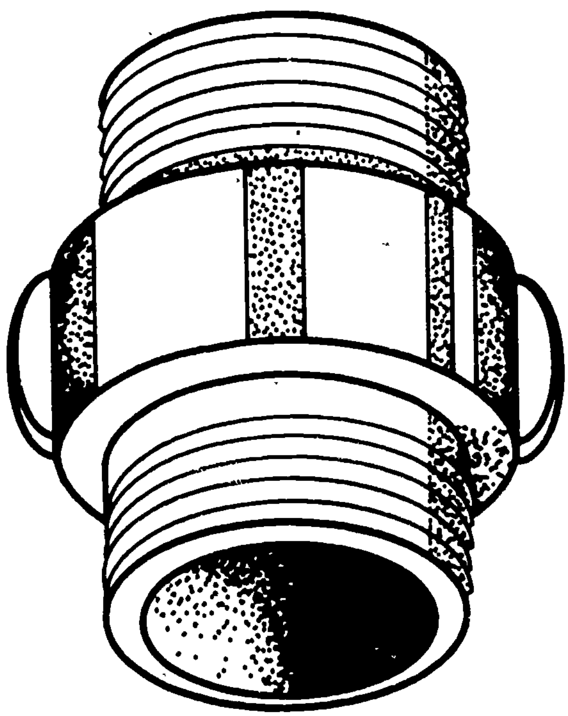
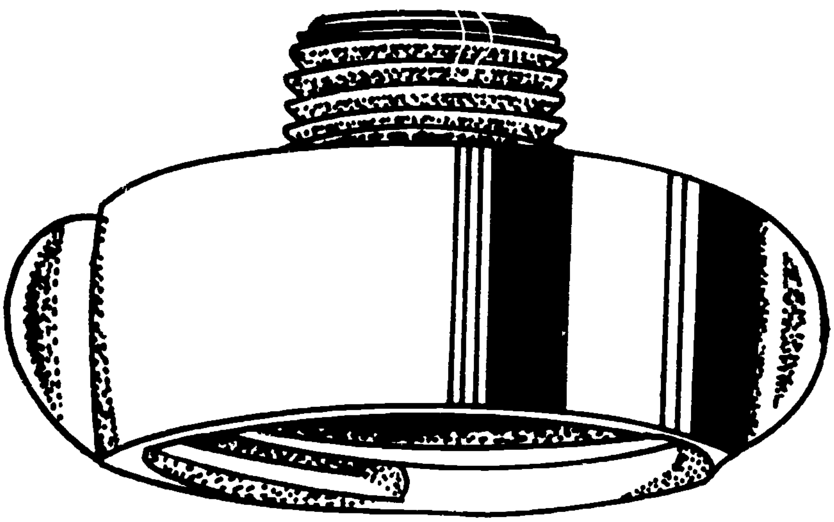


IIA-9

II A-10



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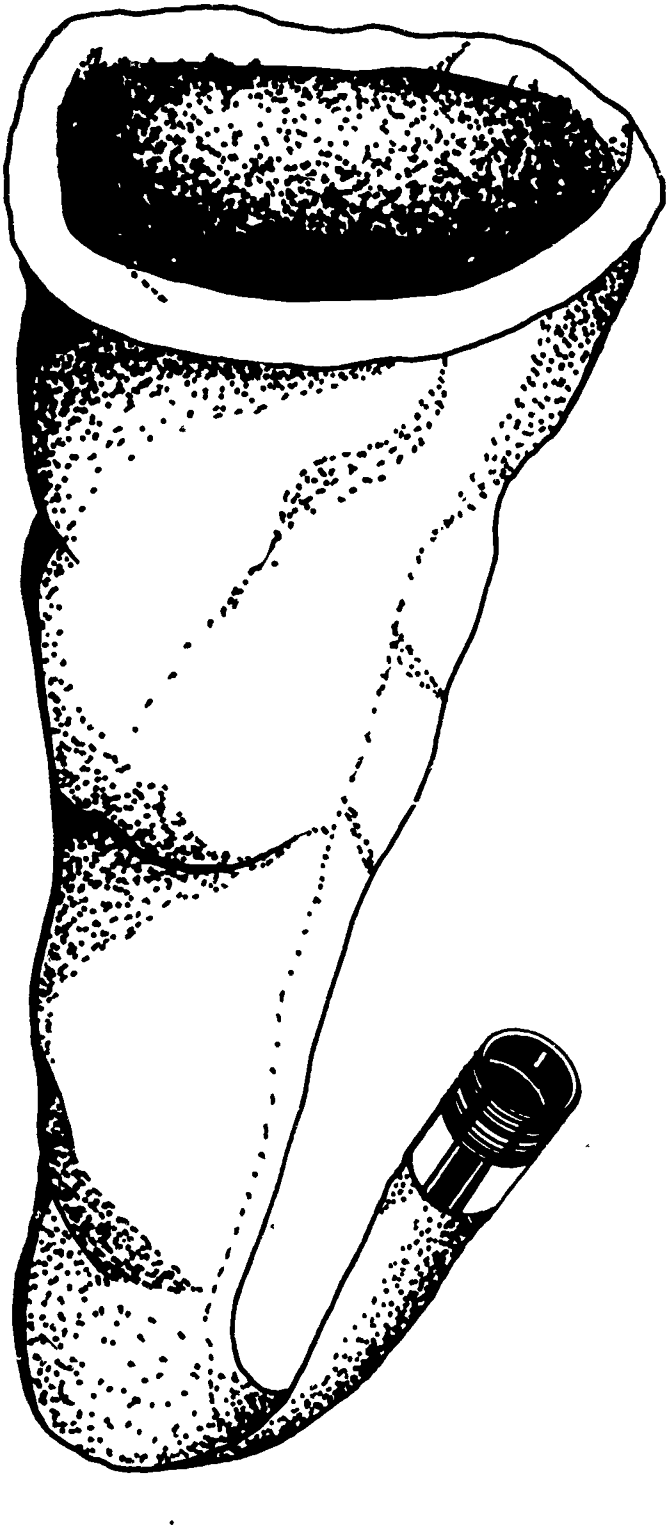

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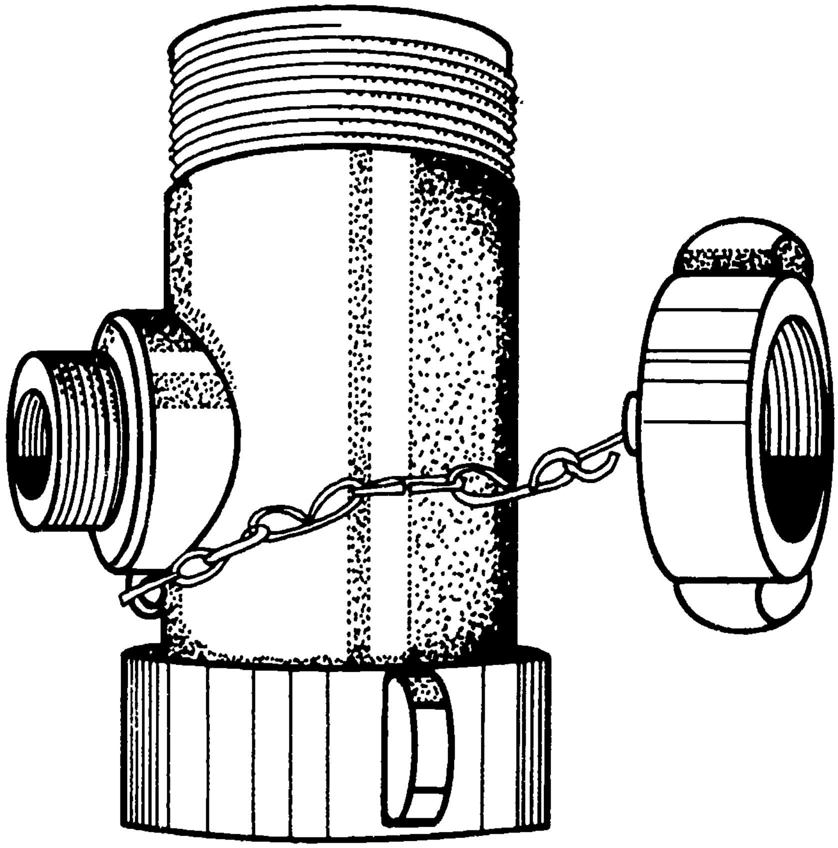
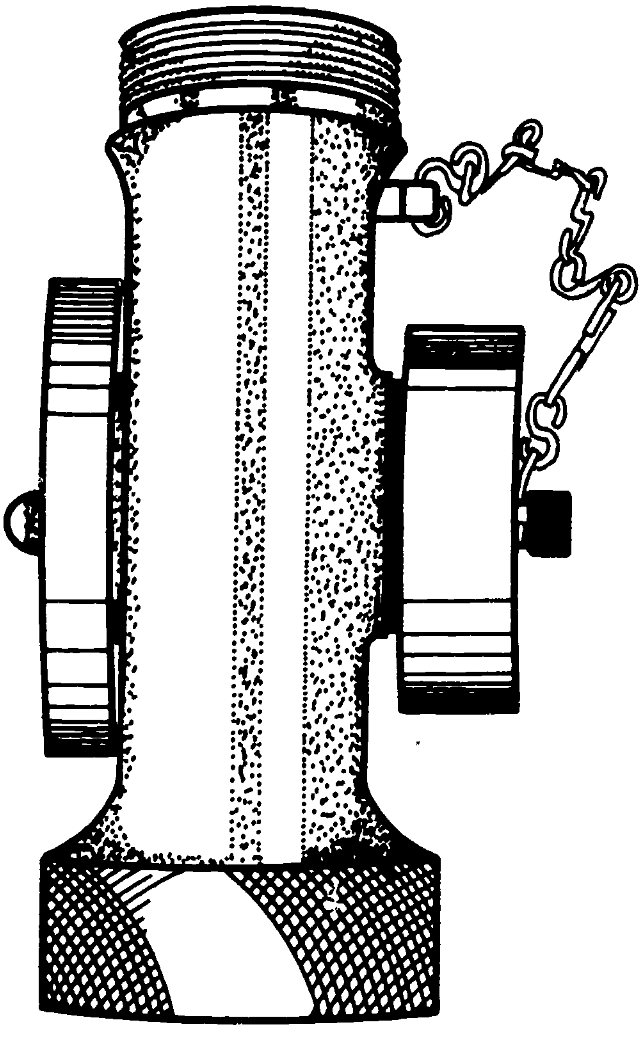
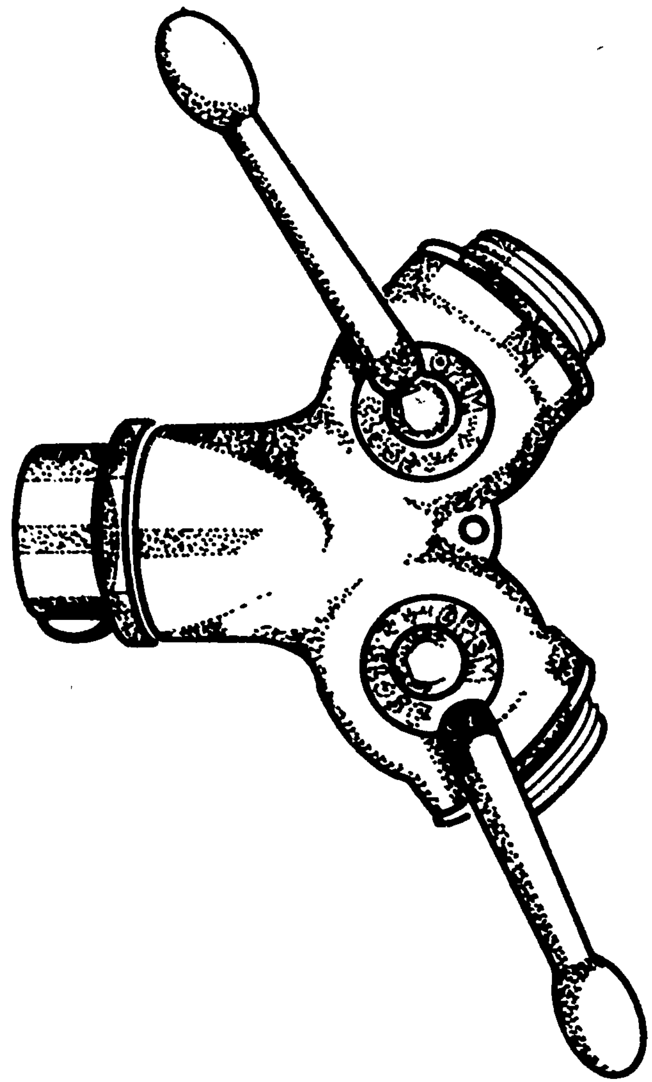
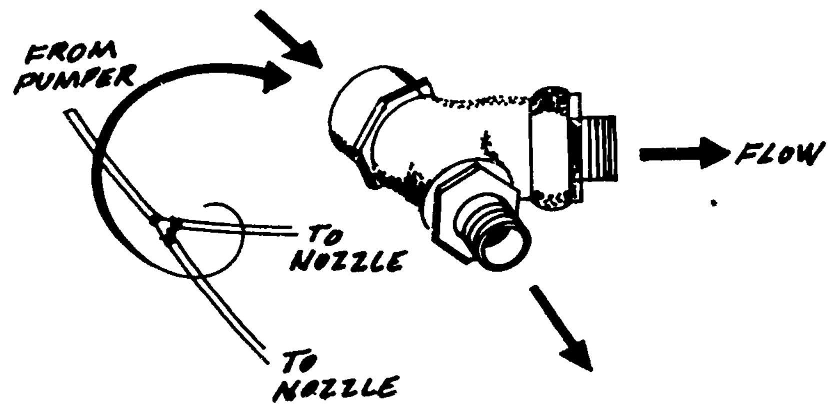


IIA-13

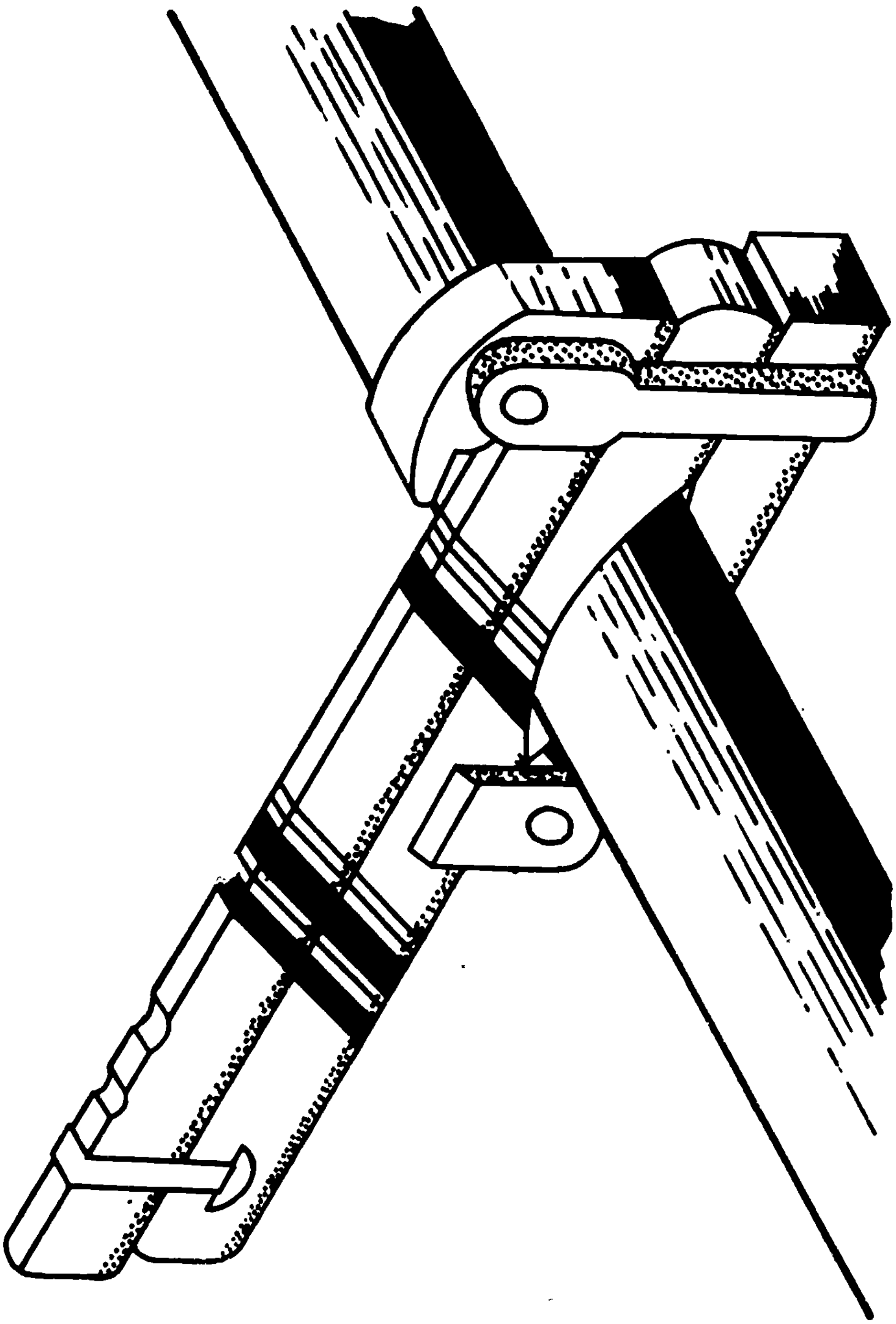




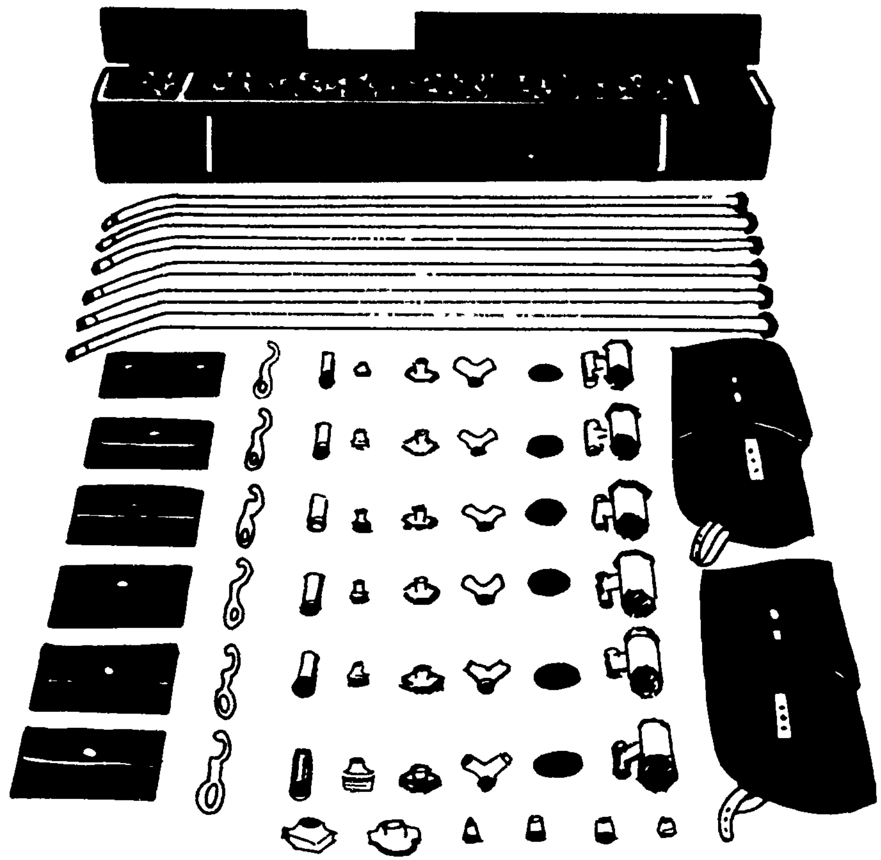


II A-14

IIA-15

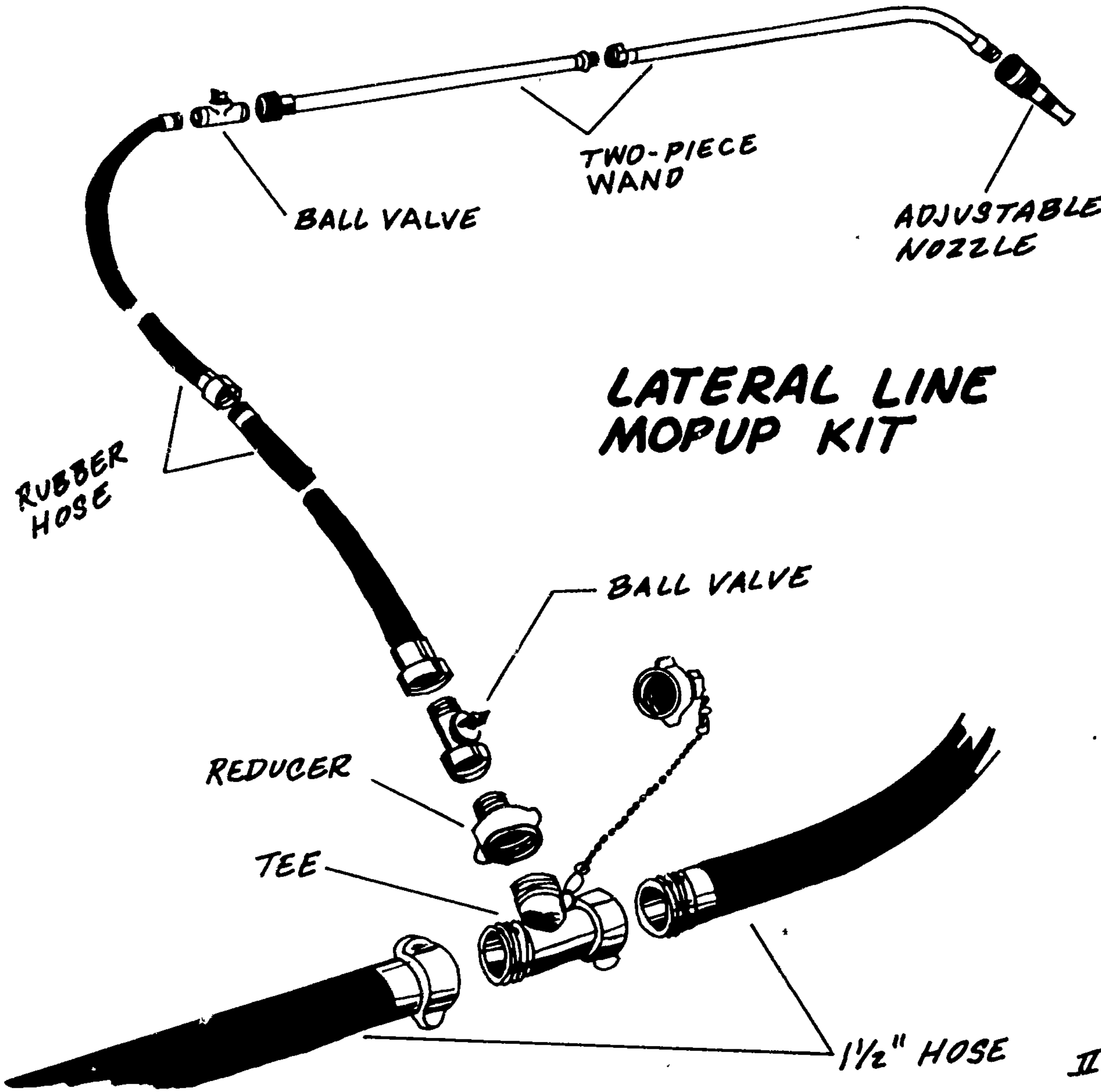


SIX MAN MOPUP OUTFIT



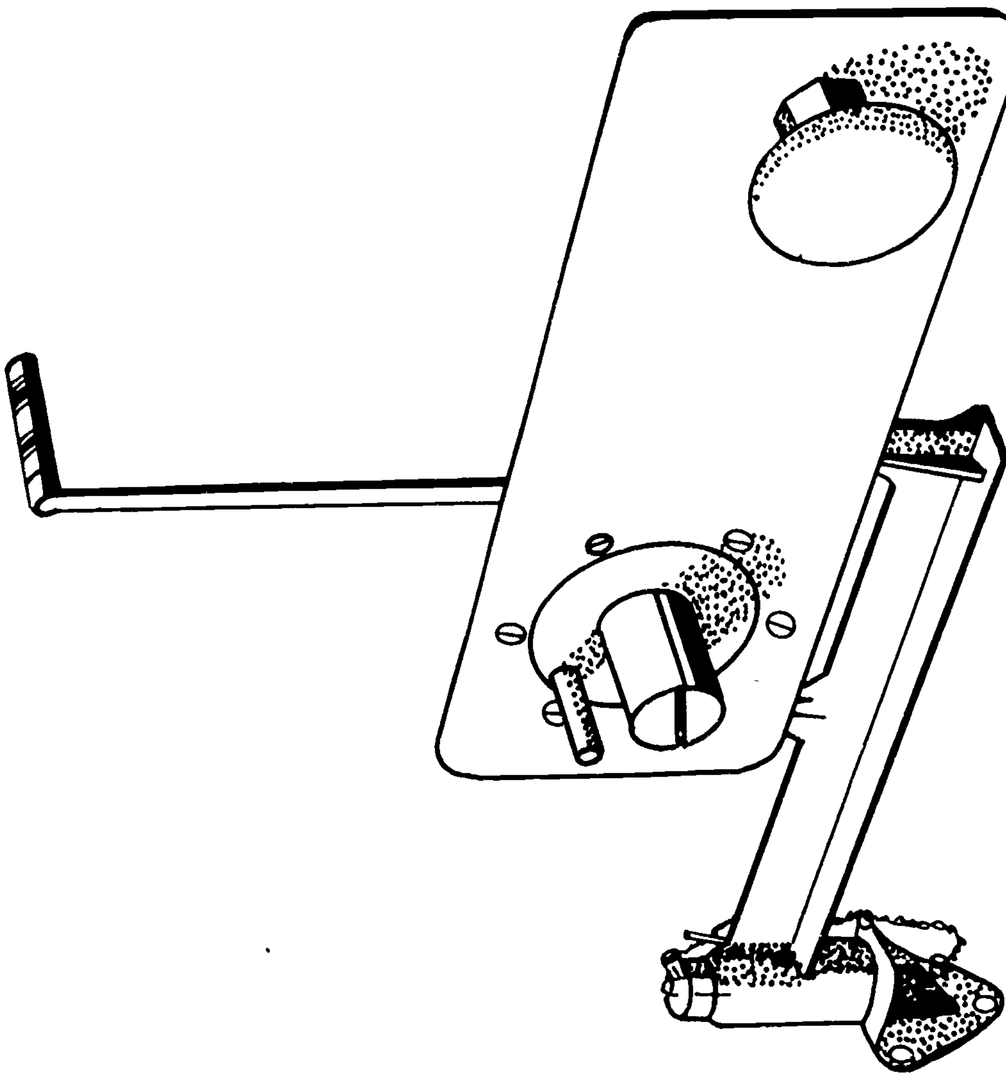
II A-16

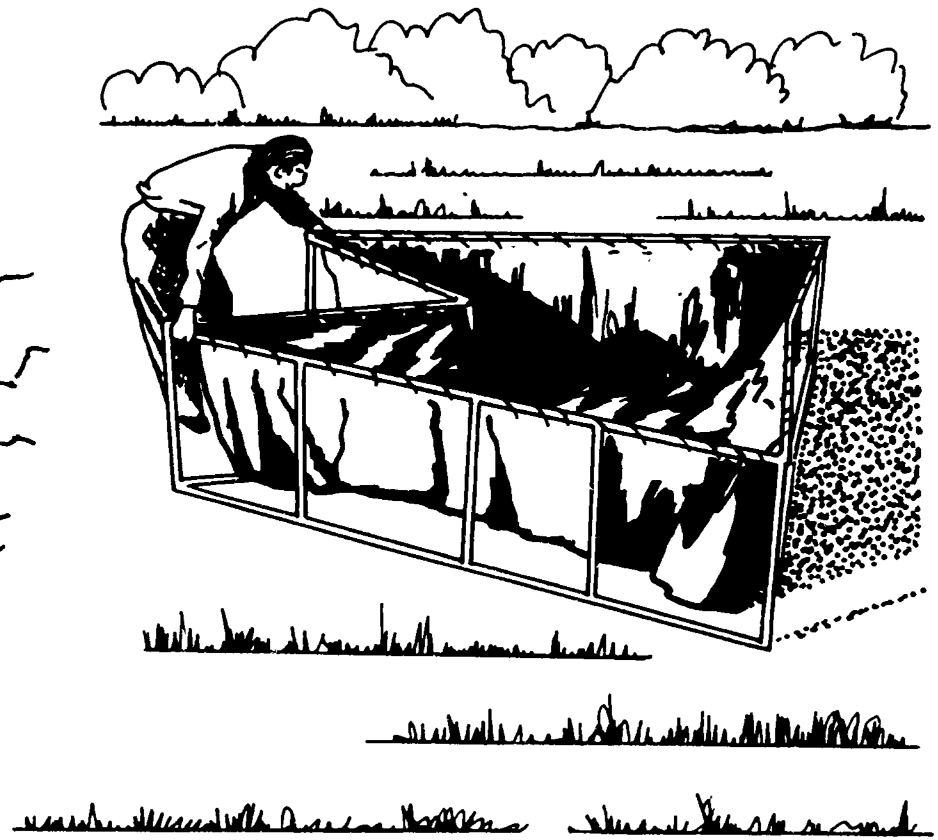
LATERAL LINE MOPUP KIT



IIA-17

II A-18





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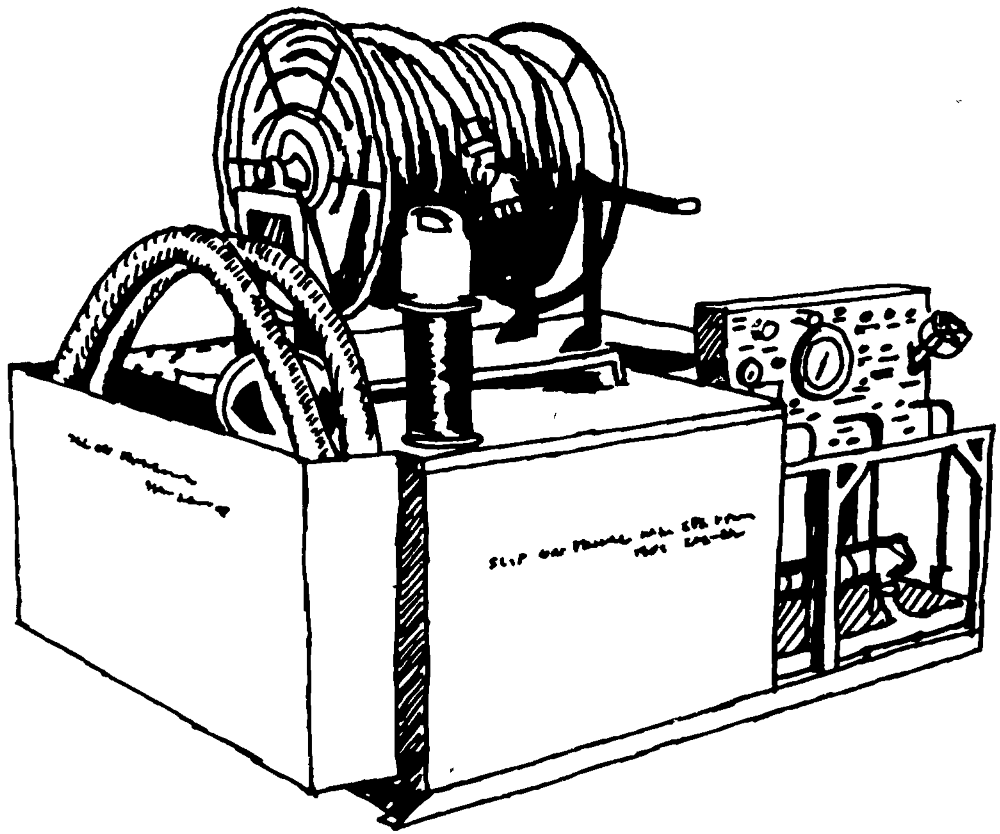
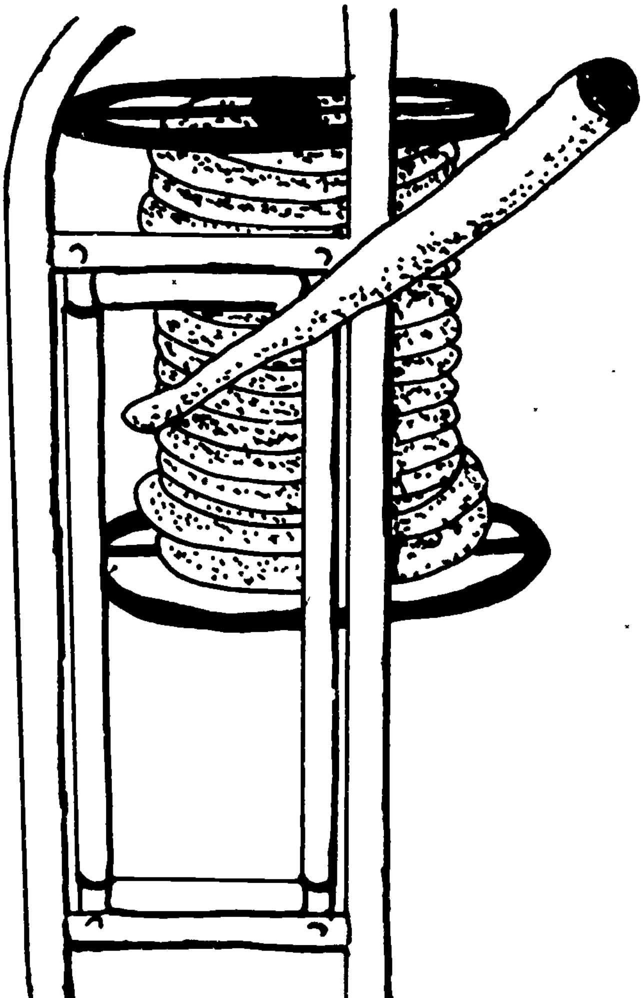
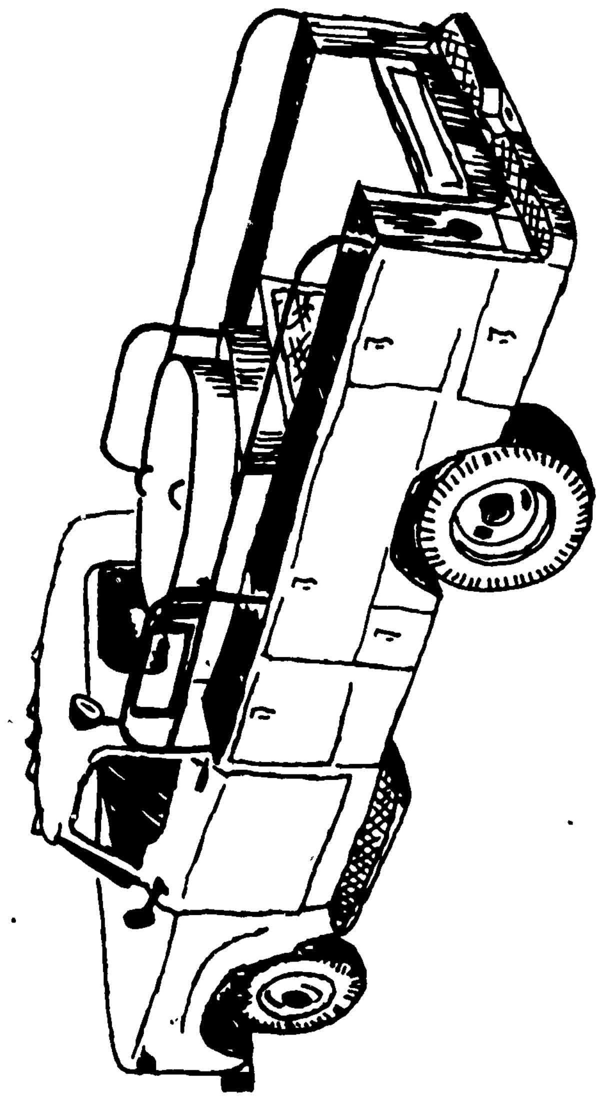


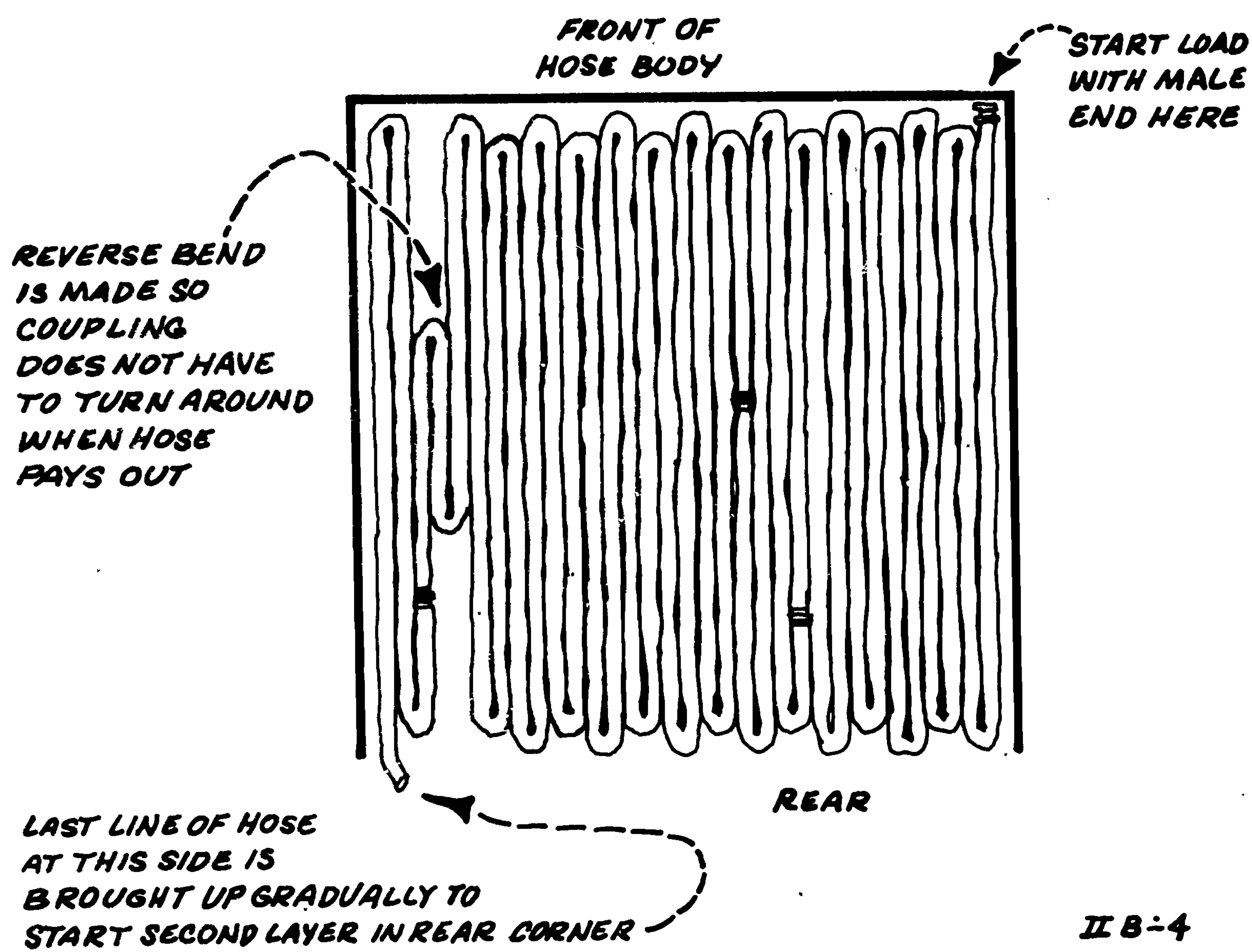
II B-1

II B-2

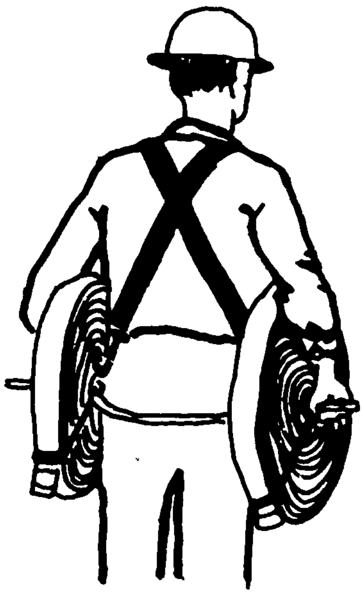


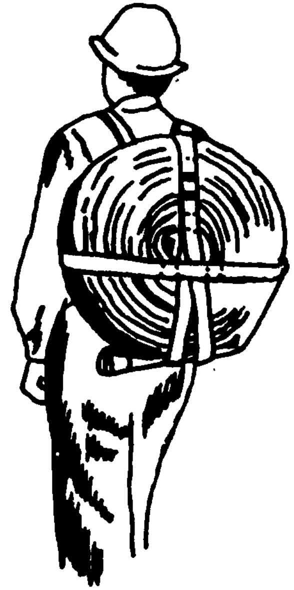
II B-3




FRONT OF HOSE BODY
START LOAD WITH MALE END HERE
REVERSE BEND IS MADE SO COUPLING DOES NOT HAVE TO TURN AROUND WHEN HOSE PAYS OUT
REAR
LAST LINE OF HOSE AT THIS SIDE IS BROUGHT UP GRADUALLY TO START SECOND LAYER IN REAR CORNER

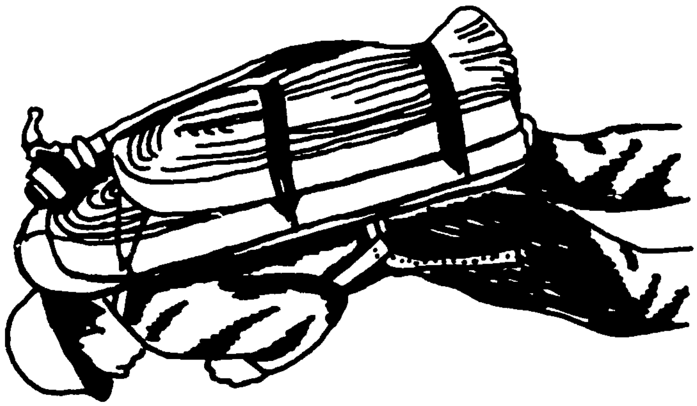
II B-4



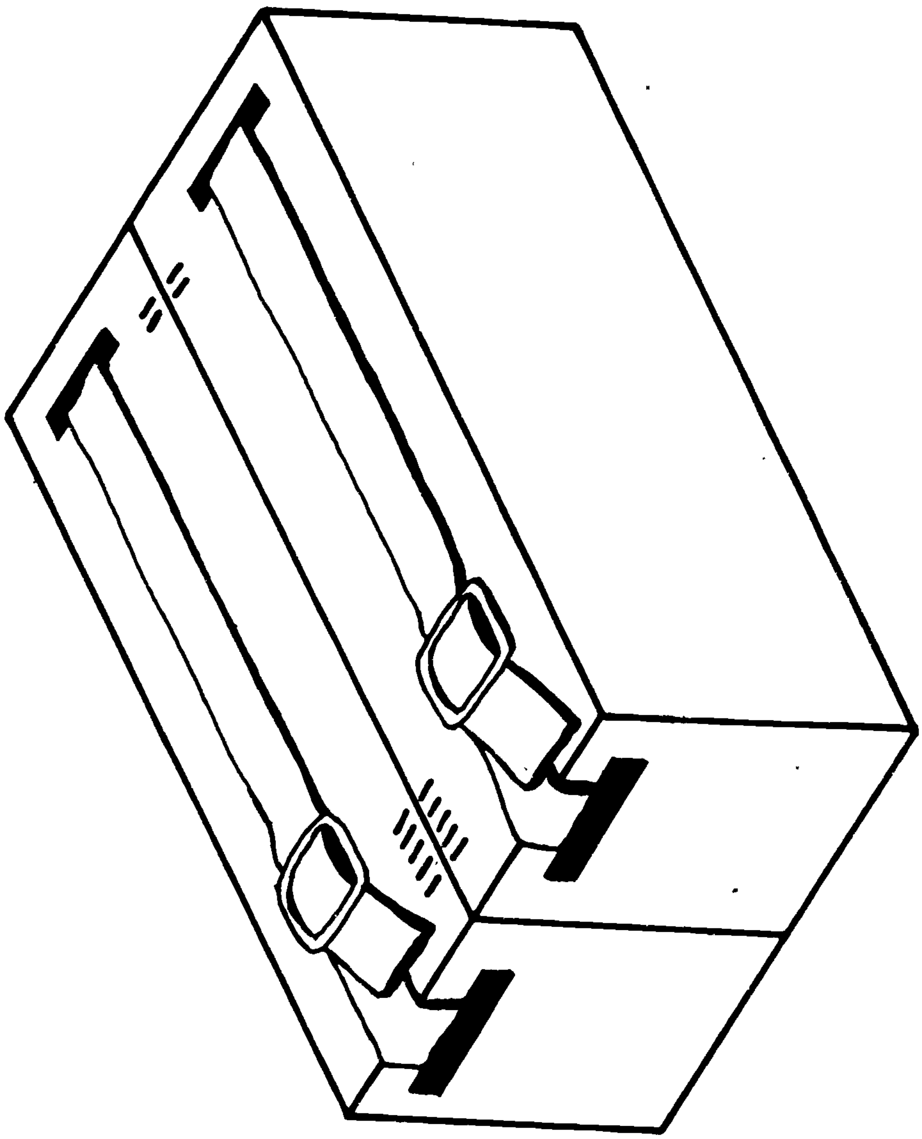


II B-5

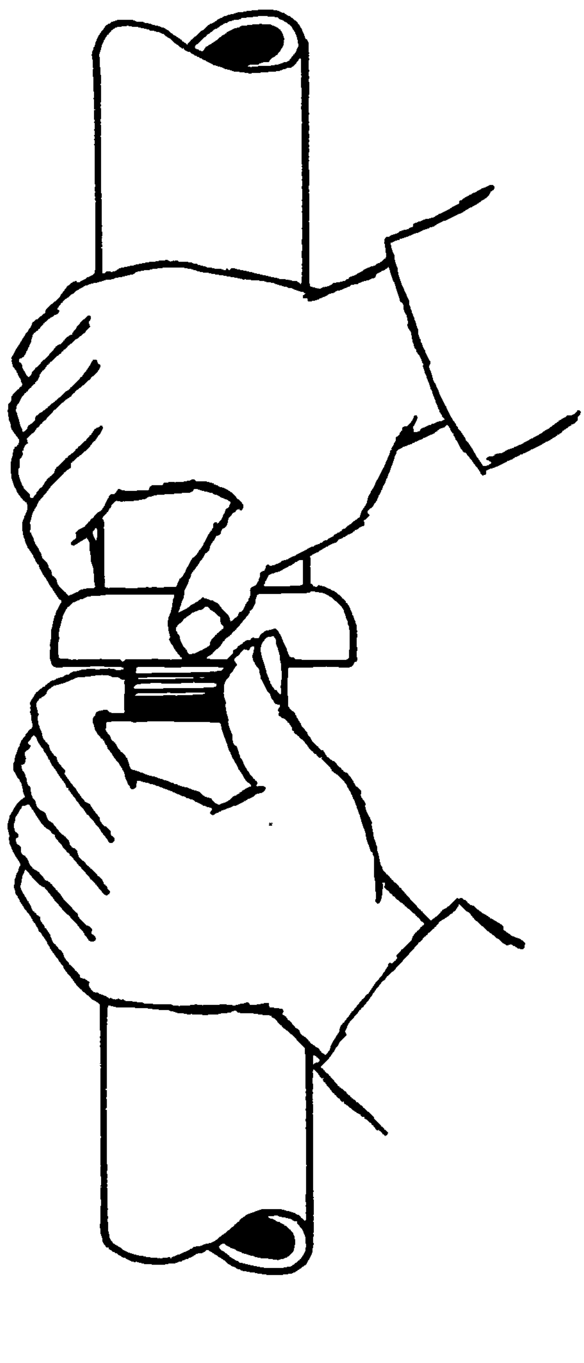
II B-6

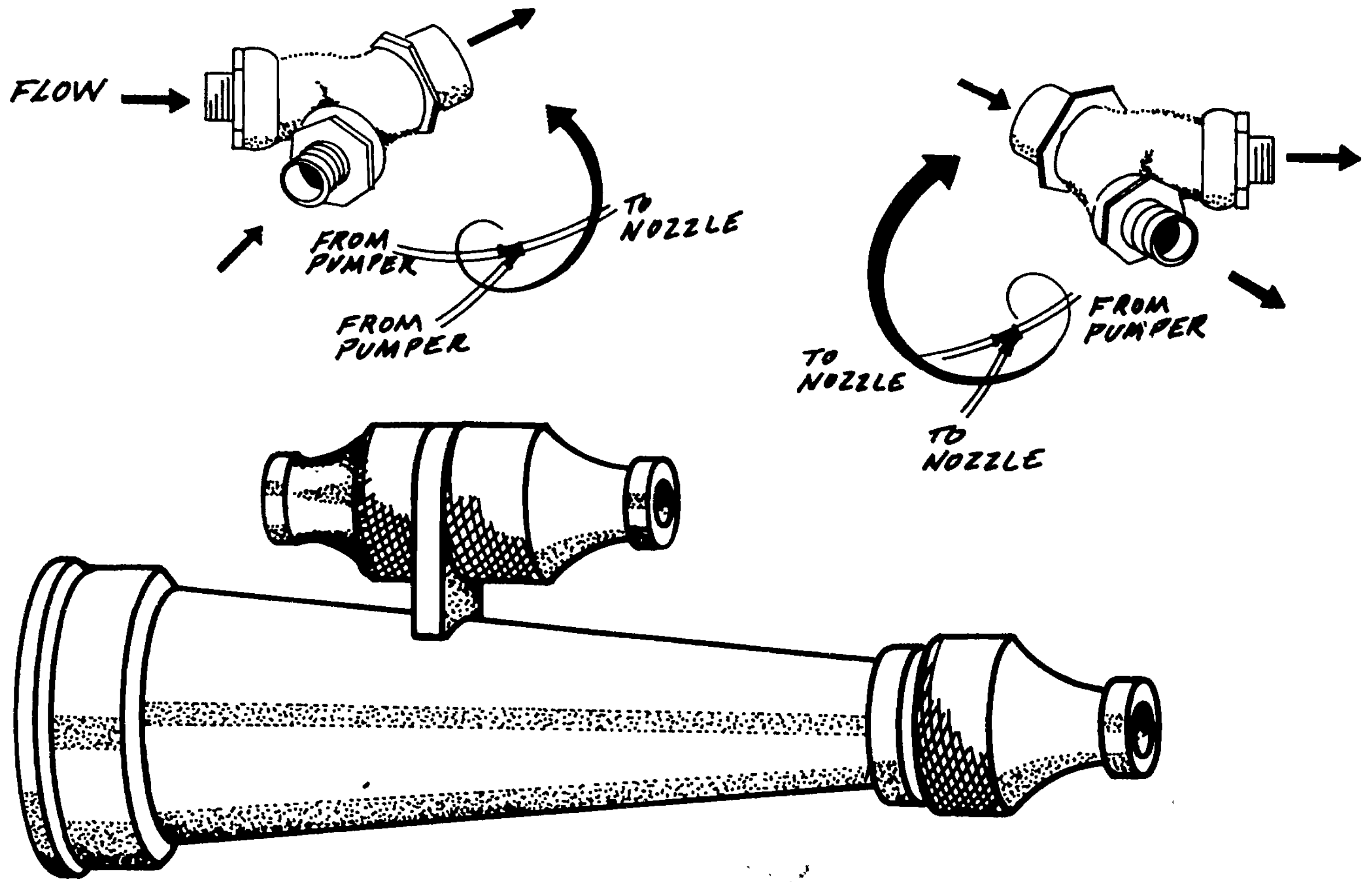


II B-7

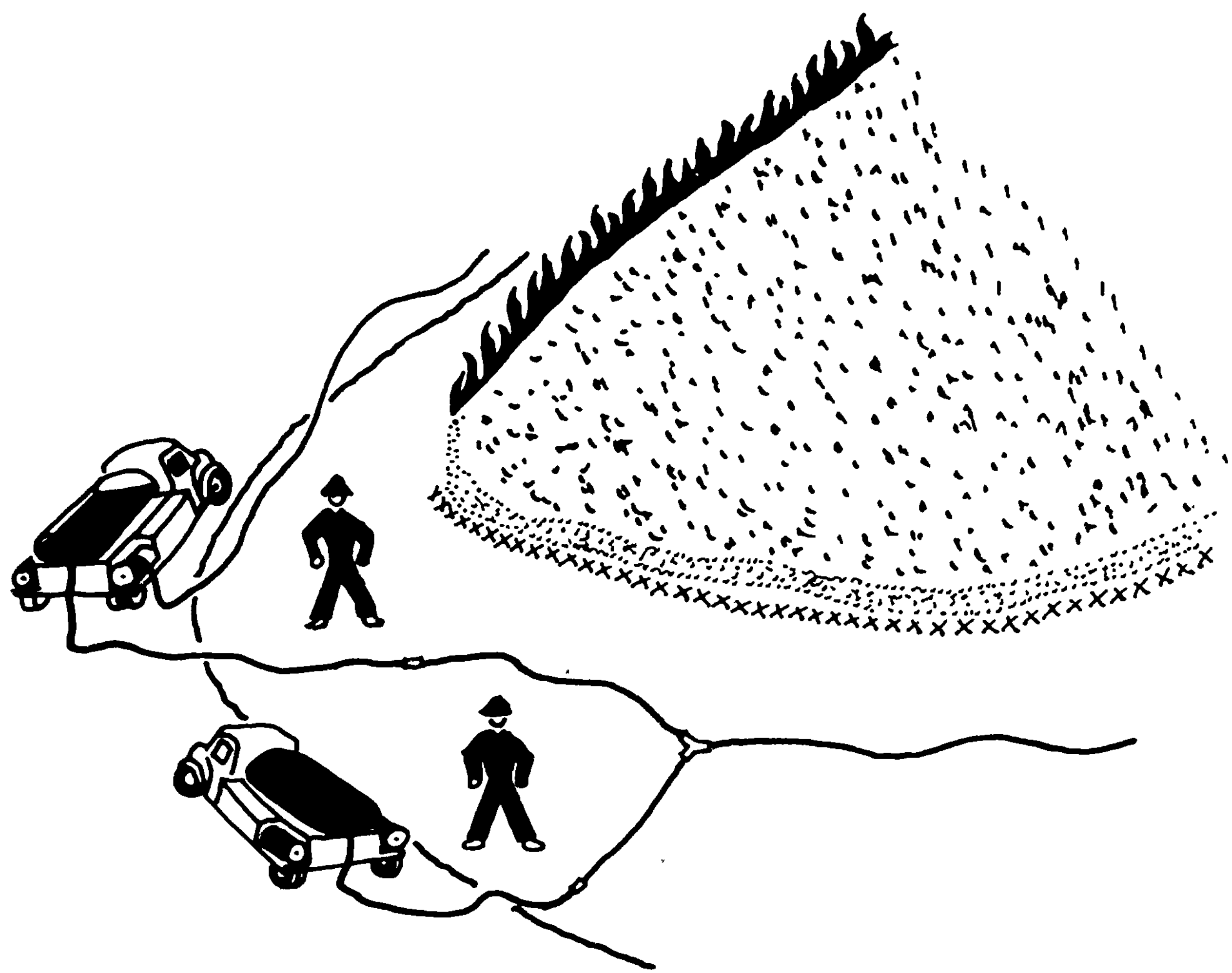


II B-8



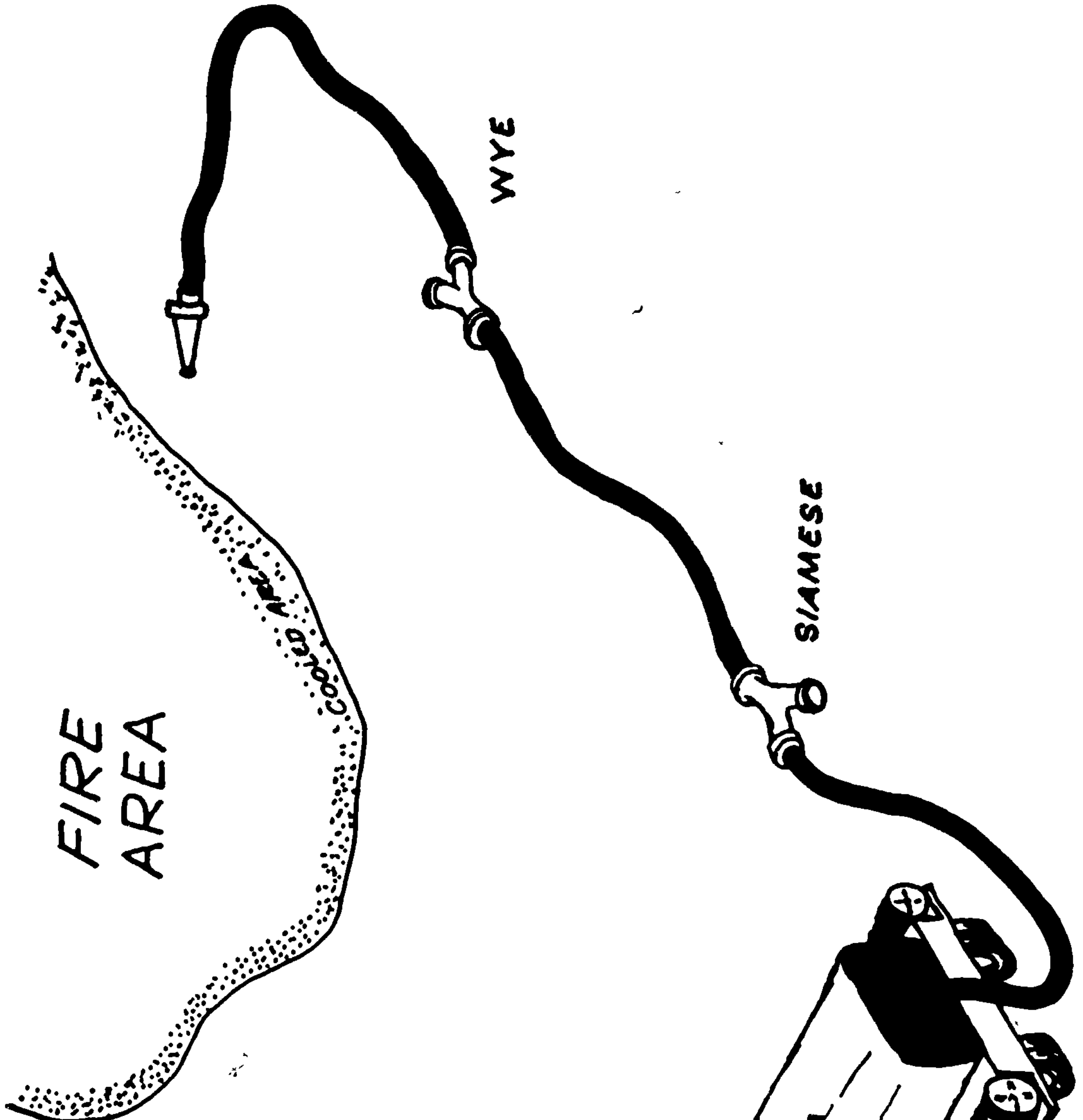

FLOW
FROM PUMPER
FROM PUMPER
TO NOZZLE
TO NOZZLE
TO NOZZLE
FROM PUMPER

II B-9

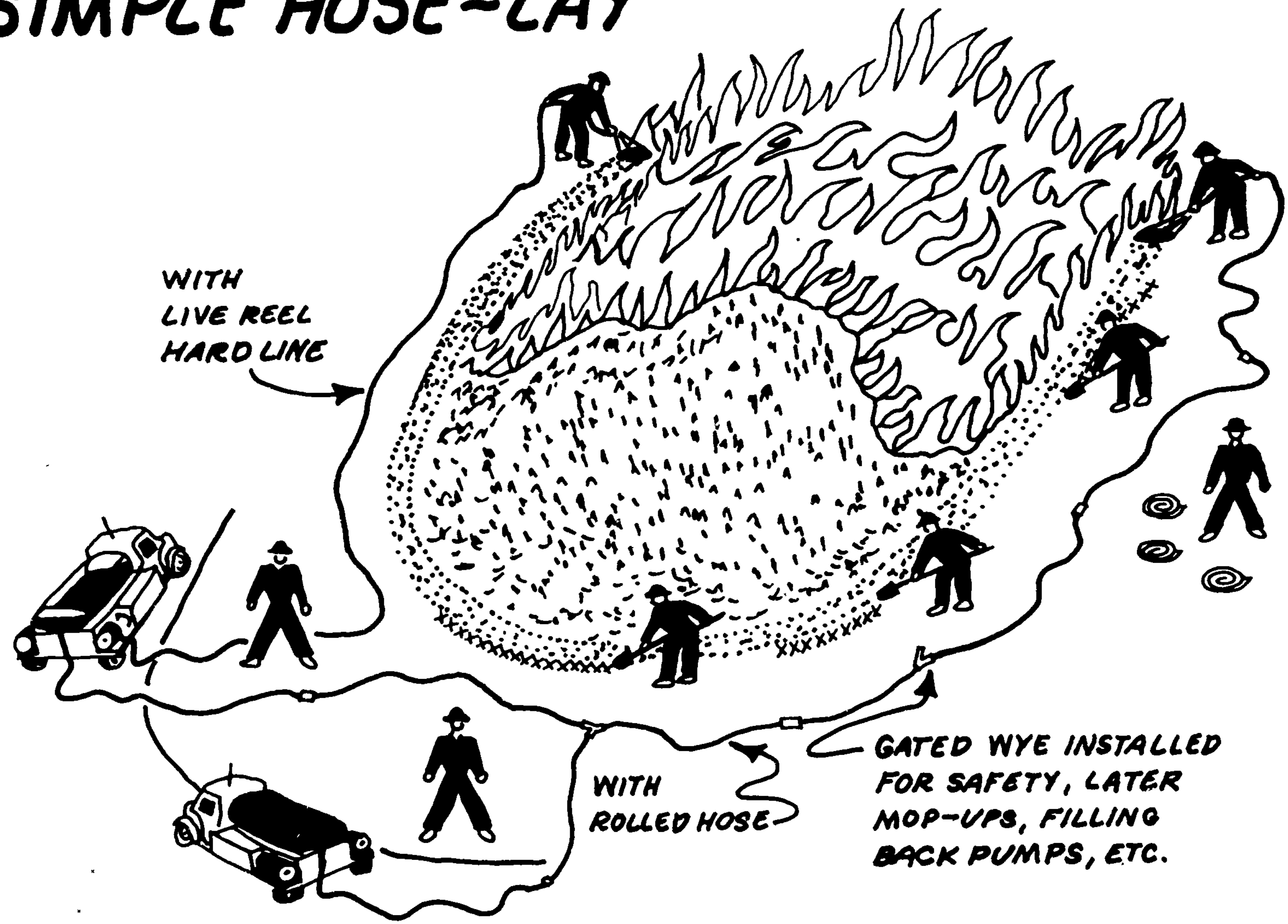


II B-10

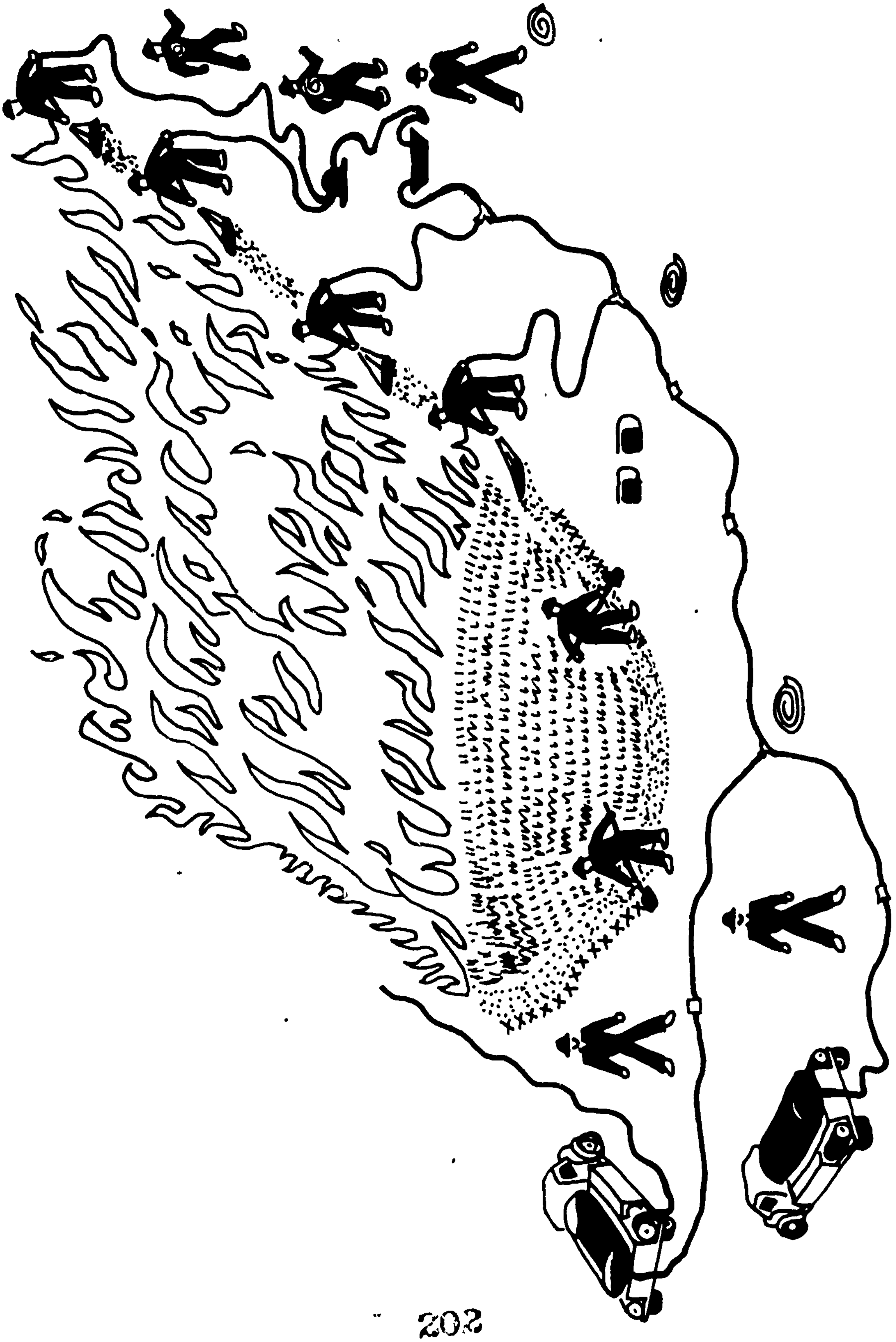
II B-11



SIMPLE HOSE-LAY



II B-12



II B-13

FRICTION LOSS IN LBS/100 FT OF HOSE

Hose Size (ID) Type

Flow (gpm)	1/2" G.H.P.	3/4" H.P.	1" CJRL	1-1/2" CJRL	1-1/2" Linen	2-1/2" (Lined)
5	22	3.5				
10	75	13	3.0		1.0	
15	155	25	6.0	1.0	2.2	
20		42	10	1.5	3.6	
25		62	15	2.5	5.5	
30		86	20	3.5	8.0	
40		140	34	5.5	13	
50		215	50	8.0	20	
60			70	11	28	
70			90	15	37	
80			115	19	47	
90			140	23	59	
100			170	30	72	2.5
150						5.8
200						10.1

IIC-1

Type Tip	Size Tip	GPM @ 100 PSI	Pattern	FSN No.
Straight-stream	1/8"	5	32'	See Mfr.
" "	5/32"	7	35'	" "
" "	3/16"	10-1/2	38'	4210-203-3855
" "	1/4"	19	42'	4210-177-6135
" "	5/16"	29	46'	See Mfr.
" "	3/8"	42	49'	4210-203-3845

SPRAY-STD. NARROW PATTERN	3 GPM	3	18^{0}	4210-204-3358
" " " "	6 GPM	6	18^{0}	4210-204-3386
" " " "	8 GPM	8	18^{0}	SEE MFR.

SPRAY-SPEC. BOARD PATTERN	9	9	30^0	SEE MFR.
" " " "	12	12	30^0	" "
" " " "	15	15	30^0	" "
" " " "	18	18	30^0	" "
" " " "	24	24	30^0	" "
" " " "	3*	3	60^0	" "

*THIS SPRAY TIP PRODUCES SOLID CONE PATTERNS.

Gallons per minute discharge @ 50# nozzle pressure

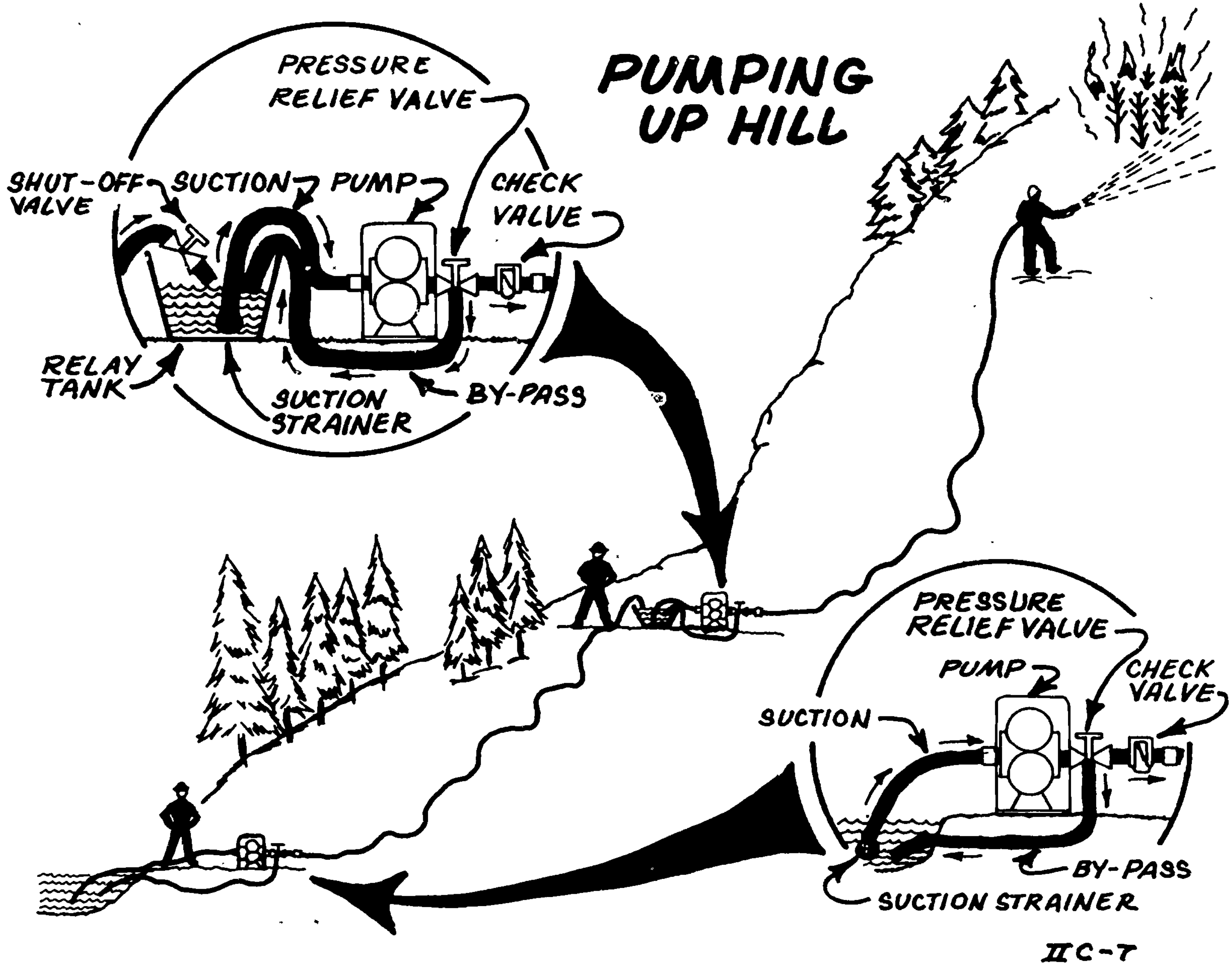
TIP SIZE	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1	1-1/4	1-1/2	2
GPM	3	7	13	20	29	52	81	117	209	316	472	842

Common fog nozzles: "Forester" 3 spray tip = 1.7 gpm
"Fog nozzle" 4-hole spray tip = 7.3 gpm
Garden hose type nozzle = 3.8 gpm

PERFORMANCE DATA FOR THE GORMAN RUPP, PACIFIC MARK 3 AND PACIFIC MARK 26 PUMPS:

GORMAN RUPP		PACIFIC MARK 3		PACIFIC MARK 26	
psi	gpm	psi	gpm	psi	gpm
50	50	50	70	Free Flow	84
100	42	100	67	50	74
150	27	150	55	100	51
175	20	200	44	150	19
190	15	250	25	170	Shuts off

PUMPING UP HILL



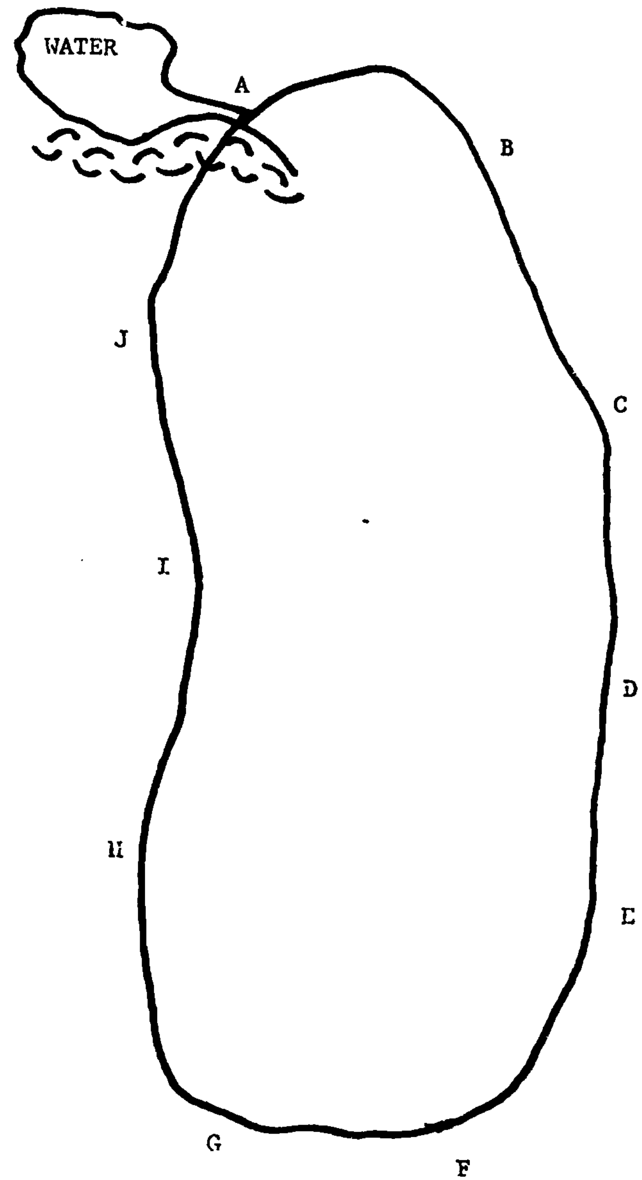
IIC-7

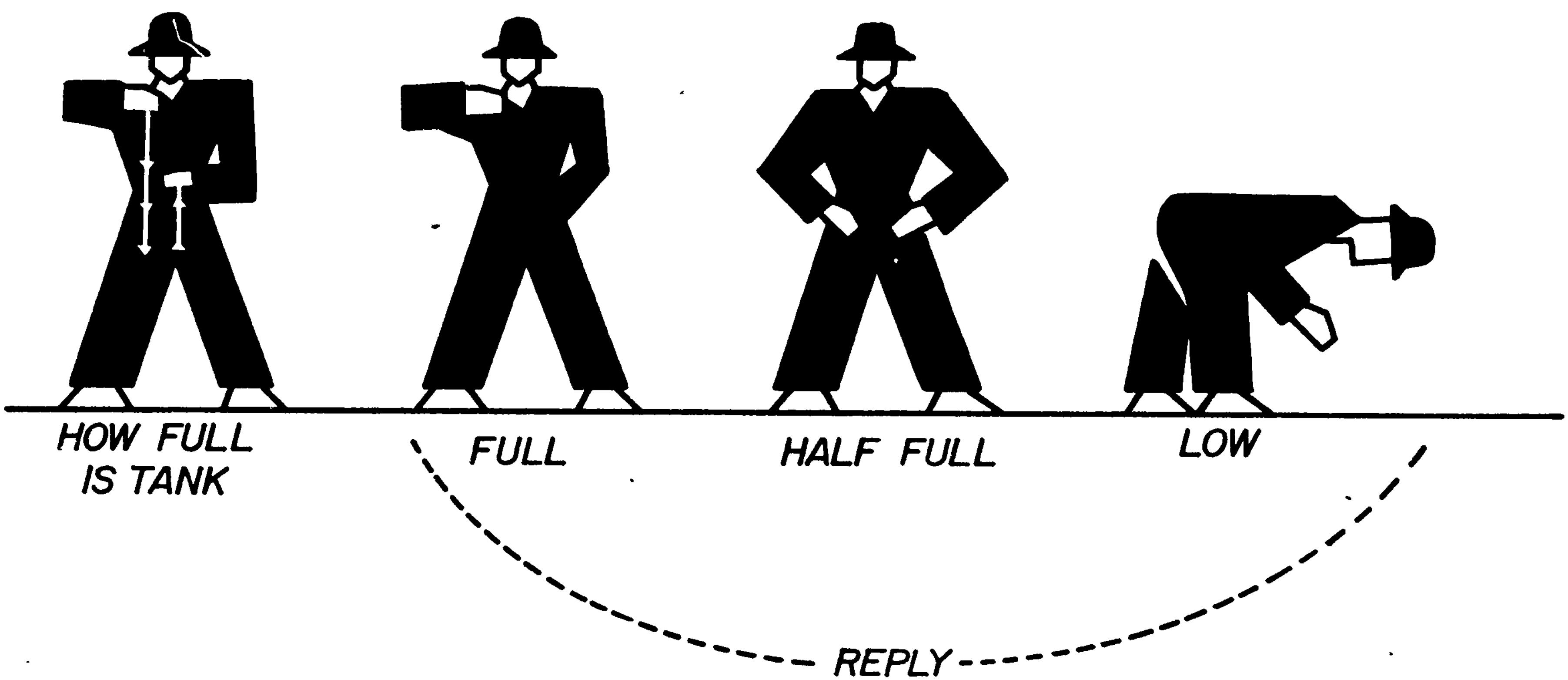
EXPLANATION OF SKETCH:

1. Point A is at the Water Source.
2. All points on line are 1,000 ft. apart.
3. Following are the elevations above or below the water source:

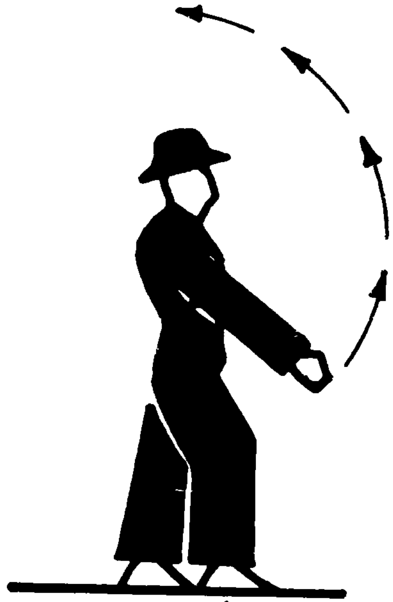
A. 0	F. - 50'
B. + 100'	G. - 50'
C. + 100'	H. + 50'
D. + 150'	I. + 100'
E. + 50'	J. + 100'

IIC-8

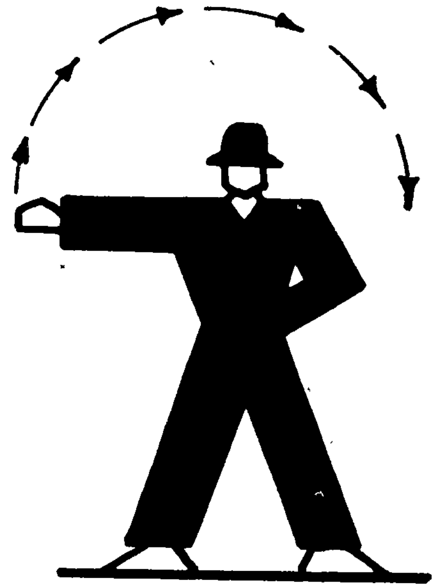




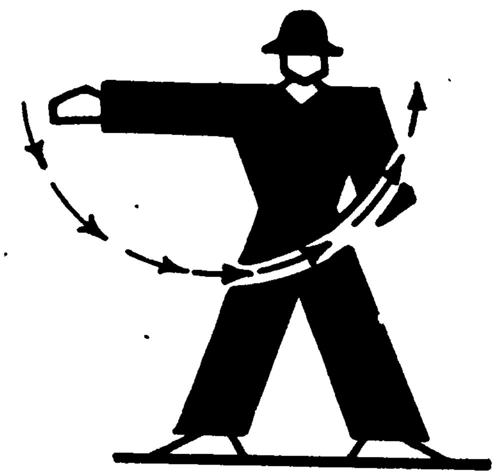
II D-1



DELIVER WATER
AT NOZZLE

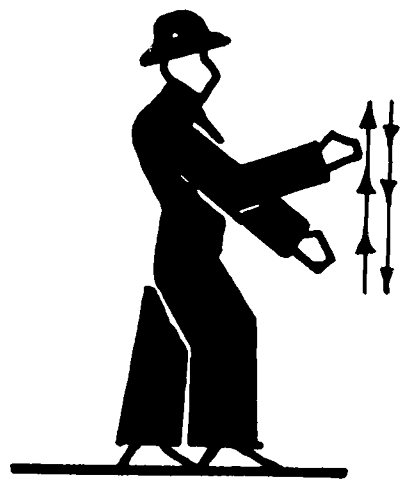


INCREASE
PRESSURE

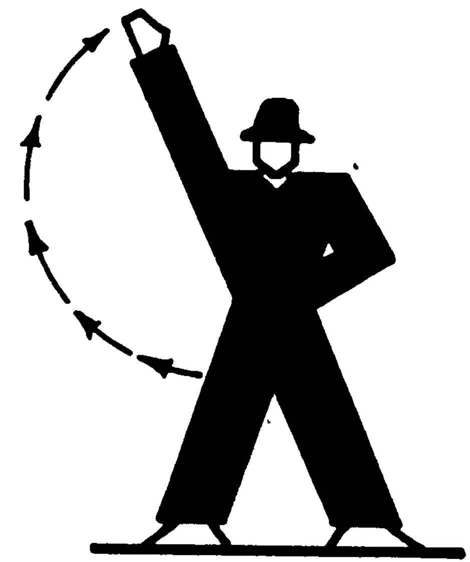


DECREASE
PRESSURE

II D-2

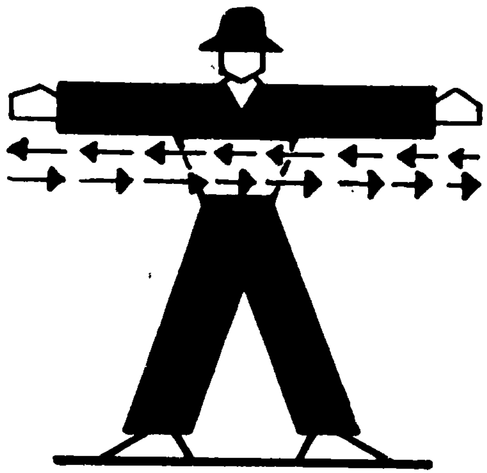


BROKEN
HOSE

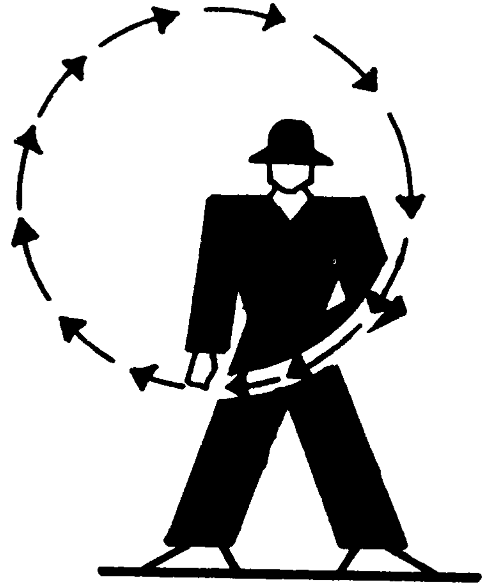


MORE
HOSE

II D-3

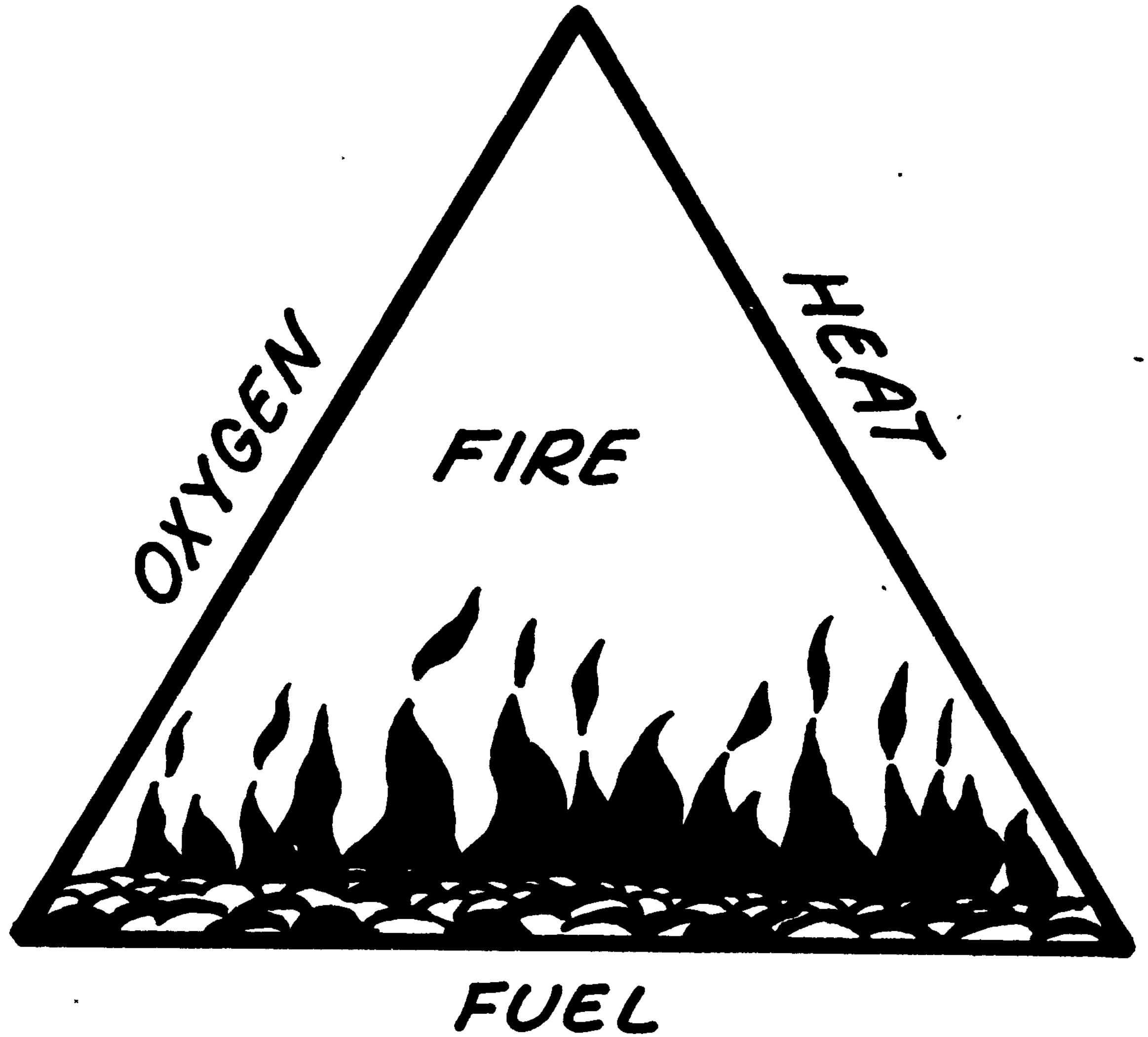


SHUT DOWN

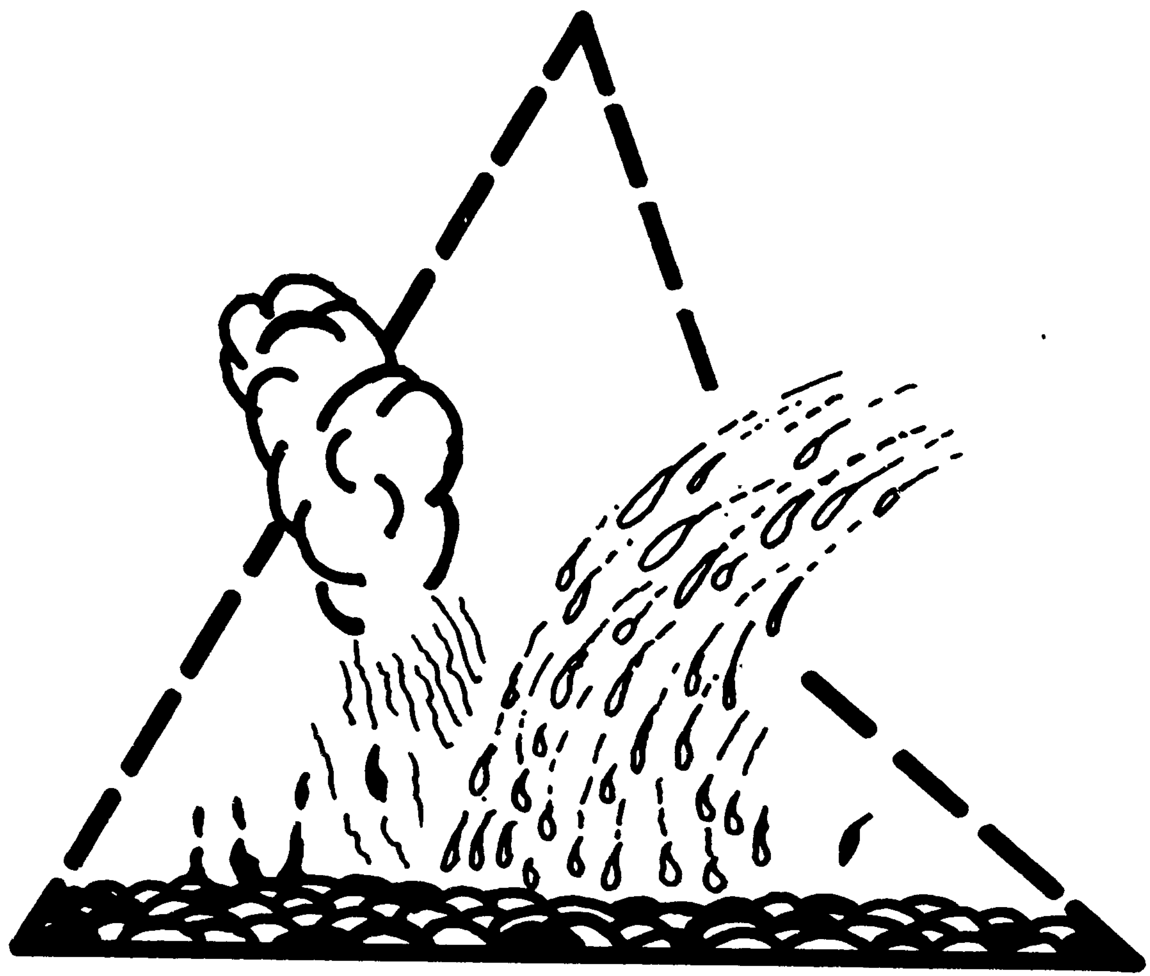


ROLL UP HOSE

II D-4

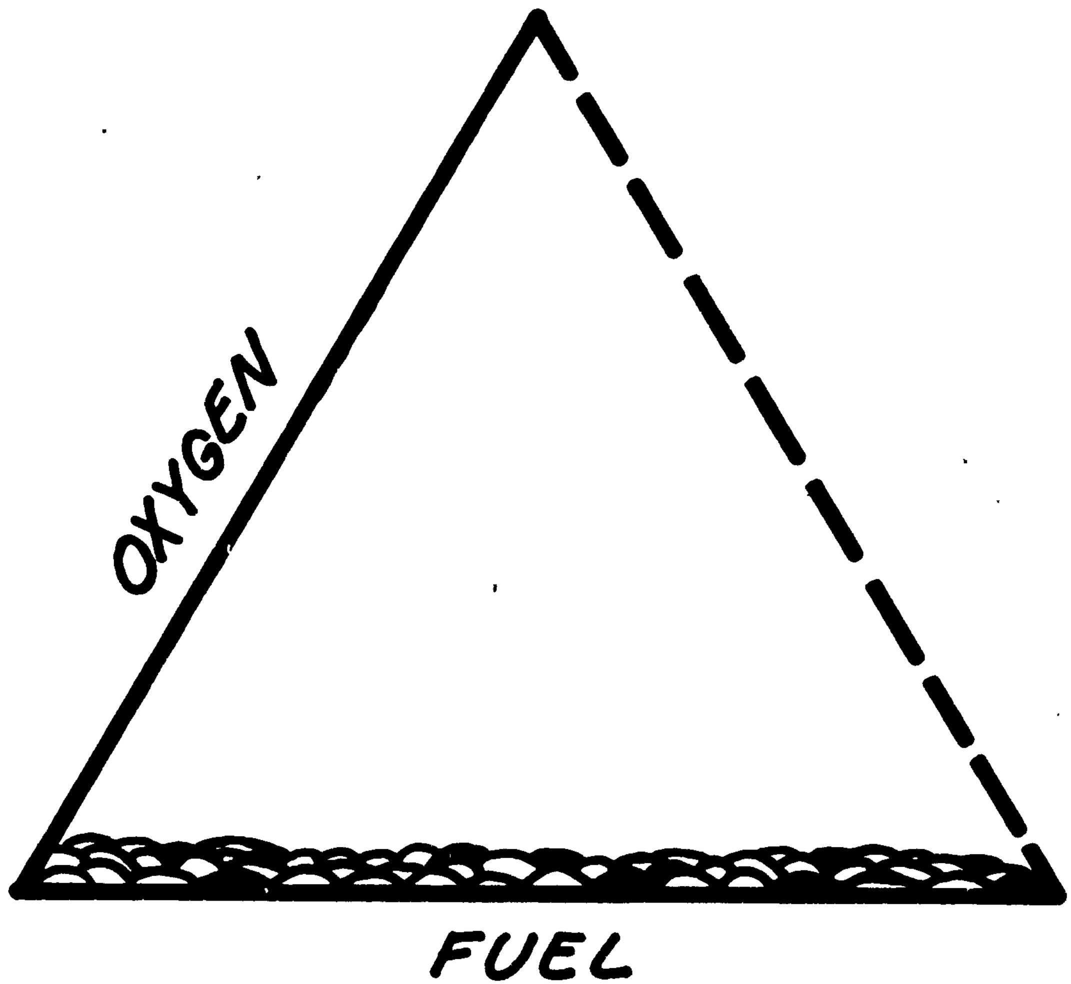


III A-1

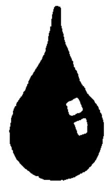


FUEL

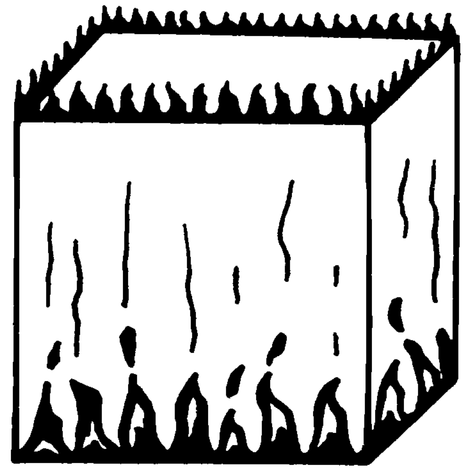
III A-2



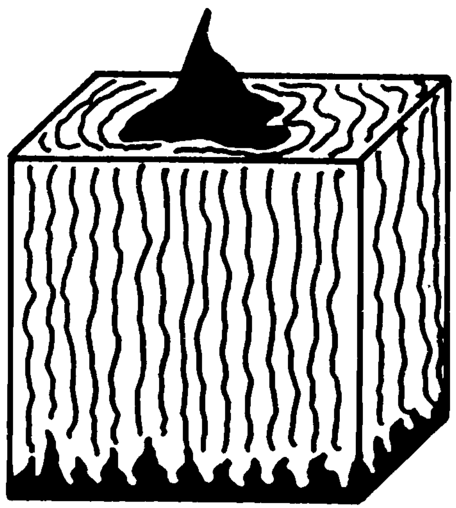
III A-3



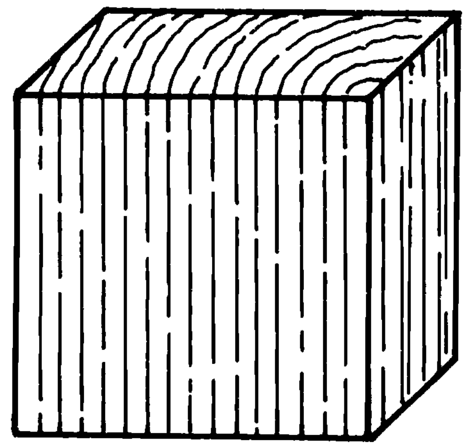
THIS IS ~
1 VOLUME OF
WATER



THIS IS ~
300 VOLUMES OF
BURNING FUEL



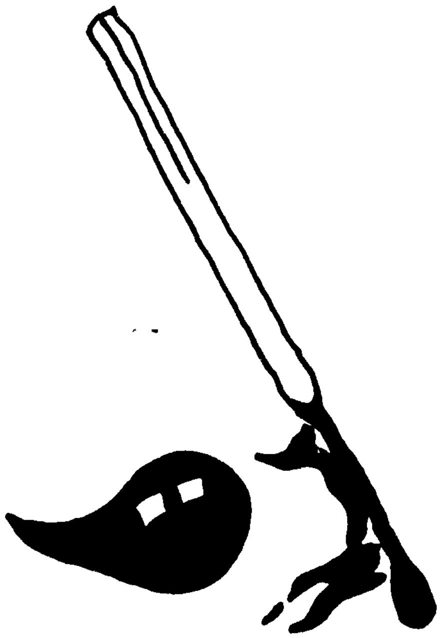
IF ~
PROPERLY APPLIED,
1 VOLUME OF WATER

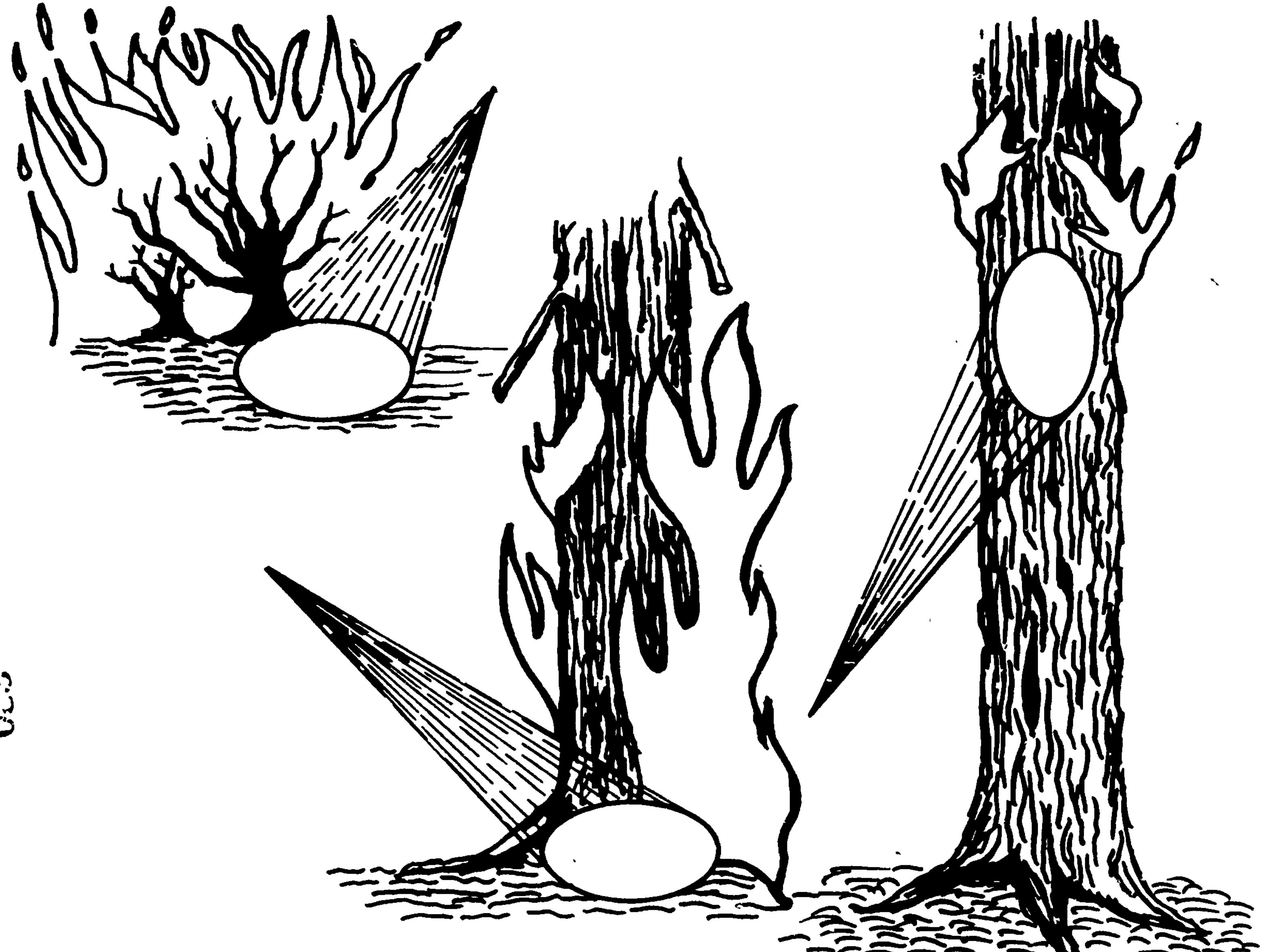


CAN EXTINGUISH
300 VOLUMES OF
BURNING FUEL

III-A-4

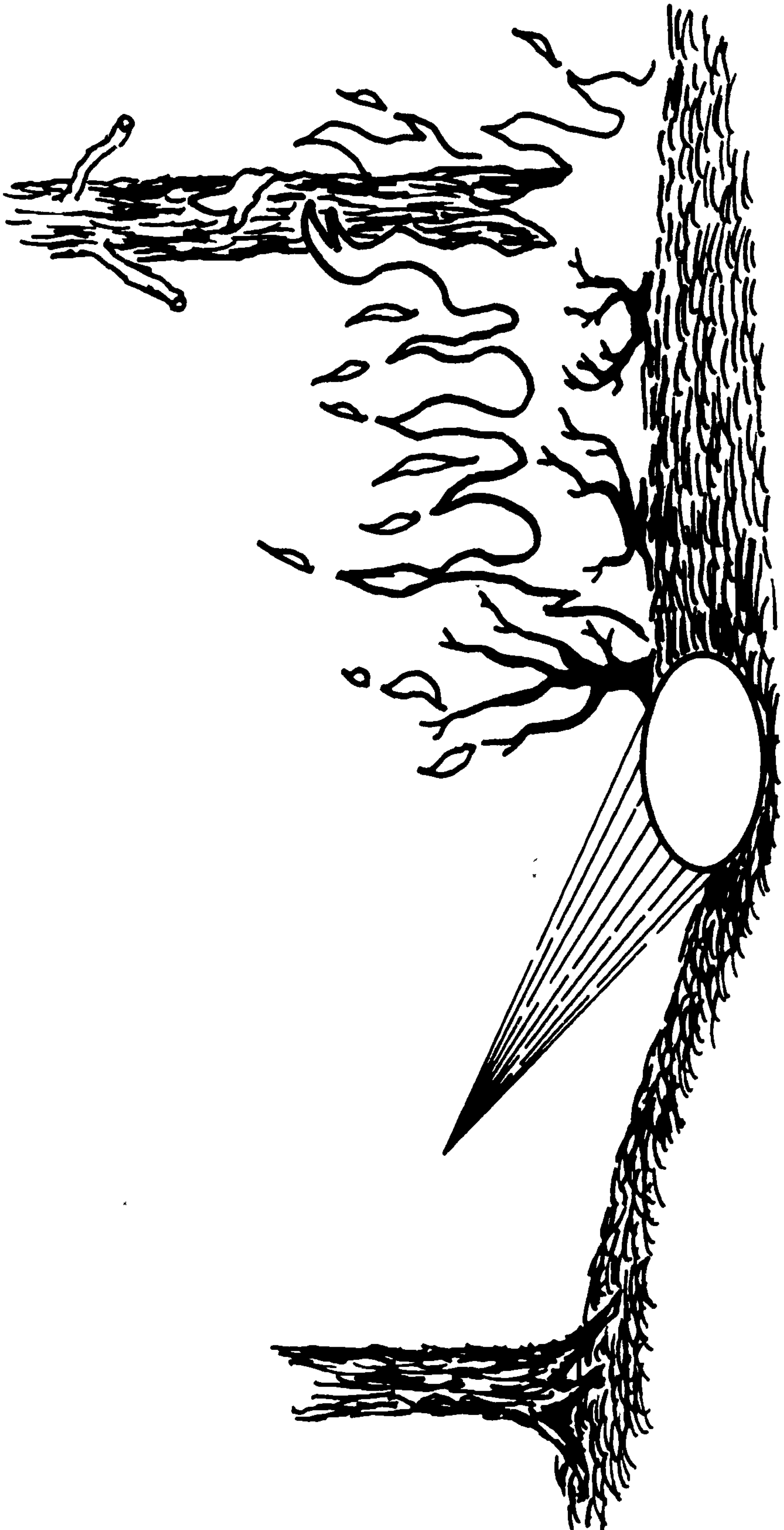
III A-5

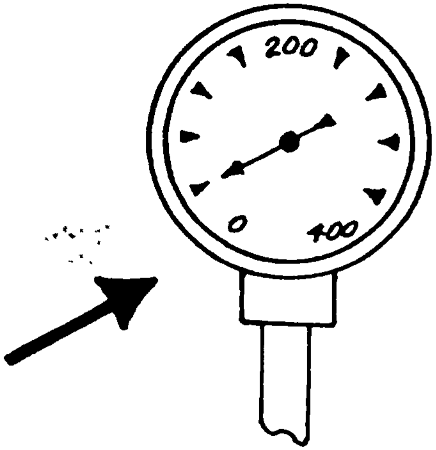


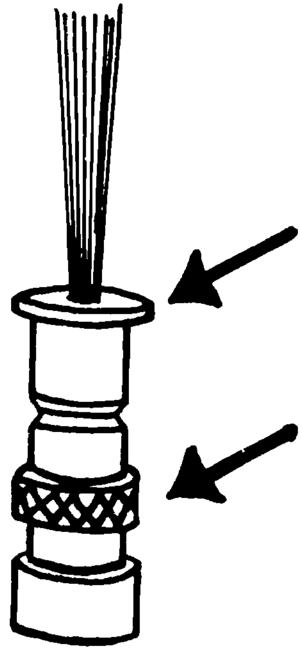


IV A-6

III A-7

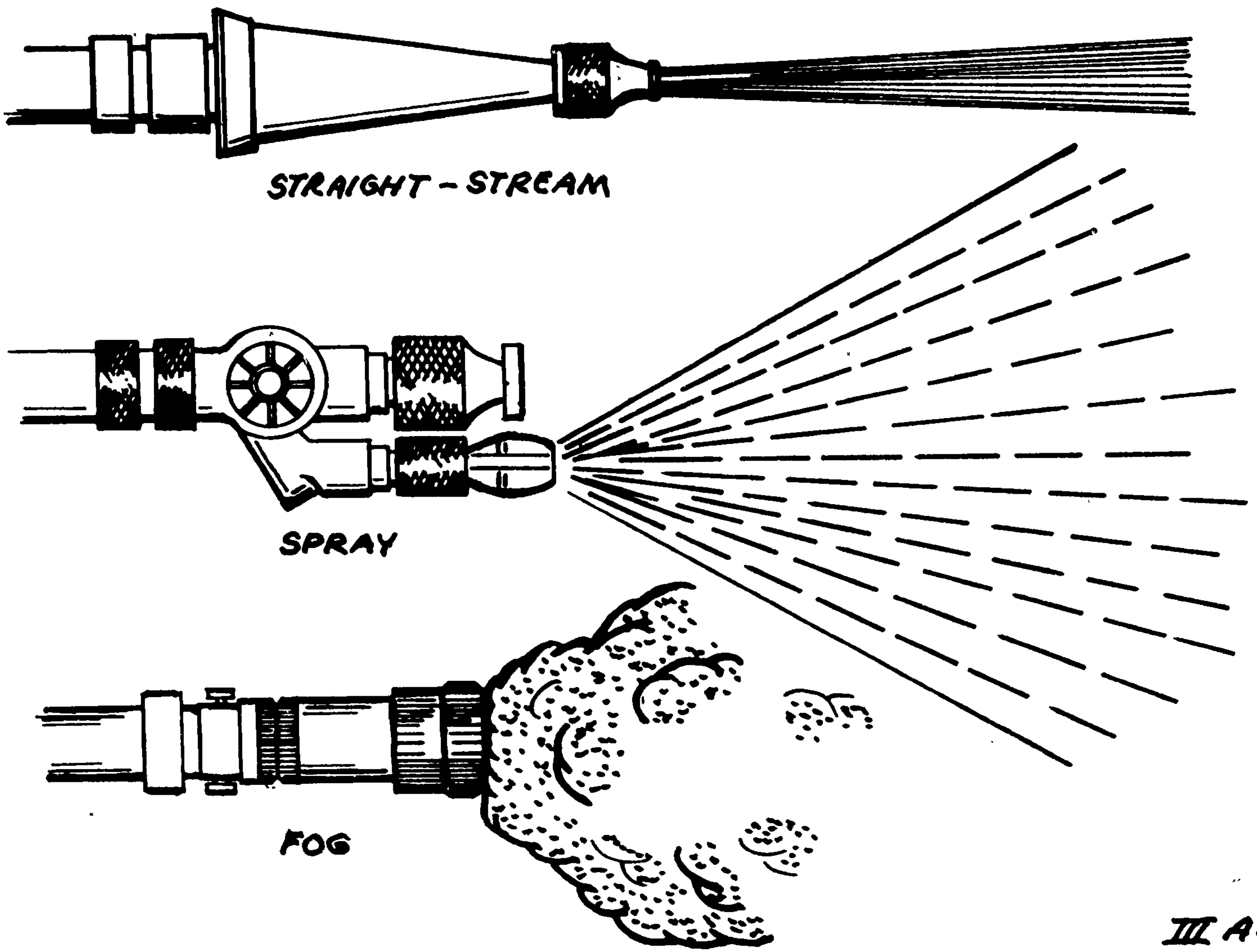




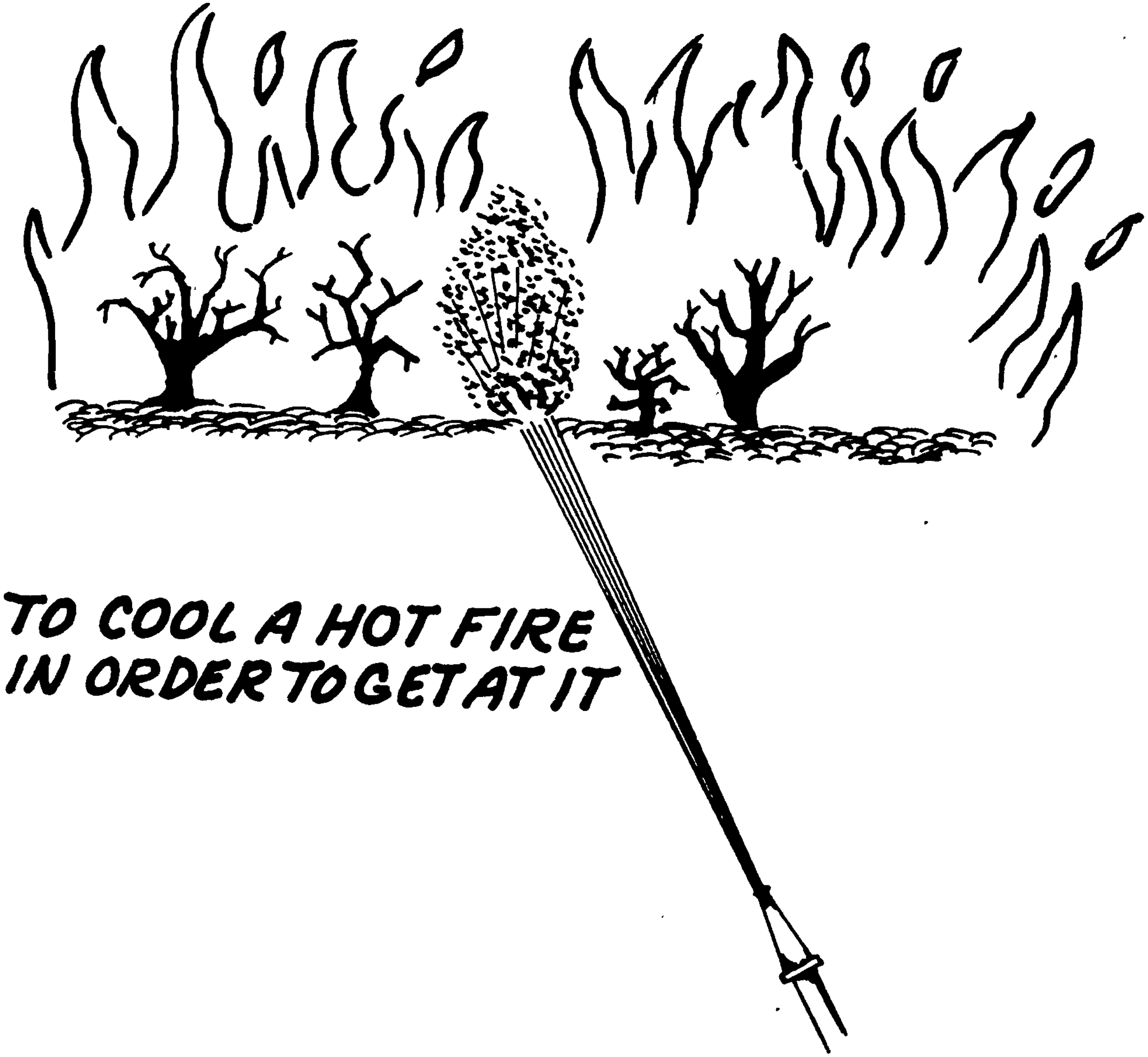


III A-8

SELECT THE RIGHT NOZZLE

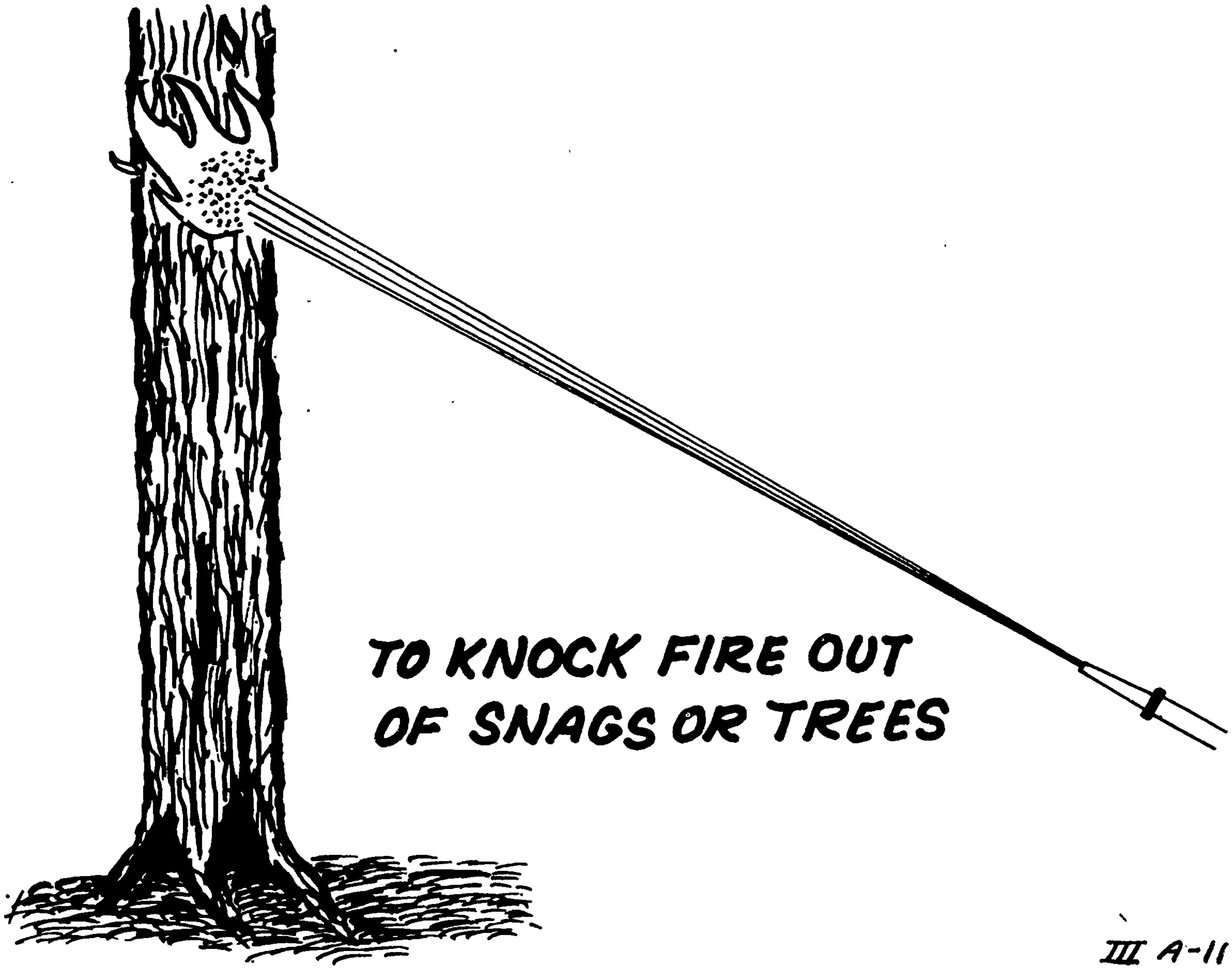


III A-9



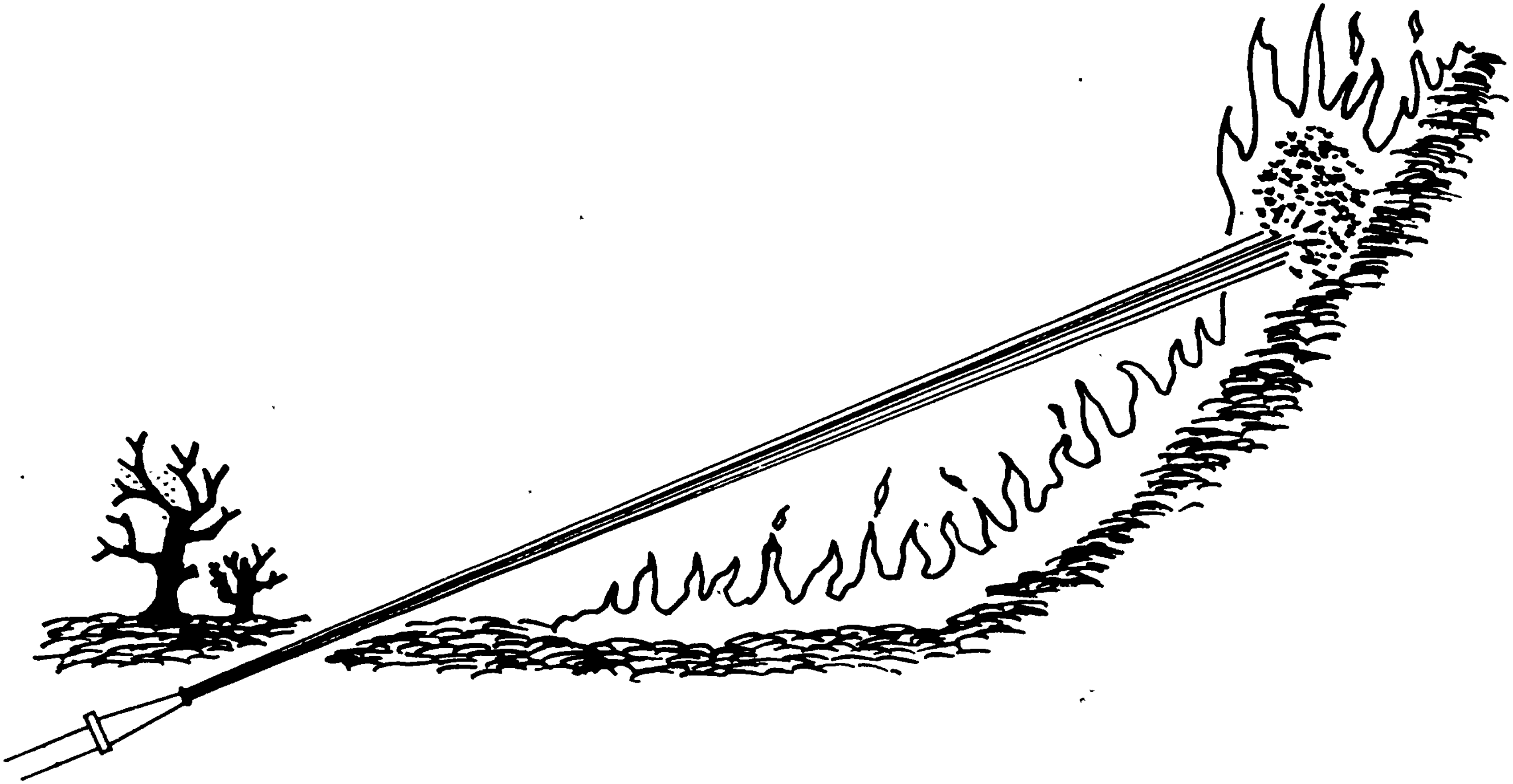
TO COOL A HOT FIRE
IN ORDER TO GET AT IT

III A-10



TO KNOCK FIRE OUT
OF SNAGS OR TREES

III A-11

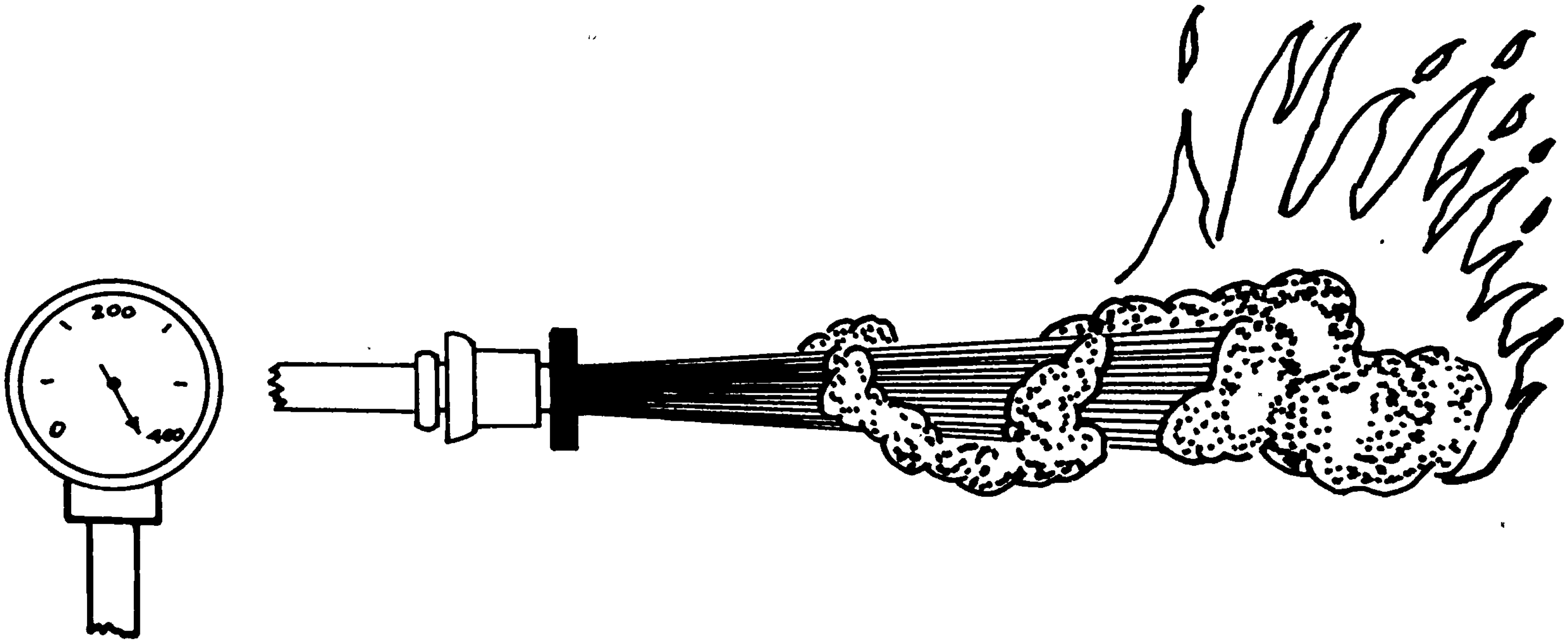


TO HIT DANGEROUS HOT
SPOTS AHEAD OF YOU

III A-12

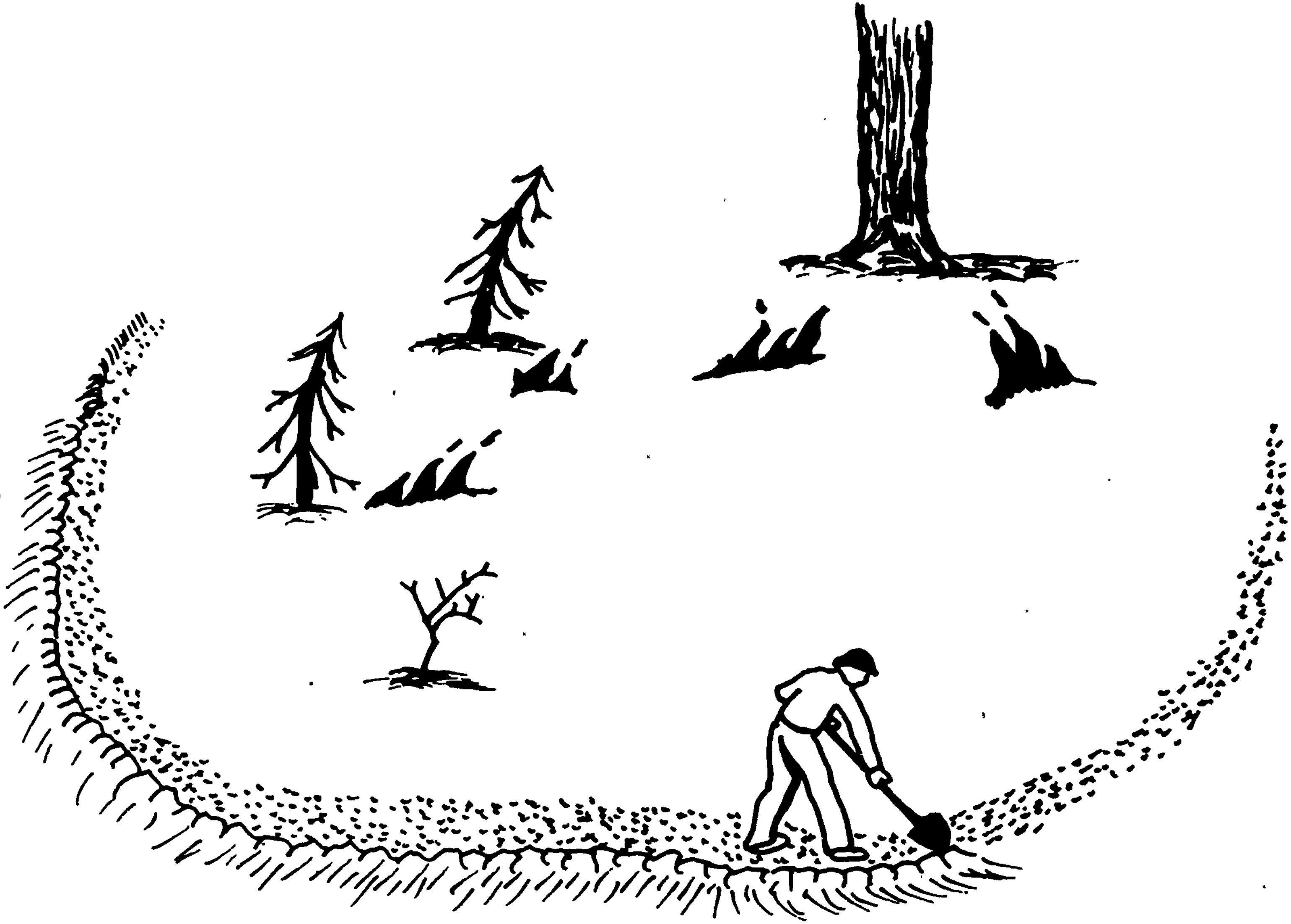
III A-13

EXCESS PRESSURE FANS FIRE



III A-14

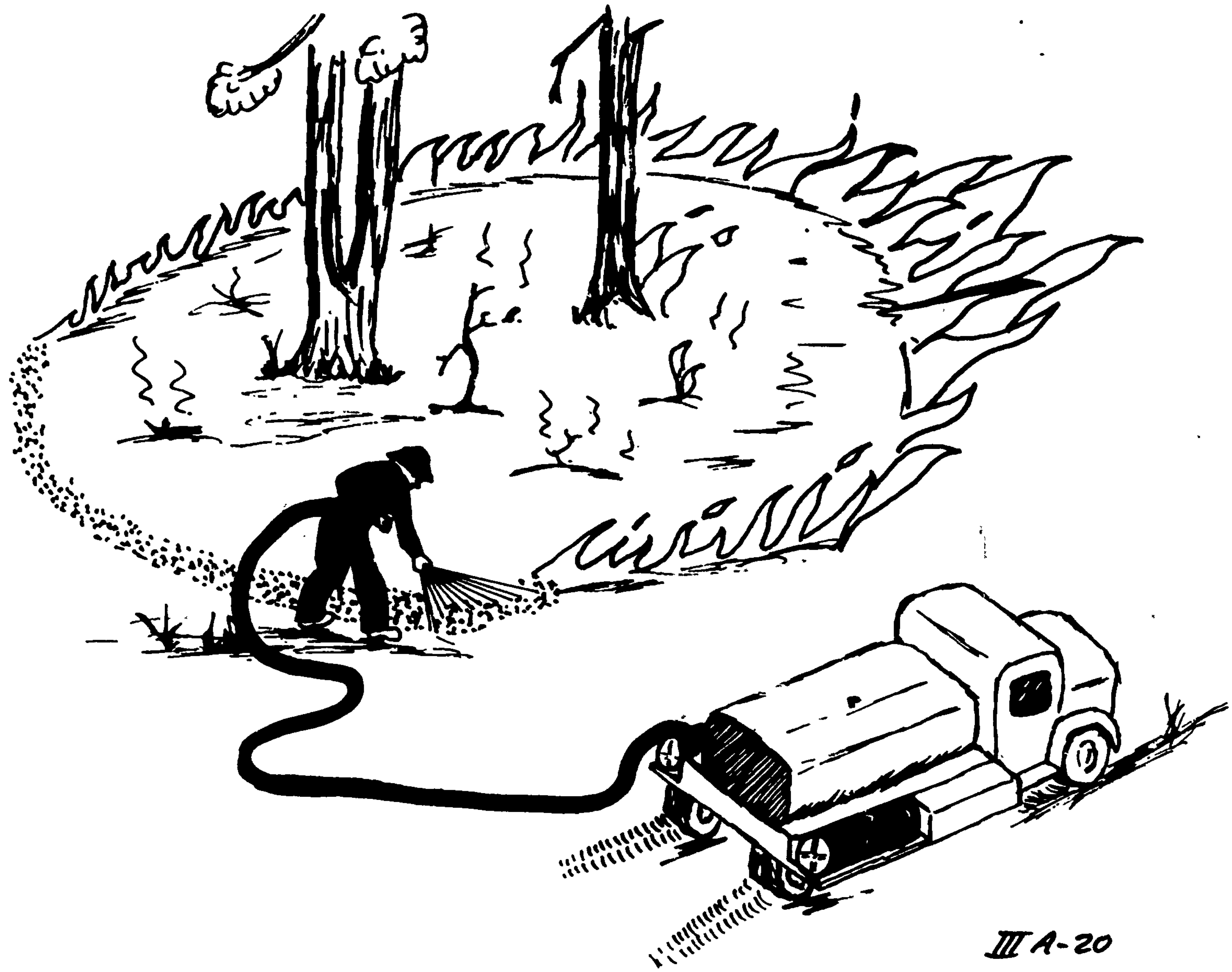
III A-15



III A-16

III A-17

III A-18



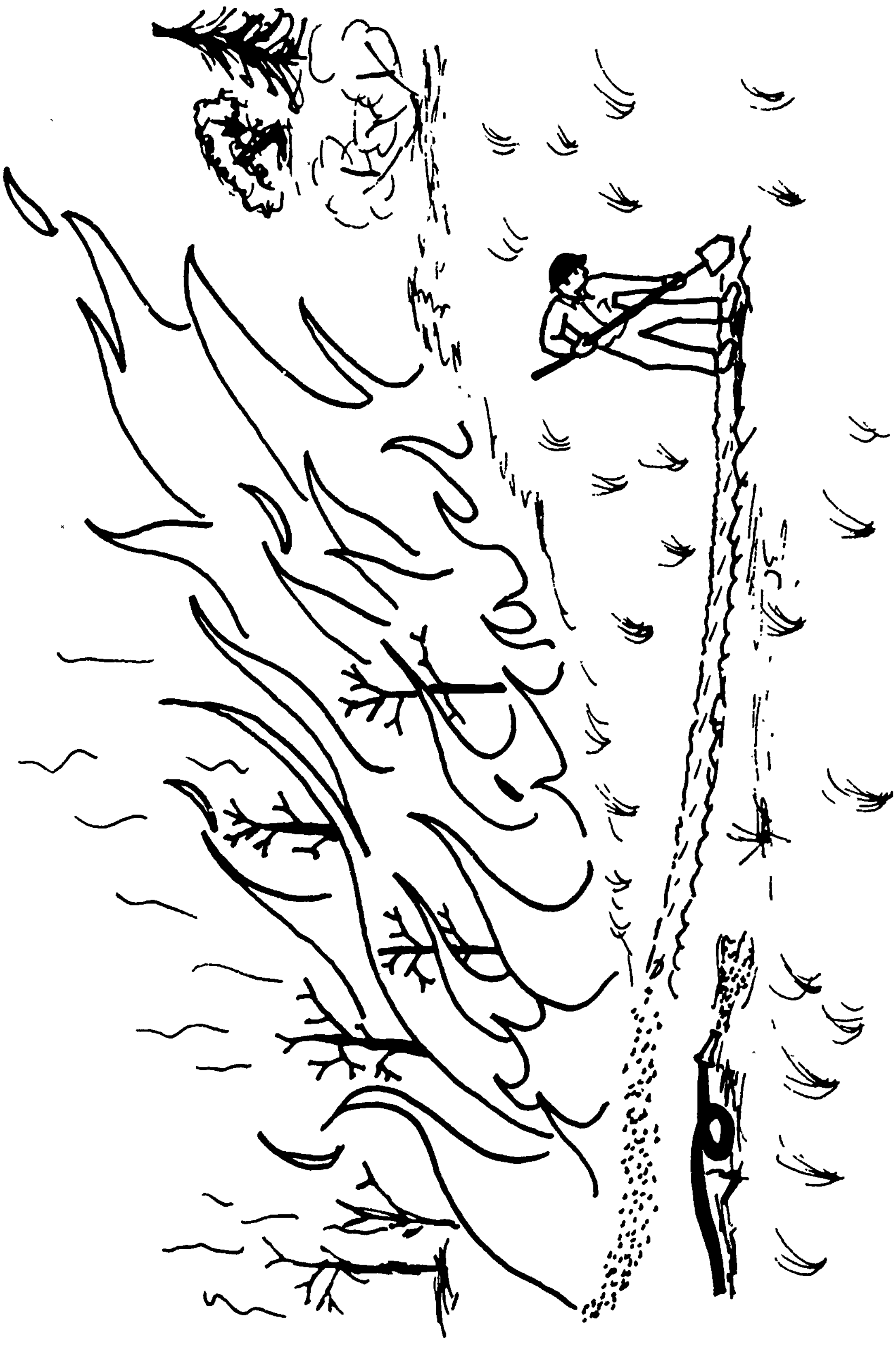
III A-20

WHILE YOU'RE WORKING ---

EVERY MINUTE <u>KNOW</u> HOW MUCH

THE TANK HAS IN IT!

III A-21

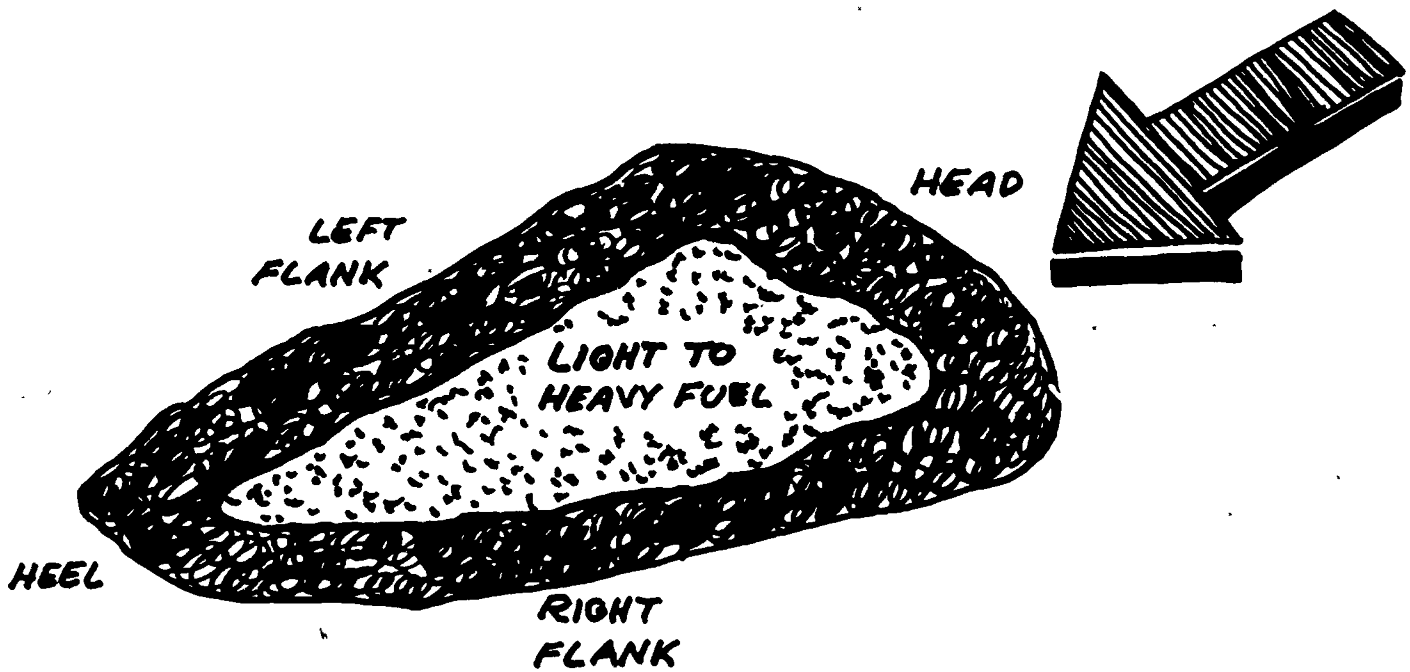


III A-22

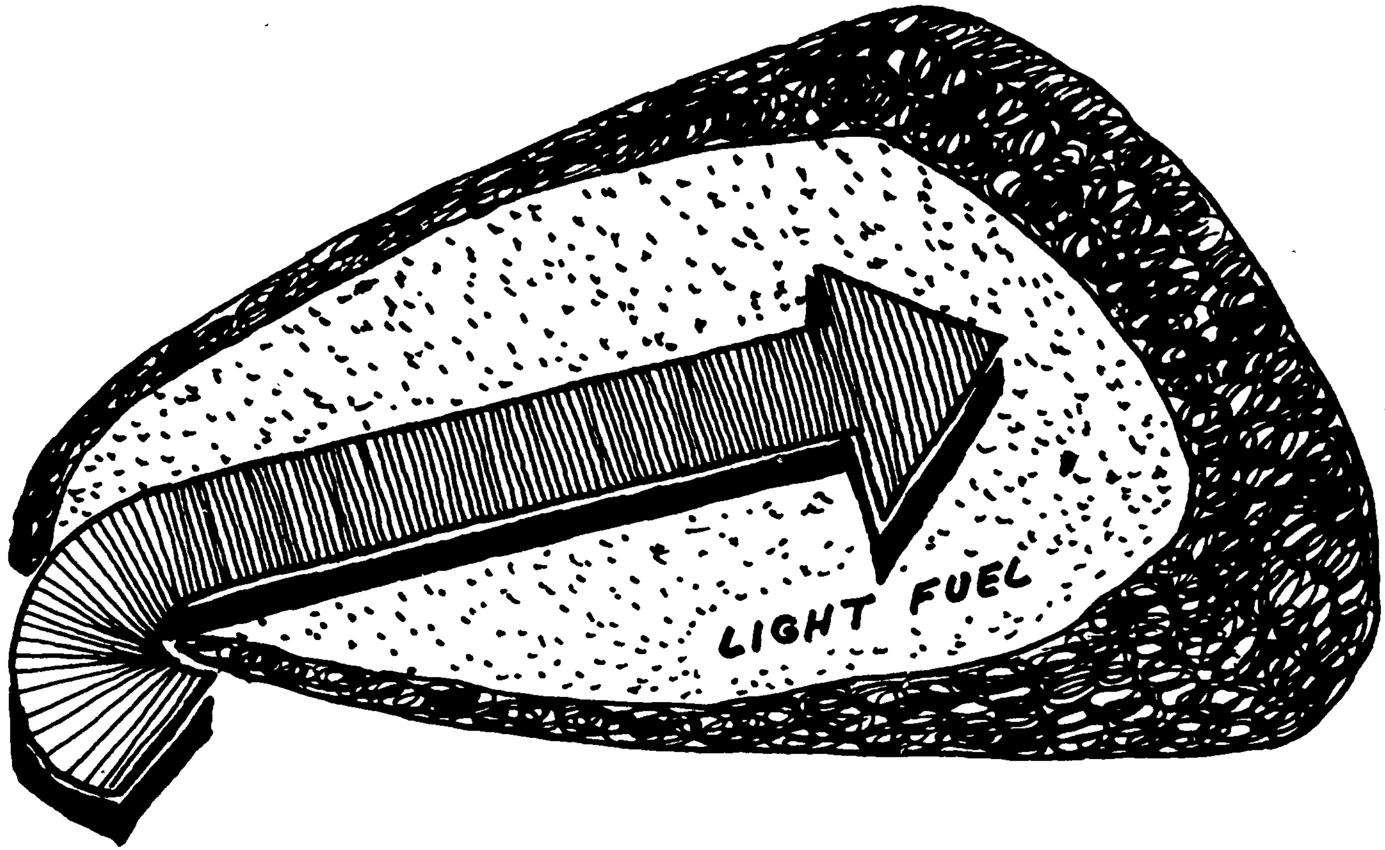
WHEN YOU CAN DO IT

HIT THE HEAD
WATER COOLS

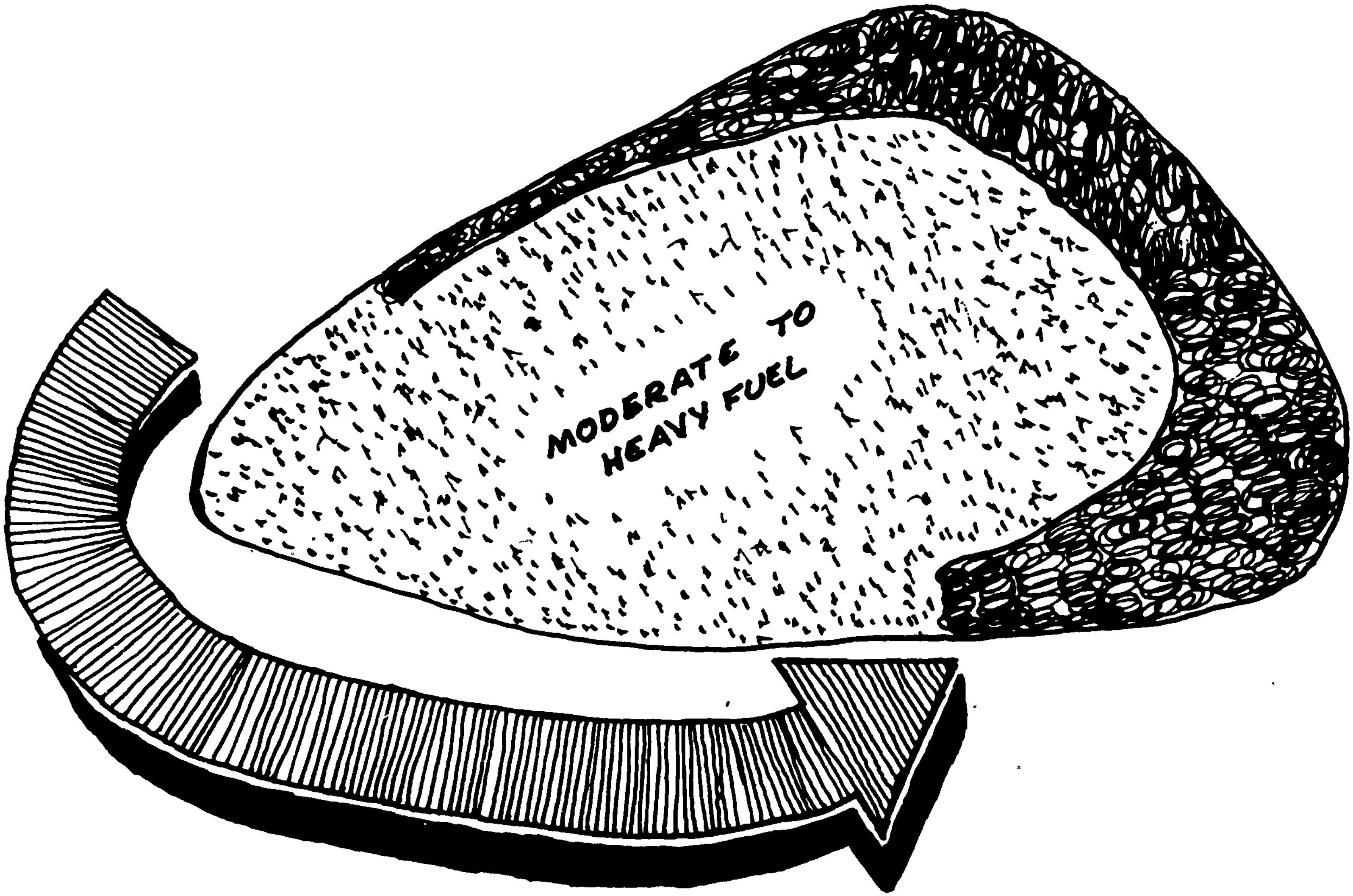
AND STOP THE SPREAD



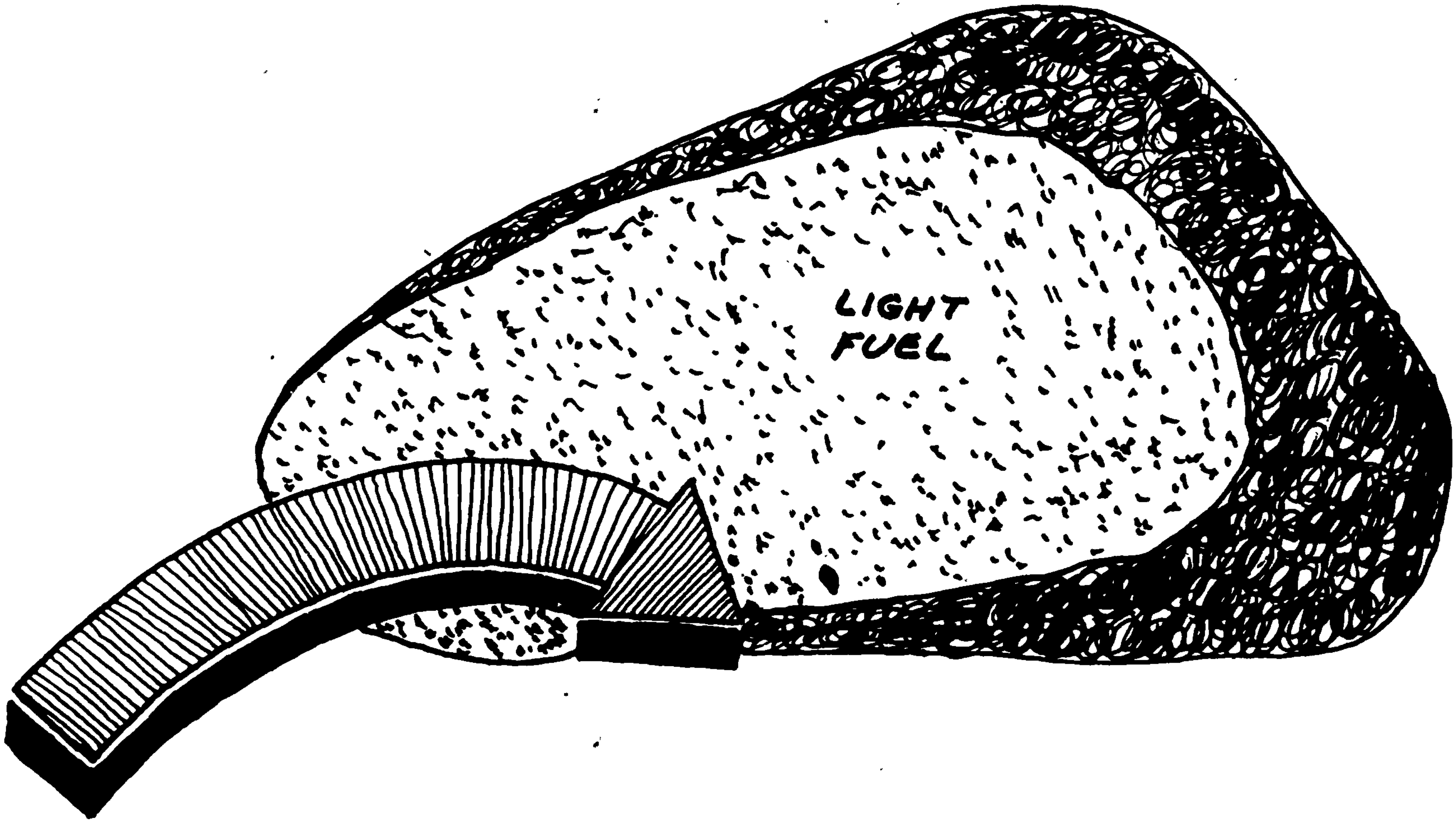
III A-23



III A-24

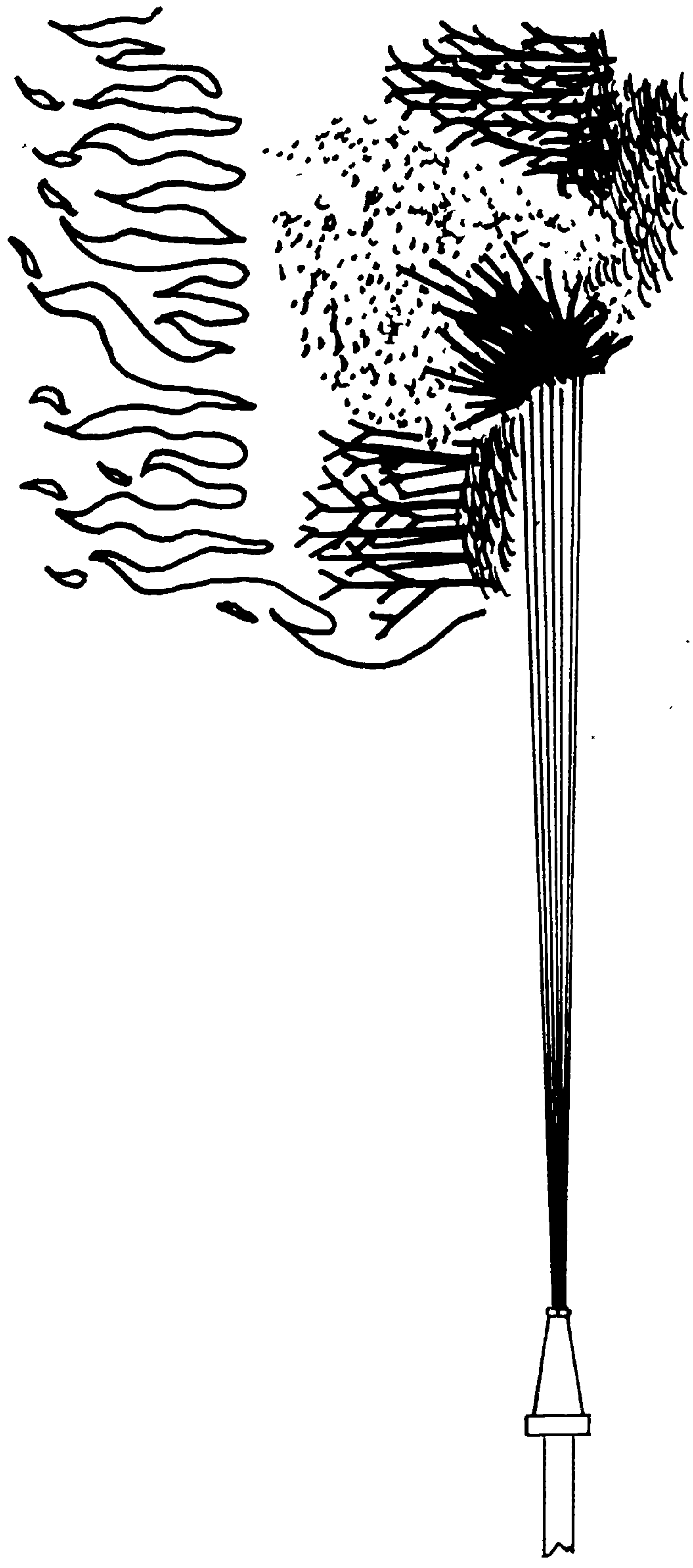


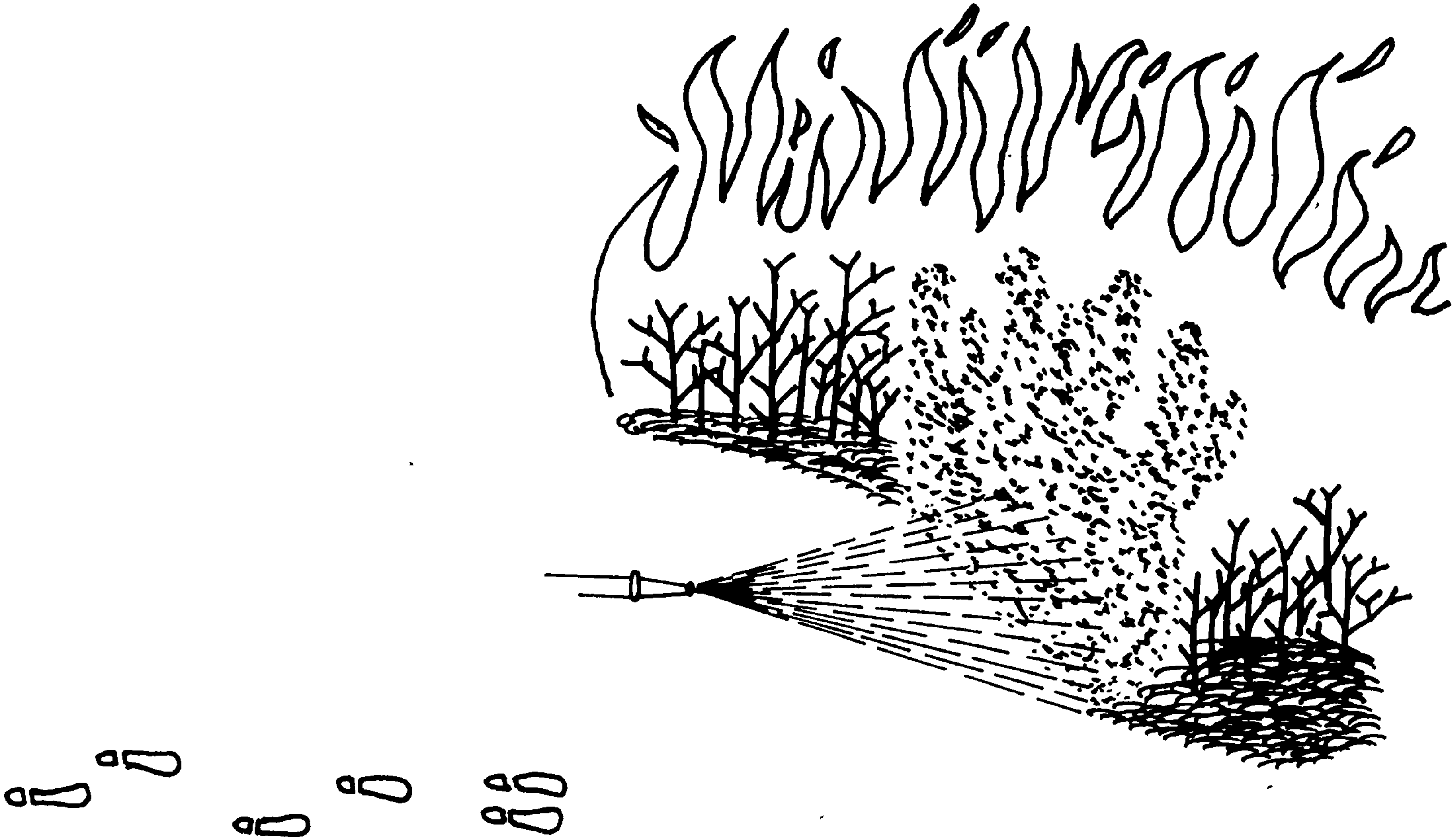
III A-25



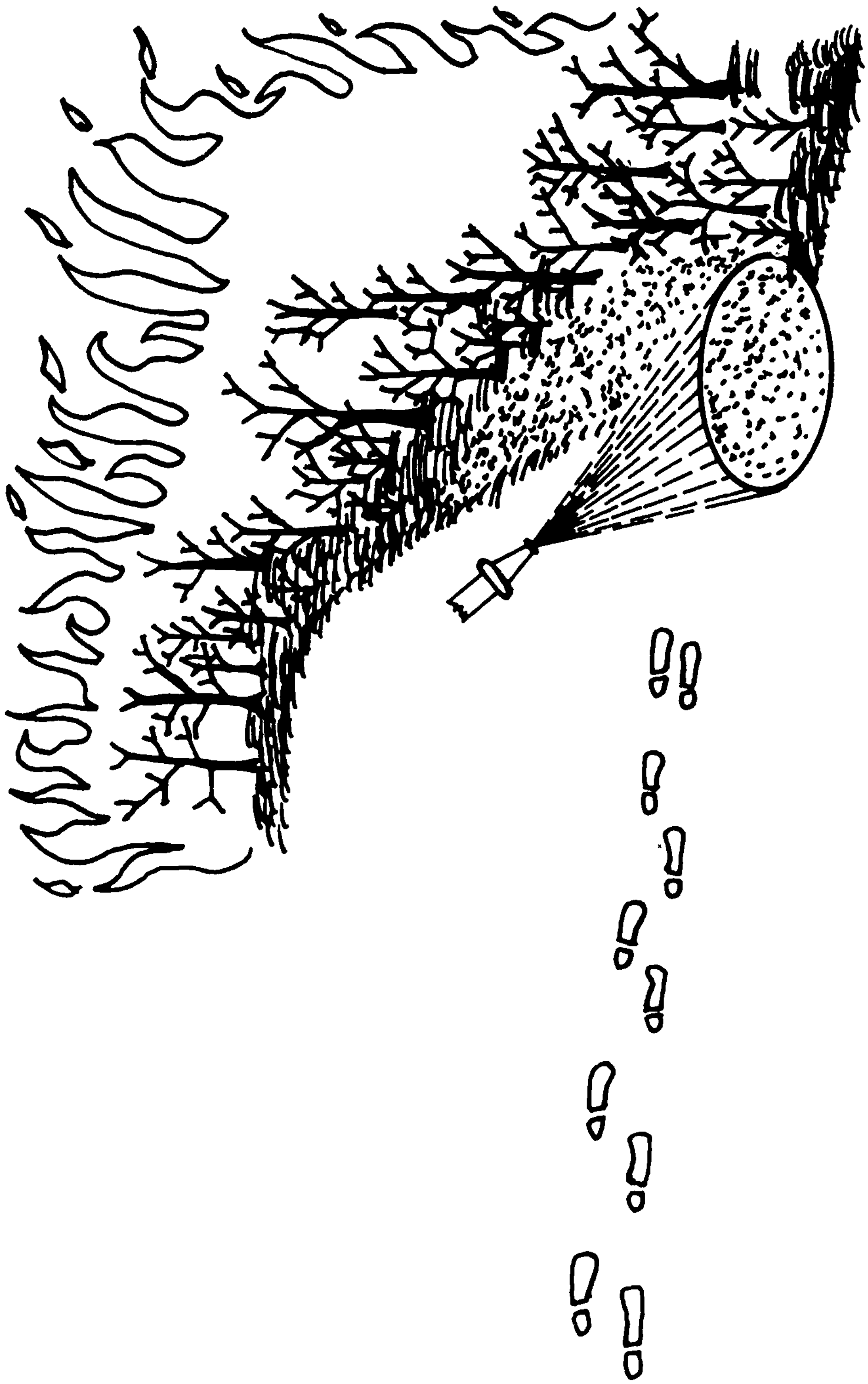
III A-26

III A-27



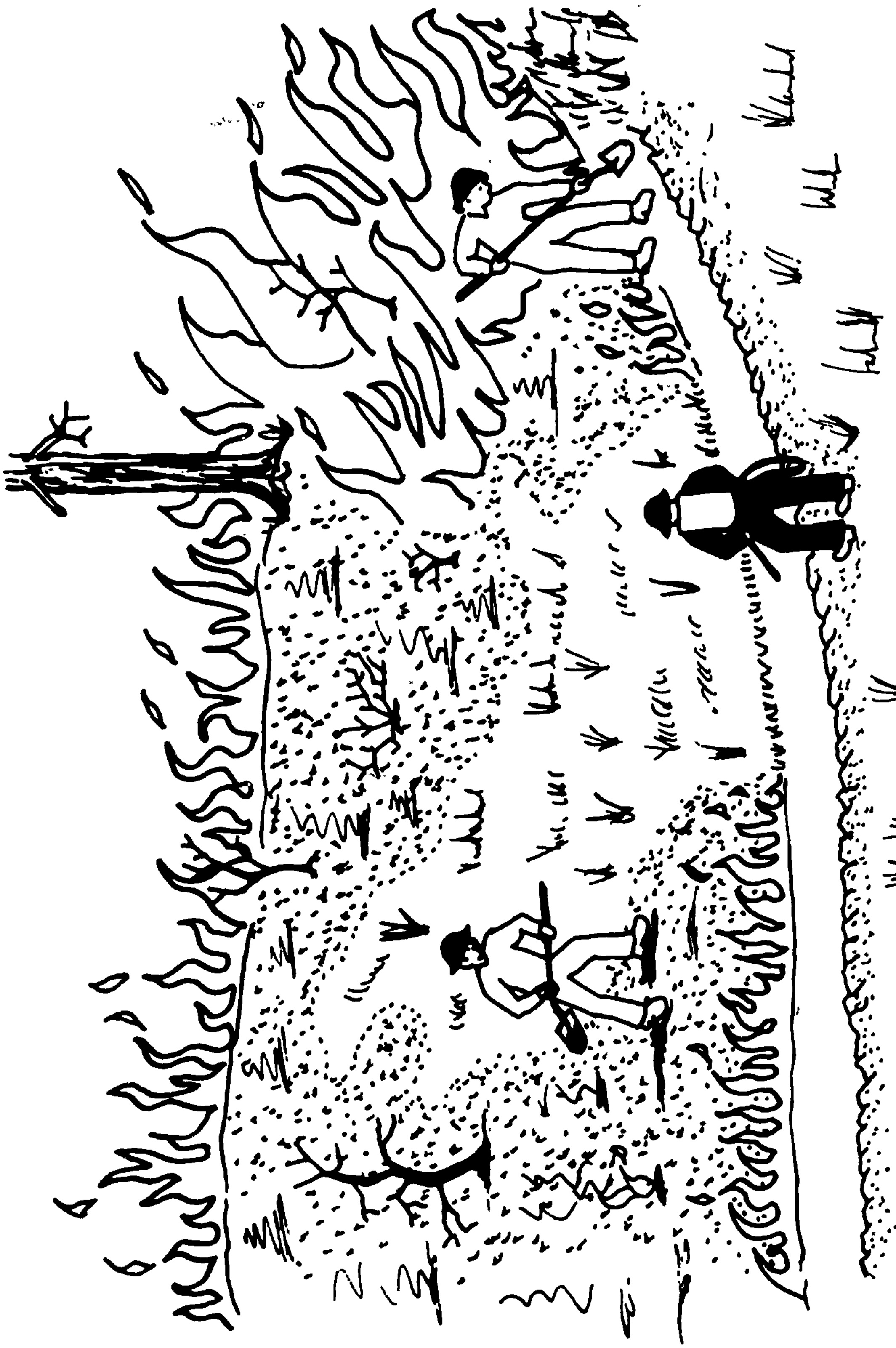


III A-28

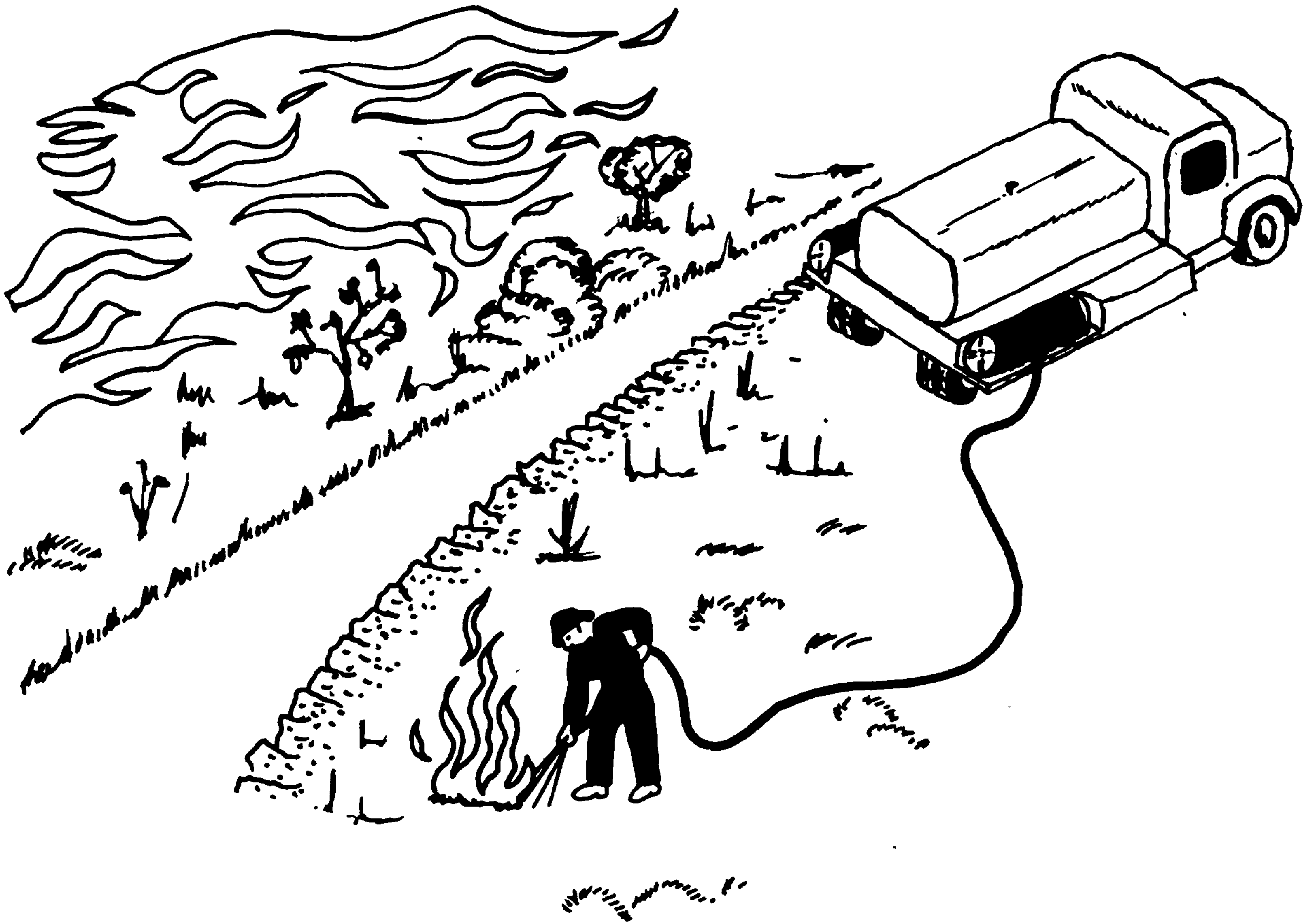


III A-29

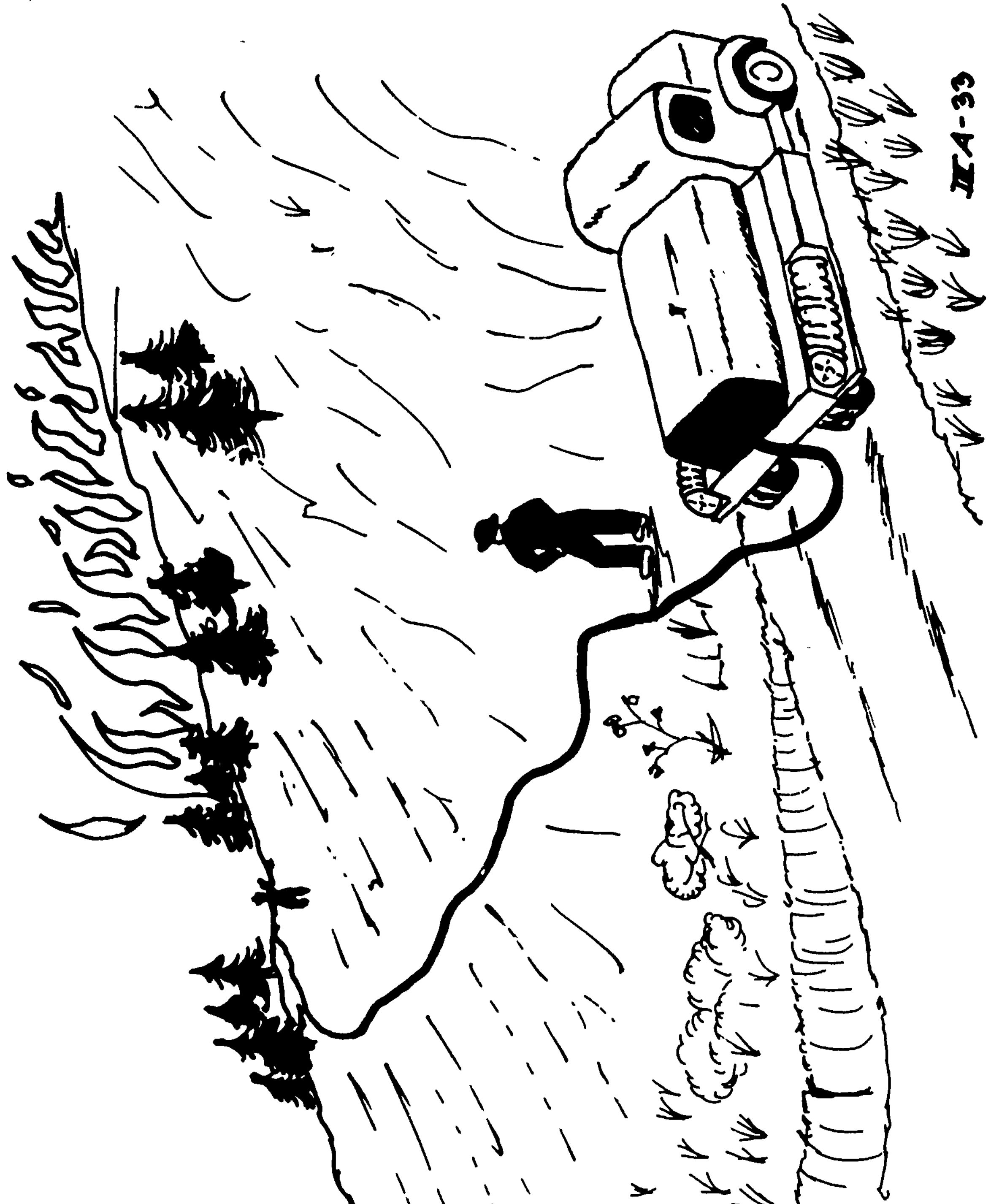
III A-30



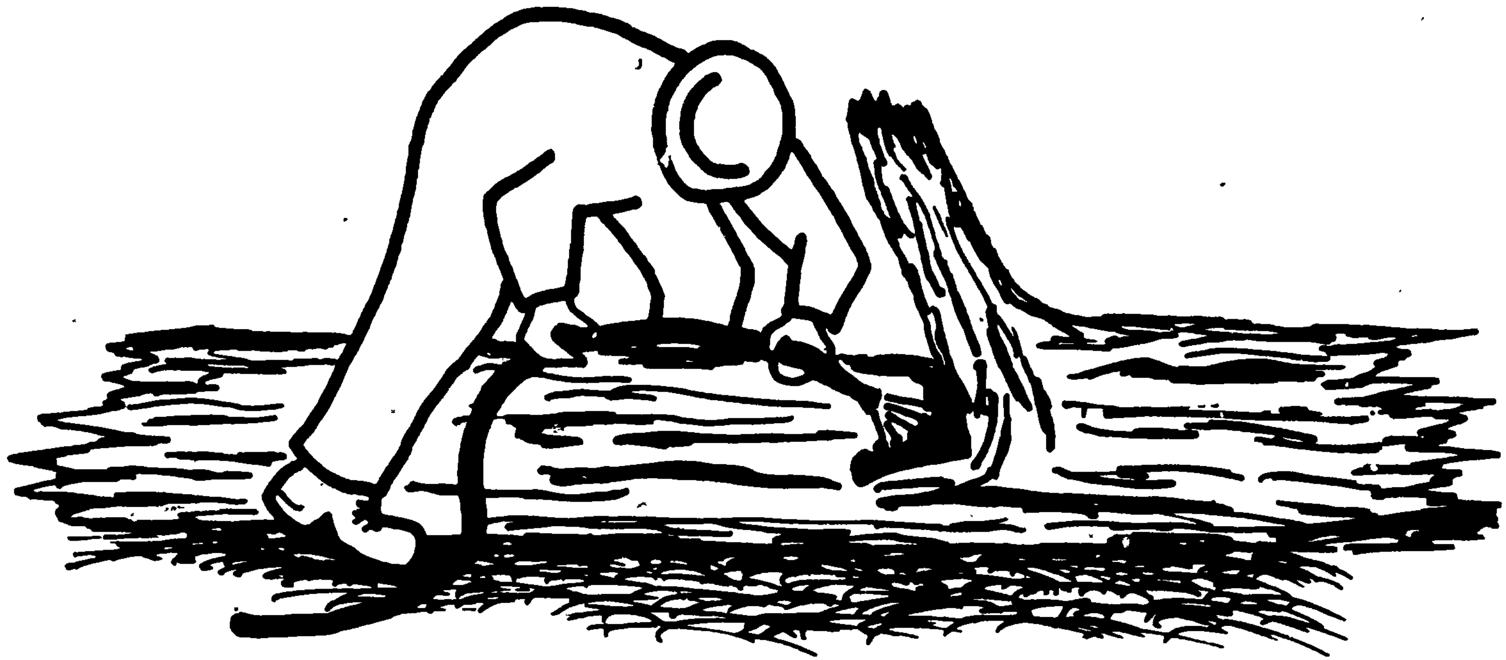
III A-31



III A-32

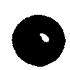


IIA-33

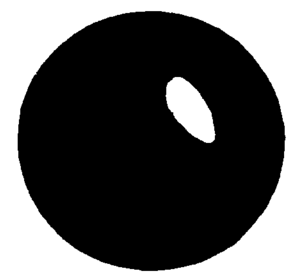


WORK CLOSE

III A-34



ONE UNIT
OF WATER TO



300 UNITS
OF FIRE IN MOP-UP

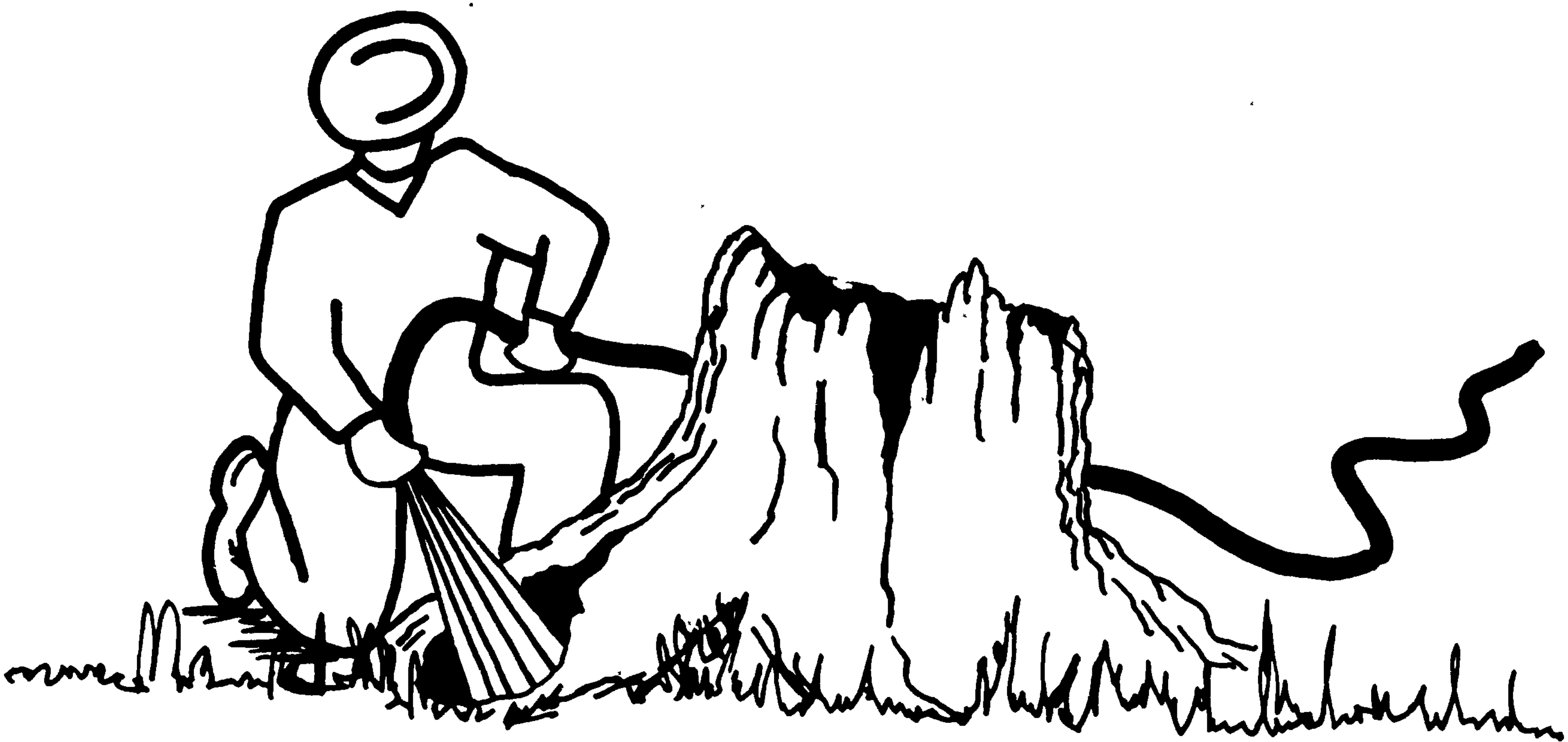
III A-35

ROLL IT OVER

III A-36

FEEL FOR HOT SPOTS

III A-37



USE WATER ON ROOTS BURNING UNDERGROUND

III A-38

KICK UP AND COOL HOT SPOTS

III A-39

RAKE ~ SQUIRT

III A-40

TANKERS

MODEL 60 PTO	275 GPM @ 100 PSI	
500 GAL. CAP.	175 @ 400	
MODEL 40 PTO	79 GPM @ 100 PSI	
75,125,200 GAL. CAP.	70 @ 200	
LOCKHEED SLIP-ON	122 GPM @ 50 PSI	
1,000 GAL. CAP.	85 @ 175	
	39 @ 250	

SLIP-ON PUMPS

CEDCO HPZZ	30 GPM @ 100 PSI	
	15 @ 200	
EDWARDS EBE	11 GPM @ 100 PSI	
	10 @ 150	

PORTABLES

GORMAN-RUPP MOD. 61½	50 GPM @ 50 PSI	
	42 @ 100	(TO 175)
PACIFIC PUMPER MARK 3	70 GPM @ 50 PSI	
	67 @ 100	(TO 250)

BACKPACK CAN

4-5½ GAL. CAP.	0.75 - 1.25 GPM

III D-1

Tip Size Inches	Minimum Stream Length* @ 100 PSI (Feet)	Flow Rate @ 100 PSI Minimum (GPM)	Flow Rate @ 100 PSI Maximum (GPM)
1/8	29	4.2	5.2
3/16	34	9.4	11.6
1/4	40	16.8	20.6
5/16	41	25.3	32.1
3/8	41	37.9	46.3

*Measured 36" above the ground and to the center of the area where the stream strikes the ground.

SPRAY TIPS. The spray requirements specify a uniform solid-cone mist with a minimum horizontal range of 12 feet. The flow rate at a tip pressure of 100 psi, must be within the range shown in the following table:

Tip Number (gpm)	Discharge Angle (Deg.) Minimum	Discharge Angle (Deg.) Maximum	Flow Rate (gpm) Minimum	Flow Rate (gpm) Maximum
3	18	22	2.0	4.0
6	18	22	5.0	7.0
8	18	22	7.0	9.0
9	26	30	8.0	10.0
12	26	30	11.0	13.0
15	26	30	13.5	16.5
18	26	30	16.5	19.5
24	26	30	22.5	25.5

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