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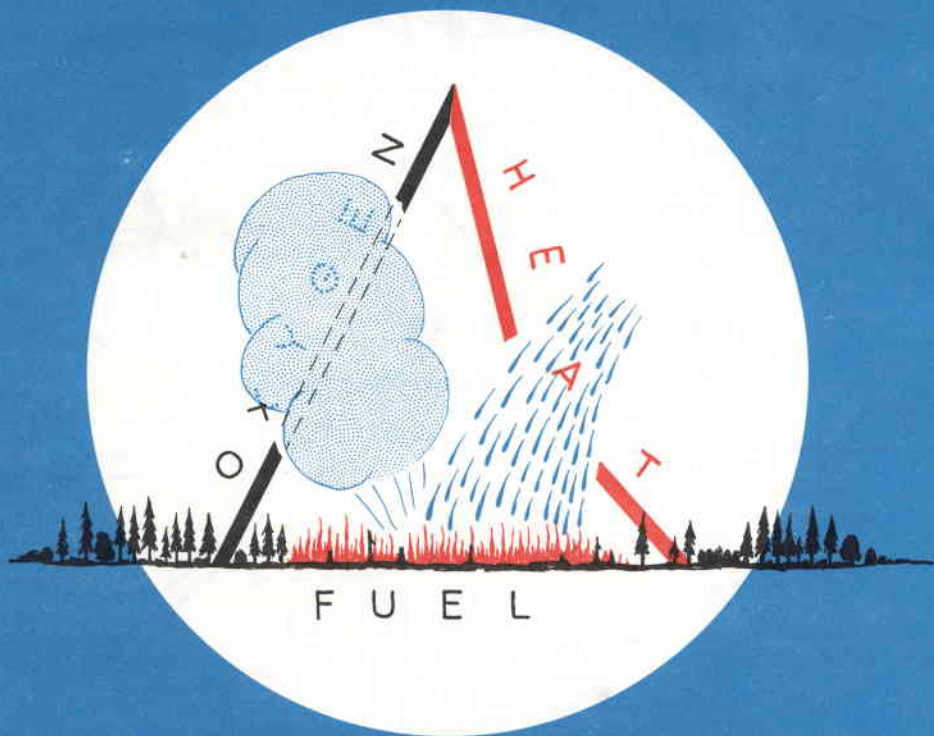
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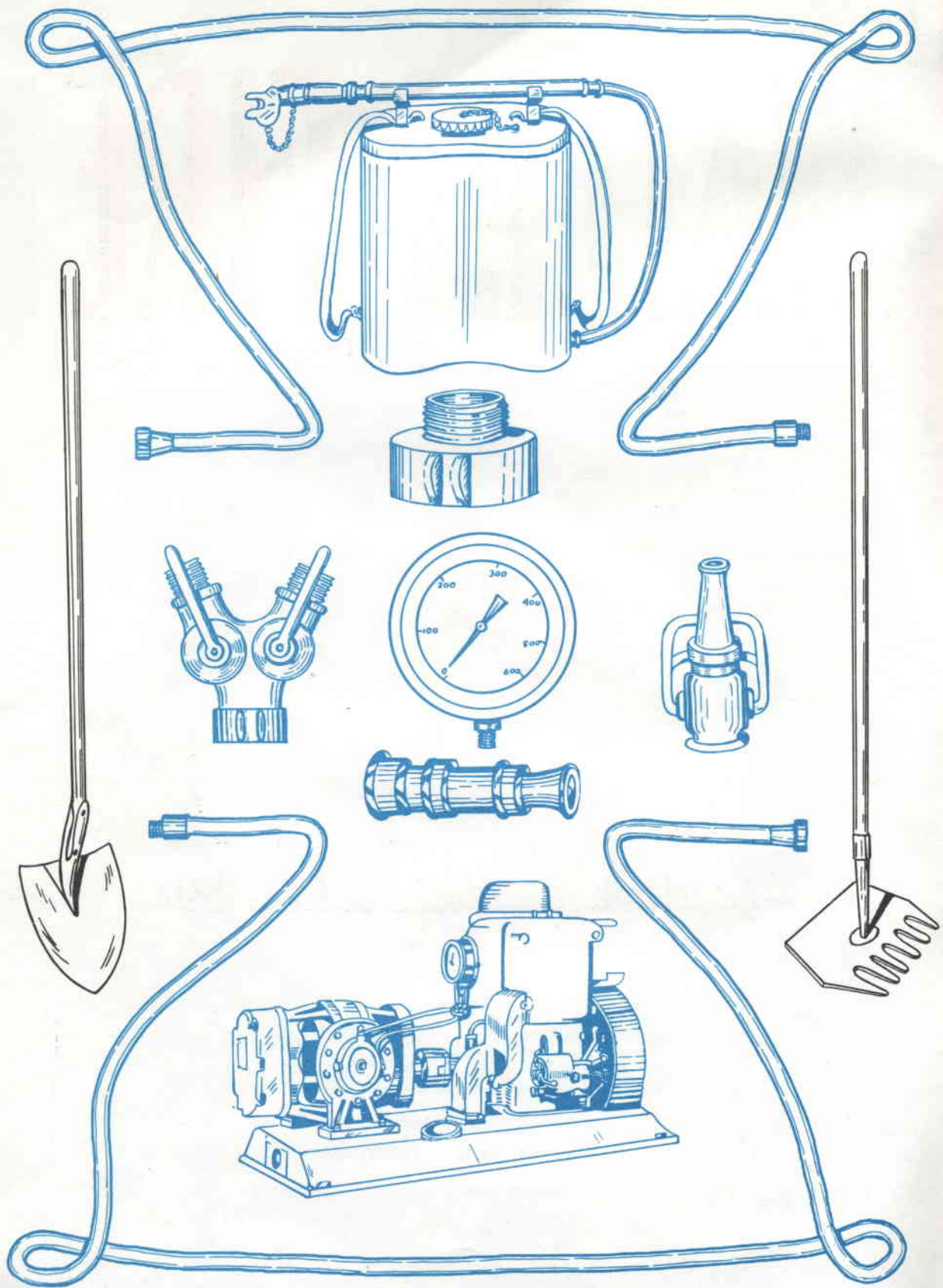
*1968*

# WATER vs. FIRE

Forestry Library



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# **WATER vs FIRE**

**FIGHTING FOREST FIRES WITH WATER**

By

**ALVA G. NEUNS**

**California Forest & Range Experiment Station**

**1968 Reprint**

*1950 original*

**CALIFORNIA DIVISION OF FORESTRY**

*Cooperating with*

**U. S. FOREST SERVICE**

**CALIFORNIA REGION**

## ACKNOWLEDGMENTS

This booklet was written from technical material assembled by fire specialists Stanley R. Stevenson, Charles R. Arment, Wilfred W. Skinner, and edited by Charles C. Buck.

Illustrations were prepared by Wayne E. Deemer, Audrey E. Kursinski, Donald F. Buckner, Roy A. Riley, Alva G. Neuns.

In addition to these members of the California Region and California Forest and Range Experiment Station of the U. S. Forest Service, and the California State Division of Forestry, acknowledgment is made to the many men throughout the United States who have contributed through their experience and research to the present widespread and growing use of water on forest fires.

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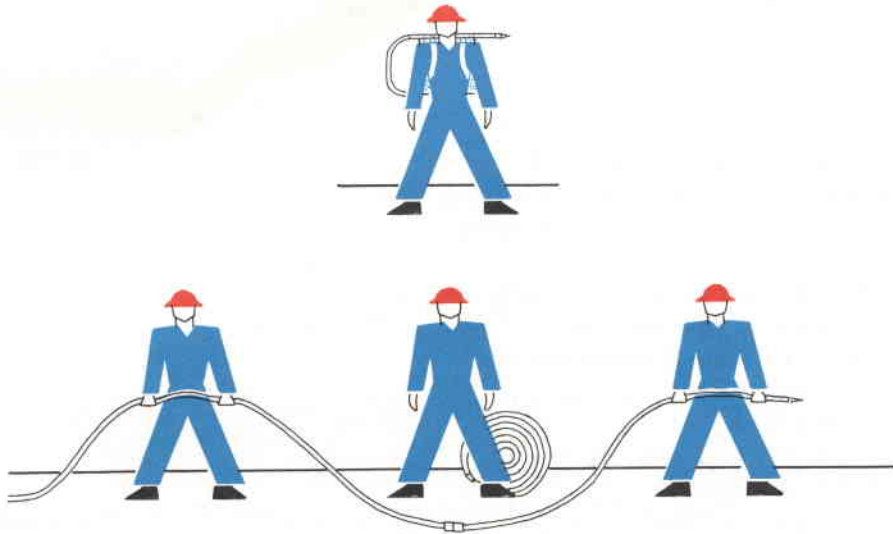
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The pictures on this page represent men who will work with WATER to suppress FIRE burning in forest areas. There may be any number of men, depending on fire conditions. This booklet assumes that you are one of them—also that you may be all of them in turn. Sometimes you'll be the whole team all by yourself—but usually in cooperation with others.

Obviously, every fire condition and fire problem cannot be covered, but you will always find that water will allow you to make direct attack more often and corral fire faster—with less work.

The primary purpose of this booklet is to show you ways to fight fire with water, how to make a little water do a big job and the why, when and where of doing it.

This booklet will not do any of these things for you. You will need much in the way of practice to get the "feel" of the job for yourself.



THERE'S LOTS OF SWEAT IN FIRE YET and there probably always will be. Nobody is going to argue that one—but you can save buckets of it if you save water all the way. If the fire isn't out when you run out of water, you're going to have a long way to go with a shovel; and it's hard work—remember?

Anyhow, the idea is to keep the damage low. That's what you're out there for in the first place. If you aren't interested in how much valuable timber or watershed or stock range is going to burn—drop back a couple of miles to where the going is easier and holler for a fleet of bulldozers. Of course, another of your responsibilities—the one of keeping costs down to a minimum—might be hard to carry out in that case.

Instead of asking your boss for a transfer to trail work or a lookout job (you've got to save water there, too, if you like to drink the stuff) it would be well to learn a few tricks of the water-fireman's trade:



**SAFETY.** Just because fighting fire with water is the safest way known, it won't make you accident-proof—nobody ever is. So stick to your safety rules.



FIRE DOESN'T LIKE WATER MUCH. Water can be a mighty formidable enemy of fire as you can see, if you consider the triangle on the left. There is usually plenty of fuel around. There's plenty of oxygen too—if there wasn'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

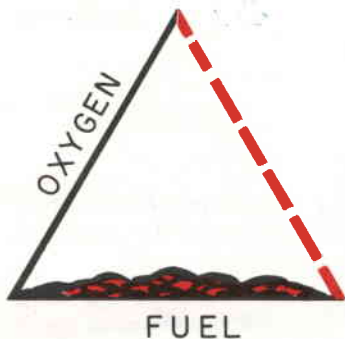
form a closed Triangle Corporation called FIRE. One of the best ways to break it down is to



C-O-O-O-O-L THE FUEL.

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 this is important. It has a way of getting back together again—and that's why it is always a good idea after you've knocked FIRE down with any cooler—to put a line around it and keep it down.





YOU GET 100% if you can do the trick shown in the pictures at the right. 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.

The flame will burn merrily on unless the water spreads over the fuel and cools it down below kindling point.

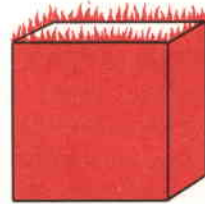
The same is true on the fire line. It'll take very little water to cover volumes of fuel—especially if you break the water up into a spray—because then many single droplets can cool many units of fuel—simultaneously.

If your weapon is water, use it sparingly. Of course, it's possible to be too saving. Remember:

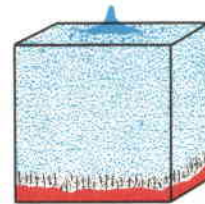
Burning litter, grass or duff,  
NOT TOO LITTLE—JUST ENOUGH  
Logs that smoulder, trees and such,  
NOT TOO LITTLE—NOT TOO MUCH.



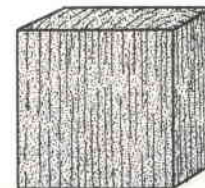
THIS IS  
1 VOLUME OF WATER



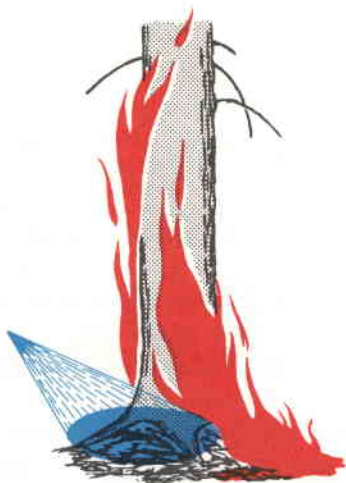
THIS IS  
300 VOLUMES OF  
BURNING FUEL



IF~  
PROPERLY APPLIED,  
1 VOLUME OF WATER



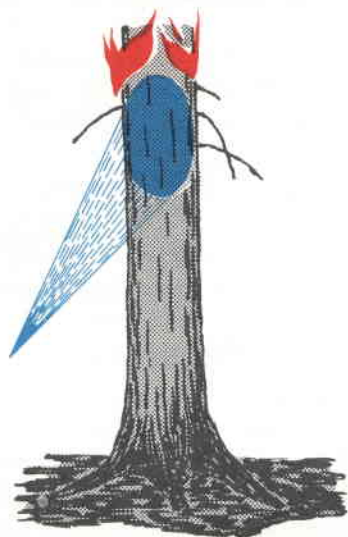
CAN EXTINGUISH  
300 VOLUMES OF  
BURNING FUEL.



A LITTLE SPRAY GOES A LONG WAY toward knocking down a lot of flame, *if* you put it where it will do the most good. The tiny drop of water put out the burning match because you hit the base of the flame. Where there's smoke there's fire; where there's fire there's burning fuel, and it's always at the root of the trouble. So—

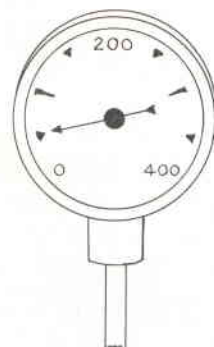
Whether water knocks the flame  
Depends a lot on how you aim.

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.



to  
land  
on.

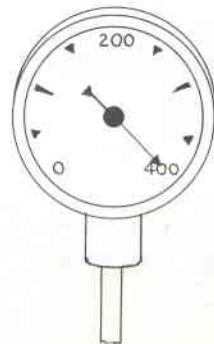
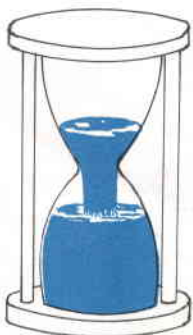




TIME WAITS FOR NO MAN—neither does fire. Water gets away just as fast unless you prove who's boss and control it. Whenever your water supply is limited, there are three gadgets you must be master of—your pressure gauge, your nozzle, and your shut-off.

It's easy to see that if you step pressure up as high as it will go and open up 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 nozzle openings and pressures. 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.

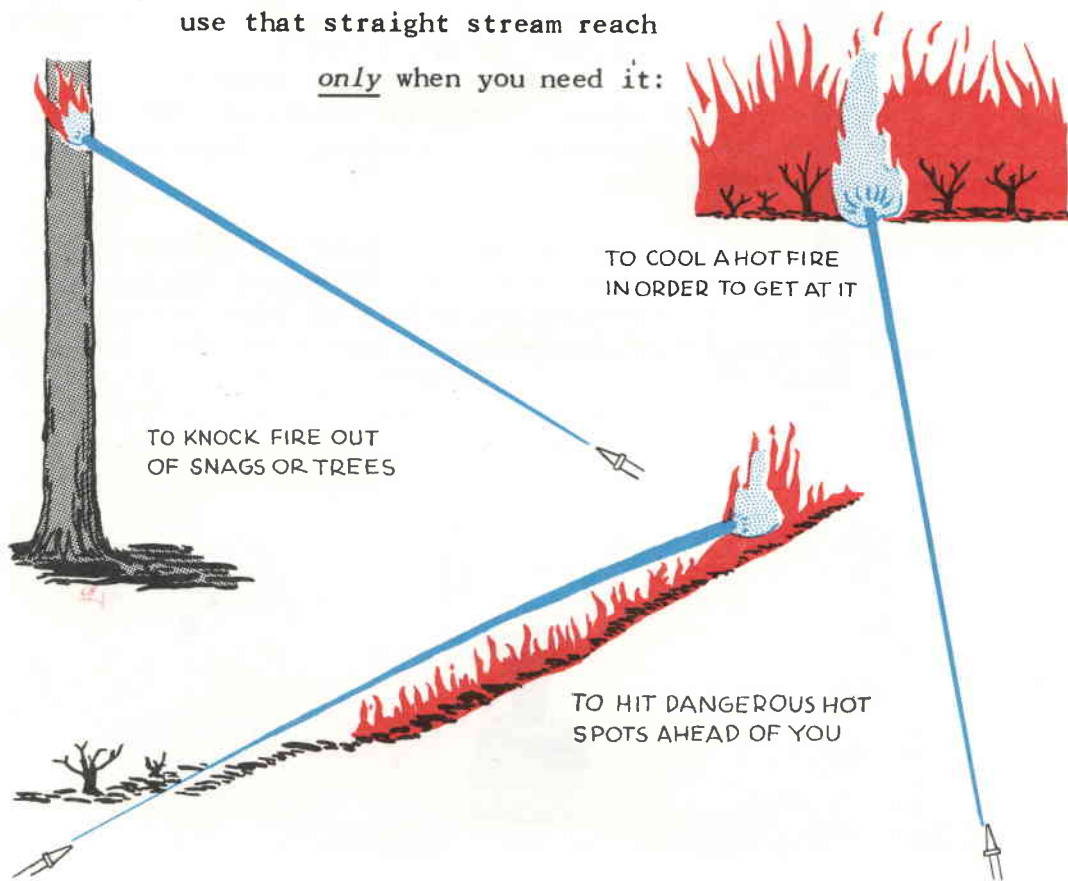


MORE FIRE TAKES MORE WATER—less fire, less water. Simple, huh? But if you're the kind of guy who's slow to change, you're going to waste a lot of water on a little fire, or a big fire will get bigger for want of enough water—adjust as you spray. Make your water match your fire.

Like the pitcher in a ballgame, you've got to watch all the bases, or fire will steal a run on you. But—because it discharges water too fast,

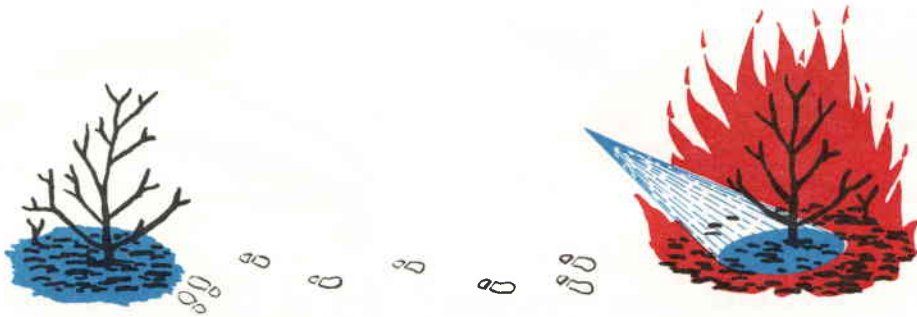
use that straight stream reach

only when you need it:

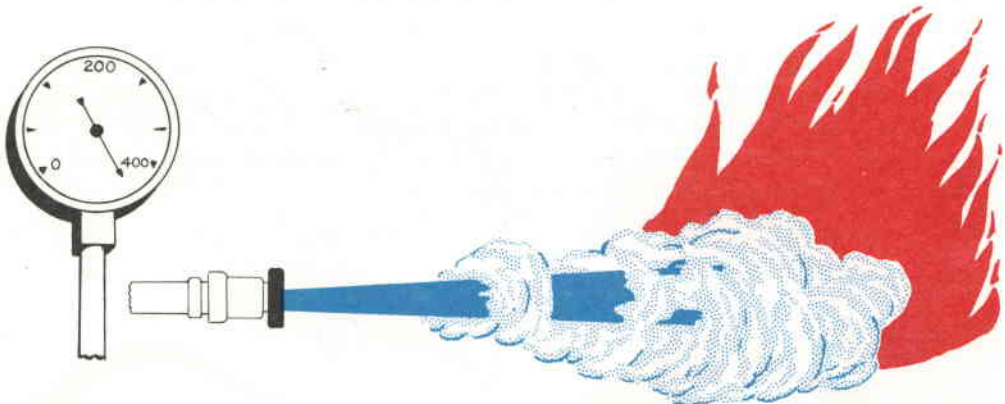


If you would water use with care;  
Spray the fuel and not the air.

Don't waste it on cold ground, either. If you're moving from one hot spot to another—shut off the water.

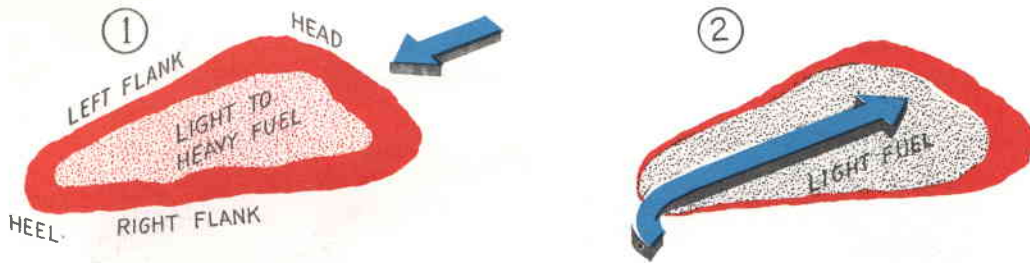


There's an "on-again-off-again-Finnigan" technique that pays high dividends in water saved. On the fire line squirt a little water at the base of the flame—shut it off—or move along. If the flame bounces back, give it more—but squirting water intermittently on and off gives you a better chance to use the least amount needed for the job. Practice this one on fire until you get the "feel" of it.



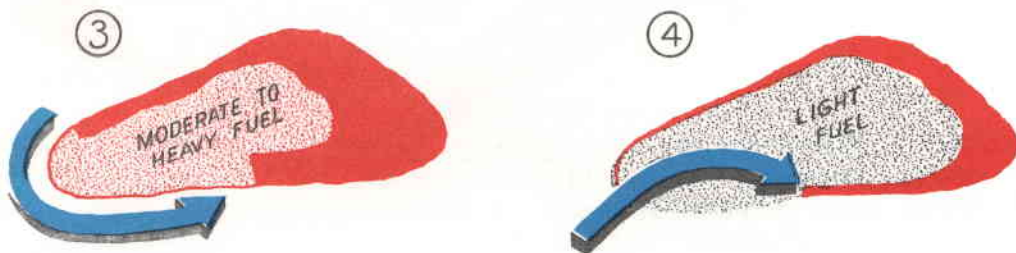
WATCH THIS ONE—some nozzles at high pressures actually deliver air as well as water on the fire—which has the effect of fanning the flame into action instead of knocking it down. When that happens, lower pressure.

When you can do it  
HIT THE HEAD.  
WATER COOLS  
And stops the spread.



THE FIRE IS SMALL—you have water. You're lucky—because with water you can often hit the fire head (1), which is the fastest way to stop it there is. 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). But most often the best strategy is a flank attack (3). Start at the heel, knocking down the burning flank as you go. Encircle the head and keep going down the opposite flank back to point of first attack or—do the same thing on the inside (4) where the heat and smoke are often 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.

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 stop it. Remember—no two fires are ever alike. Your choice of strategy must fit the fire—but using any of these diagrammed approaches, you can stop fire faster with water if you've aimed one at the other often enough in practice sessions to know what happens when they meet.

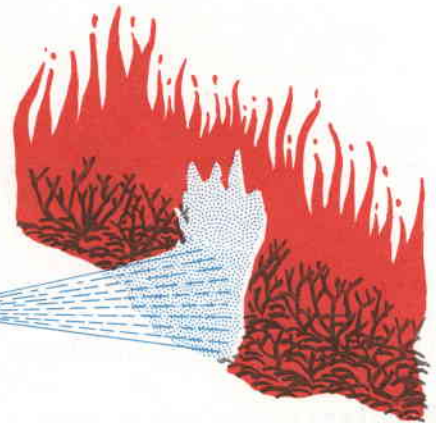


TO GET IN AND GET AT IT when the fire is hot—reach with a straight stream—aim for the base of the hot spot. If you keep your water low, bouncing some of it off the ground in a fan, you'll cool more fuel at one time.

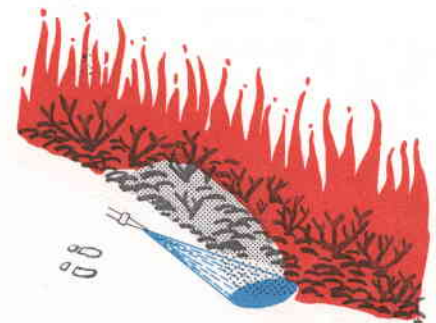


Keep moving in fast and—

CHANGE TO A SPRAY as soon as you're close enough to cover burning fuel—the spray will make a protecting water shield for you. Keep the flame knocked down. 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—



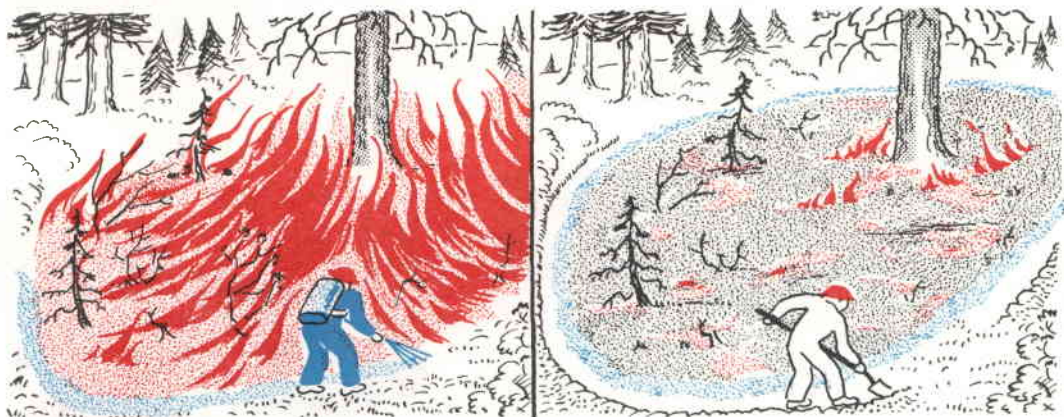
SPRAY DOWN AND PARALLEL to the fire's edge. Working that way you can cool more fuel ahead of you and waste less water doing it, at the same time making full speed forward. Make a good water scratch-line as you go—don't drown the fire but—



Knock the flame—be sure you do.  
A job half done is wasteful too.

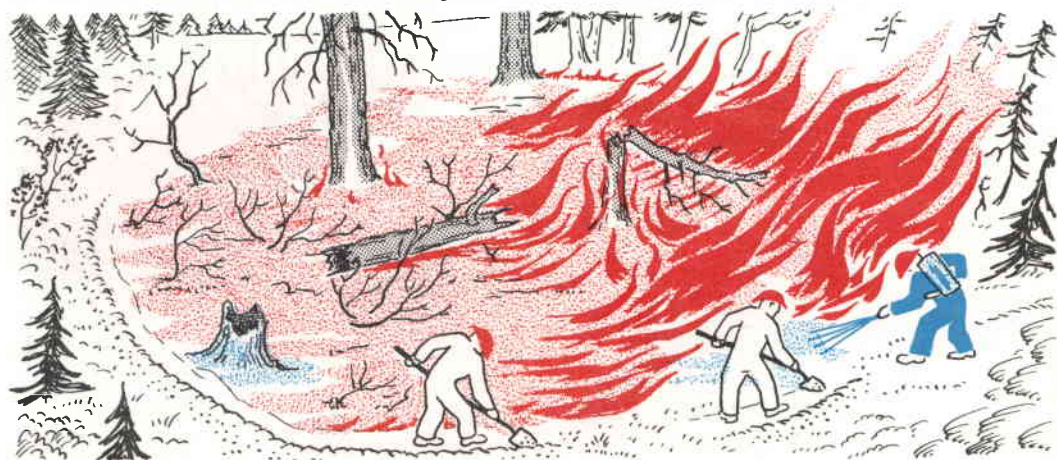
WE'VE GOT A FIRE! And it's up to you to catch it. Old smoke-eater or greenhorn, you have two things in common: training in fire strategy, and water. Too late to read this booklet again now—so tuck its helpful hints under your hard hat—and hit that fire!

Valuable things are sometimes heavy. Gold, for instance. A back-pump full of water can be worth its weight, too—if you're alone on initial attack especially.

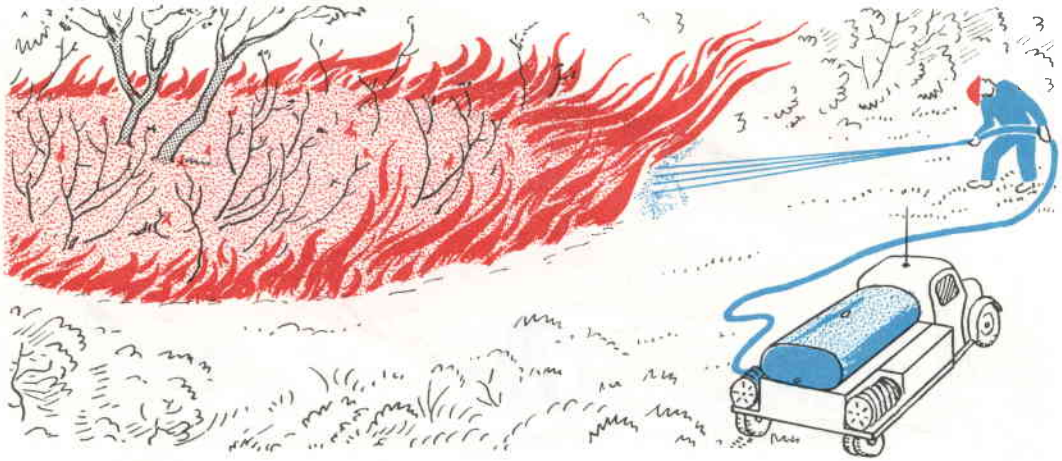


After water line—hand-tool line—at your leisure—hottest edge first. You've broken the fire triangle heat bar. Now go after the fuel bar and you've got it licked.

Popularity is not always a matter of personality. On a hot fire the cool-headed fellow with the back-pump is often 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.



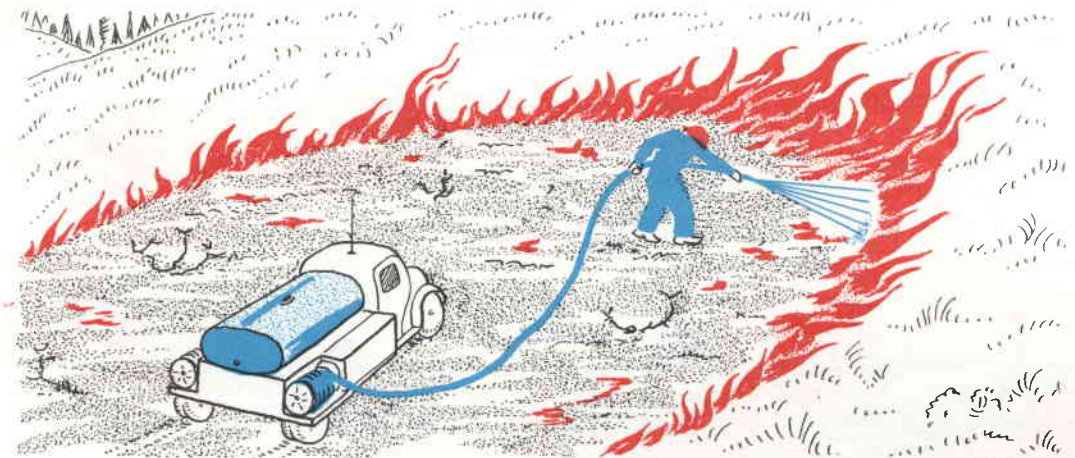


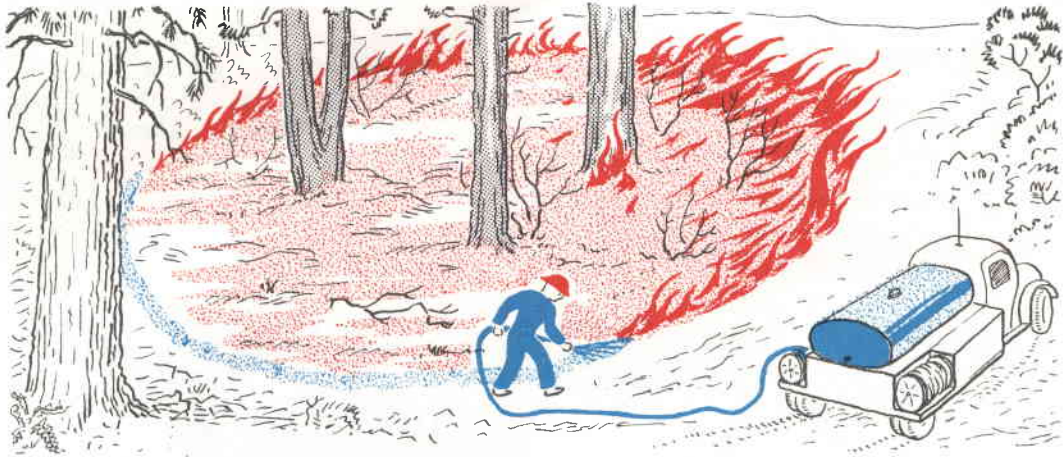


TANKERS ARE NICE TO HAVE AROUND. Roads make driving easier, but it's surprising where a tanker with a full load of precious water will go without one. Watch for stumps or rocks if you're doing the driving. You'll want to be able to take the rig back with you. As nozzleman, backed up with plenty of water + power on wheels, you can often 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—

Check your exit well and often.  
You're too young to fill a coffin!

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.

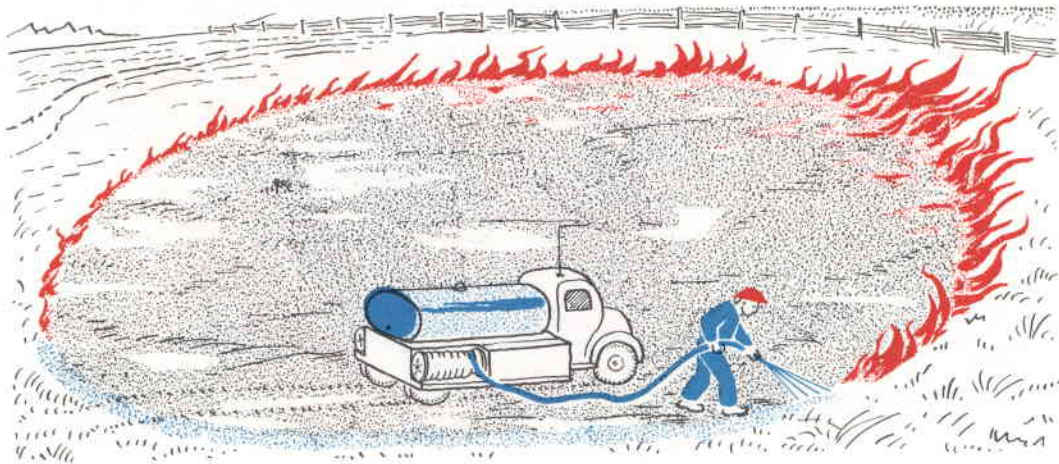




YOU'RE RACING THE FIRE on a flank attack. The tortoise won his race because the hare took a nap. A hot fast fire in heavy fuel can be put to sleep with water—but only to sleep. Knock it out faster than it can run ahead in order to pinch it off and stop it. Watch your water supply—and watch behind. Hot fires come awake fast—ready to run and overtake you. (Burning up tankers lowers their efficiency—and raises the cost of water a bit, too.) Remember—all hands to the shovel line as soon as the water job is done—or the race may still be lost.

It's cooler work inside a burn—but be careful—you can push fire out onto unburned fuel unless you keep pressure low and spray down parallel to the fire's edge. Also—

The man who burns one quickly knows  
He's waterless without the hose!



YOU DISH IT OUT, so 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 unless you can take it. 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. Miser your water—make every drop count.

While you're working—every minute  
Know how much the tank has in it.

Know too, 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!



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 to your original plan as possible. If you've been working 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' 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 sometimes happens 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.



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.

**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.

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 like mop-up work.





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 all the hot fuel? Will it stay that way?

Attacks with stationary tankers and hose-lays 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 must know how much water is available at all times.





TANKS

HYDRANTS

WELLS

RELAY TANKS

BACK PUMPS

LAKES

SOURCES



TANKERS

MULE TRAINS

SPRINGS

DRIVEN WELLS

PUMPS

STREAMS

# WAYS OF WATER

DEEMER



**FIGHTING FIRE WITH FIRE—AND WATER.** There are things you can do to fight fire when you have water that are impossible without it—especially if they must be done right now or not at all—as in backfiring in fast-burning light fuels. By making fire and water work together, backfire can be set when there is no time to build prepared line to work from.

Timing your teamwork is important here. Remember your water scratch-line will be the fire line—sometimes it will be the final line as in grass—but usually only a temporary check line. Stay close behind the torchman. Water-cool the outside edge—not too much—just enough to give the shovel man time.

Burning out between a prepared line and the main fire is safer, too, when water is on the job. Stand by with your back pump as the torchman touches the fire off. Watch for spot fires.







A HOT SPOT'S A WATER SHOT along backfire line too—but there's an old saying: Make your head save your feet. So remember—use judgment. Don't put water inside the line unless the fire threatens to spot or sloop over. Let the backfire burn clean or you'll defeat its purpose.

SOME REMINDERS—Just because you have water don't let over-confidence in it be your loss and fire's gain. Sometimes you'll be the only man out there, so it's a good idea to understudy all fire fighting jobs, but usually you are most valuable when you use water to help hand tools and other equipment.

While you're making yourself a water application expert, study up on fire strategy and behavior. Learn something every time you go out on a fire. Every fire is different so keep your eyes open—but above all learn how best to use and save your water in order to cut down the cost, time and effort needed for suppression and mop-up.

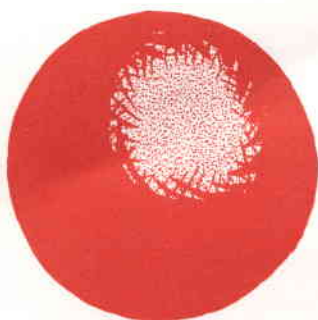
If you happen to be an old-timer some of the things in this booklet may seem new to you even though you've put plenty of water on fire. You may even be prone to doubt them—but before you do, try them out. Seeing is believing.

It makes no difference what you use to carry the water to the fire or what you apply it with—it's how and where and in what quantity that counts.

EQUIPMENT MAY VARY AND CHANGE BUT THE PRINCIPLES GOVERNING  
CONSERVATIVE WATER USE ARE ALWAYS THE SAME.



ONE UNIT  
OF WATER TO



300 UNITS  
OF FIRE IN MOP-UP



WORK CLOSE

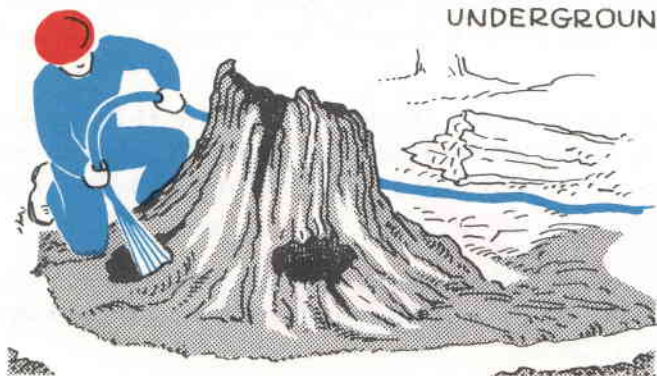
IT'S HEAT YOU'RE AFTER in mop-up—and it's hard to see because there often isn't much flame or smoke. There will be glowing and smouldering, but you'll have to look for hidden hot stuff. Find it—dig it—turn it—spray it with cooling water.

If all the cooled fuel that a good water man can mop up 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. A long tank of water makes short work of mop-up—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 all of your water stretching tricks. Intermittent squirts in the right place—not too little—not too much. Don't waste water on hydraulic digging. How much fuel can you cool with one tank of water?



ROLL IT OVER

USE WATER ON ROOTS BURNING  
UNDERGROUND



FEEL FOR HOT SPOTS



Keep in mind  
This simple rule—  
“First you *find*—  
Then cool hot fuel”

RAKE —SQUIRT—

Water and hand-tool men working together are double threat fire teams on mop-up too. This time the shovel men make the water job faster and easier. They rake—scrape—chop—dig out the hot fuel and expose it to the air—so you can spray it. Air is a good pre-cooler—let it help you save water.



KICK UP AND COOL  
HOT SPOTS

UNLESS YOU'RE A PAL OF JUPITER and have his promise of a guaranteed downpour long and heavy enough to drown your fire—you won't be commended for coming in out of the rain—no matter how bright a boy you are. So—thank the gods for such a helpful source of water—if you can't burn out tag ends, cold trail around them—but if you don't want to take a chance on starting all over in a couple of days—STICK TO MOP-UP UNTIL YOU KNOW





MANY A FIRE IS LOST because of too much water.

True  ?      False  ?

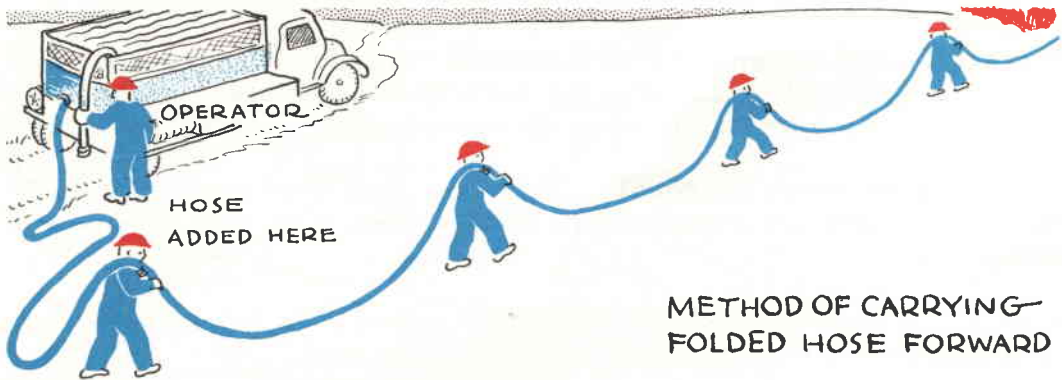
If you answered true you can go to the head of the class! Pouring water on fire—even when you have lots of it—may seem to be the easiest way to mop it up—but don't ever think so! Easy today means harder tomorrow. To know what your water is doing to your fire you've got to know where every drop is going. Is it just knocking down flame and smoke or is it getting to all the hot spots hidden underneath? If you apply a little at a time in the right place, you'll have a chance of knowing. But you can't keep track of a flood—where the water goes—or what it lands on—or whether it gets to where it should go at all. So—don't count on mere quantity of water. Limit it to no more than you can keep track of and you'll limit future work—because the fire will have fewer chances of making a comeback.

**DON'T** dump the water you have left over at the end of a mop-up job. Fires have a way of being unexpected and it's a good idea to have some water in your tank at all times. It's better than having to turn to with a shovel on the way home. Keep your hose and nozzle ready for use, too.

THE BUCKET BRIGADE MAY BE A THING OF THE PAST, but it is one of the best examples of teamwork in water use known—even though it leaves much to be desired in application technique. Cotton jacket hose is a more modern way to get water from where it is to where it is needed—but laying it with speed means equally close teamwork.

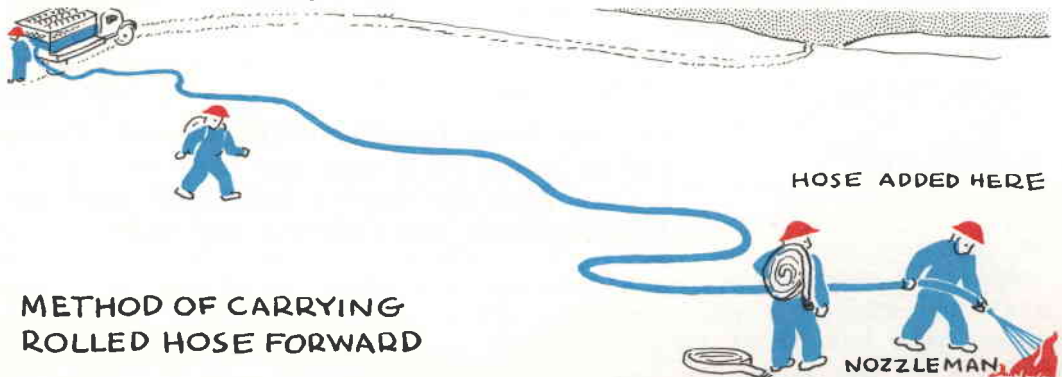
Fire tankers carry hose two ways—coupled and folded so it can be pulled out in a continuous length; or single lengths in rolls that are coupled as the hose is laid.

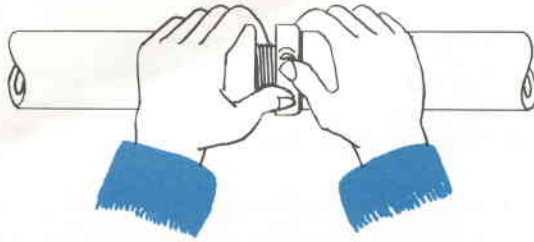
Unless you are going to fight fire in easy terrain or in buildings you probably will not be using folded hose. But if you do, you'll find it easy to master the "yo-heave-ho" type of teamwork needed to move it forward—but hard on your back if you don't have a big rew.



In mountain fire fighting rolled hose is easier to handle than folded hose. It can be carried by one man through brush and trees or up steep slopes. You will always use it with portable pumps.

As a member of a team laying rolled hose, you will have a series of jobs to do. Each job must be coordinated with those of your teammates. The following pages show what they are and how to time them.



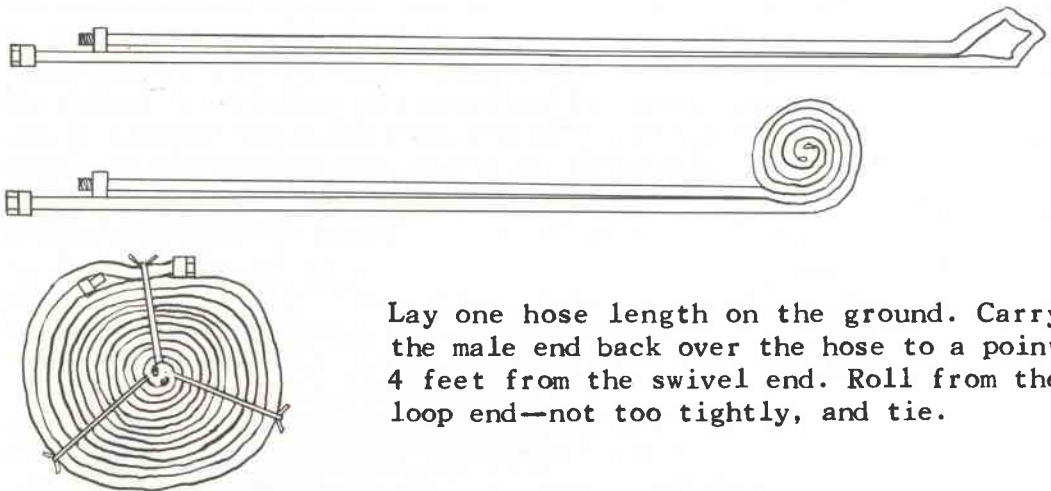


**DON'T SWEAR** at the coupling. Learn the trick of holding the hose in position with 3 fingers of each hand while using your thumbs and index fingers to turn the female collar. A little graphite will help make the turning easier. Never use oil or grease. They are hard on hose and are apt to pick up dirt and grit.

Practice coupling and uncoupling hose. Speed in laying hose depends on teamwork and the skill with which each team member can perform small operations such as screwing a coupling together.

Keep a close check on coupling threads. See that damaged or defective threads are repaired and handle them with care to prevent damage.

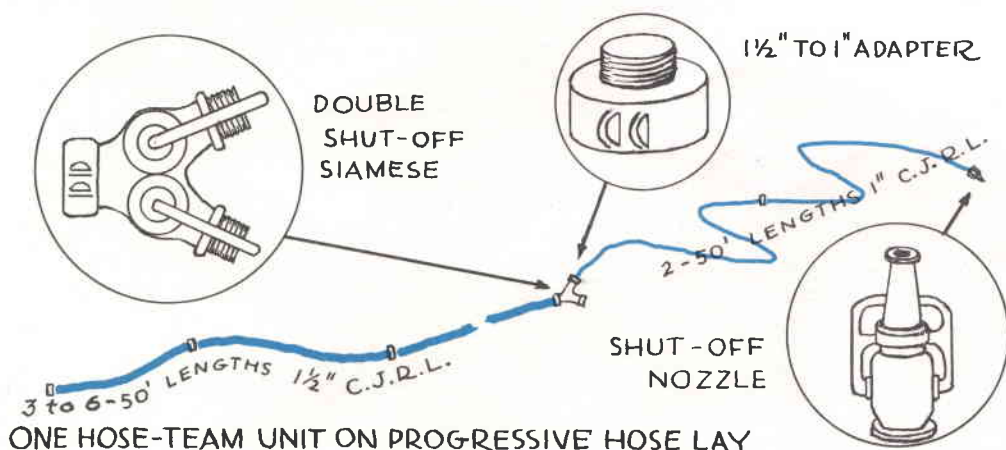
Neatly rolled hose which can be quickly and easily put into service adds speed to a hose team too. Roll it this way:



Lay one hose length on the ground. Carry the male end back over the hose to a point 4 feet from the swivel end. Roll from the loop end—not too tightly, and tie.

HOSE-LAYS GROW in length according to the distance from the water source to the fire edge and according to the size of the fire perimeter. Some grow simply by the addition of one length of hose after another. Others are a more complex hose network serviced and connected by a variety of equipment, including such things as portable pumps, relay tanks, tankers, siamese and other fittings.

Whether you will be using the simple hose-lay or more complex lays depends on how much speed water must provide toward control of the fire. If the forward spread of fire is slow—one or two nozzle-men can stop it by spraying their way up one flank and down the other—or by installing a Y at the heel and cooling their way up both flanks at one time. But if the fire is running faster than one nozzle-man can travel, more nozzle-men—applying water simultaneously—will obviously be needed to catch it.



ONE HOSE-TEAM UNIT ON PROGRESSIVE HOSE LAY

The progressive hose-lay was designed for speed and safety--especially on hot, fast-running fires. One hose-team unit after another is put into action as fast as 2- or 3-man crews can lay and connect them. This way direct attack with water can be made at many points along the fire edge at one time. The delivery of water at each nozzle is continuous and is not interrupted during the growth of the lay.

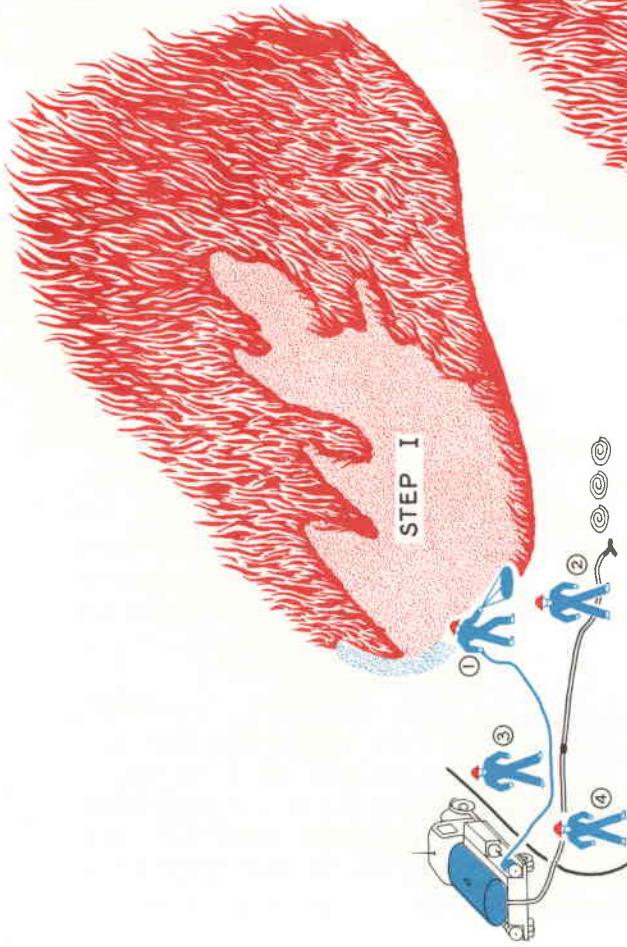
Practice and drill are the only ways to fast teamwork. You can't just read this booklet—go straight to the fire with a ten-man crew and a mile of hose—and expect to pull your weight as a member of the team. The basic steps and operations in laying a 1 1/2-inch hose-line are clearly shown here for you to study. Be familiar with them—be sure your teammates, too, know what to do and when to do it. Then go out with your equipment and practice how to do it.

STEP I

NOZZLEMAN(1) USING LIVE REEL HOSE, MAKES HEEL OF FIRE SAFE.

OPERATOR(3) AND HELPER(4) CONNECT TWO LENGTHS OF 1½" C.J. HOSE TO TANKER.

NOZZLEMAN(2) CARRIES THREE ROLLS OF 1½" C.J. HOSE, SHUT-OFF NOZZLE, AND SIAMSE TO END OF THE TWO COUPLED LENGTHS AND ATTACHES SIAMSE IN REVERSE.



STEP I

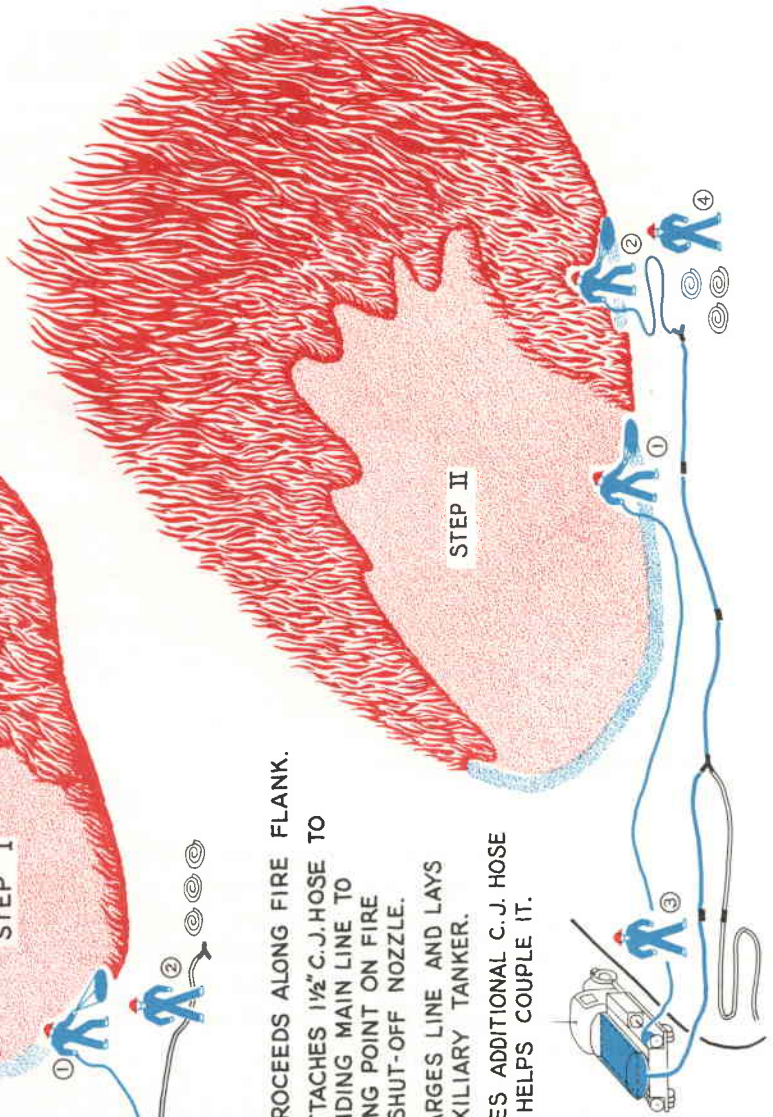
STEP II

NOZZLEMAN(1) PROCEEDS ALONG FIRE FLANK.

NOZZLEMAN(2) ATTACHES 1½" C.J. HOSE TO SIAMSE, EXTENDING MAIN LINE TO DESIRED STARTING POINT ON FIRE AND INSTALLS SHUT-OFF NOZZLE.

OPERATOR(3) CHARGES LINE AND LAYS HOSE FOR AUXILIARY TANKER.

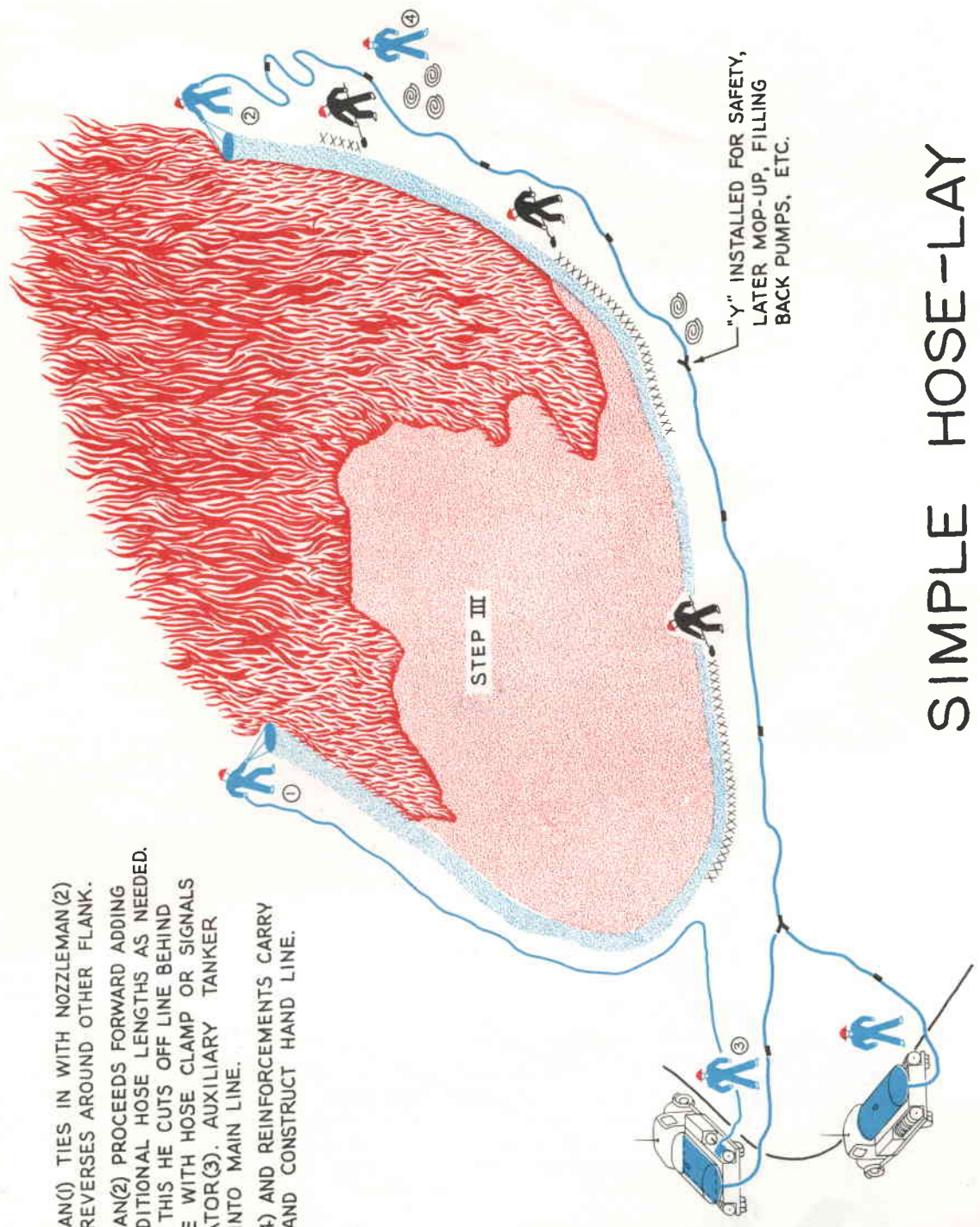
HELPER(4) CARRIES ADDITIONAL C.J. HOSE FORWARD AND HELPS COUPLE IT.



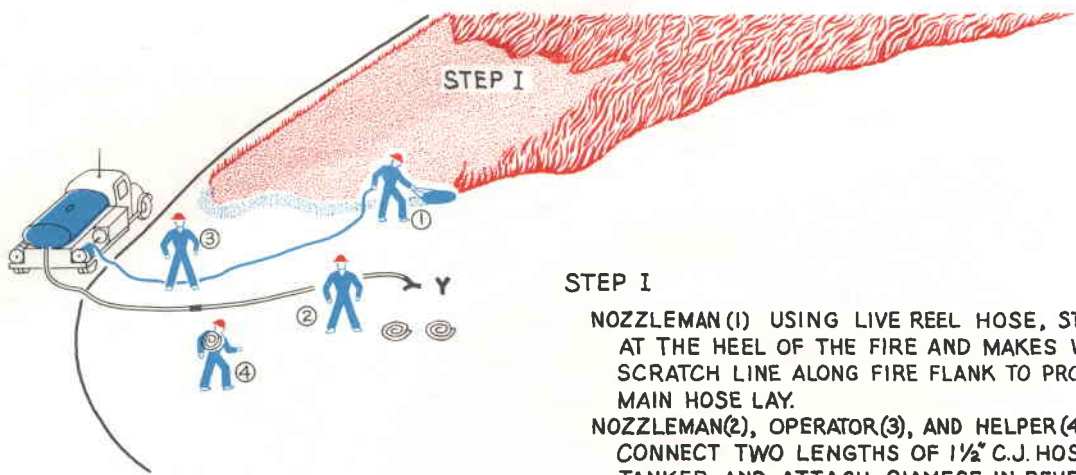
STEP II



STEP III  
 NOZZLEMAN(1) TIES IN WITH NOZZLEMAN(2)  
 THEN REVERSES AROUND OTHER FLANK.  
 NOZZLEMAN(2) PROCEEDS FORWARD ADDING  
 ON ADDITIONAL HOSE LENGTHS AS NEEDED.  
 TO DO THIS HE CUTS OFF LINE BEHIND  
 NOZZLE WITH HOSE CLAMP OR SIGNALS  
 OPERATOR(3). AUXILIARY TANKER  
 CUTS INTO MAIN LINE.  
 HELPER(4) AND REINFORCEMENTS CARRY  
 HOSE AND RECONSTRUCT HAND LINE.



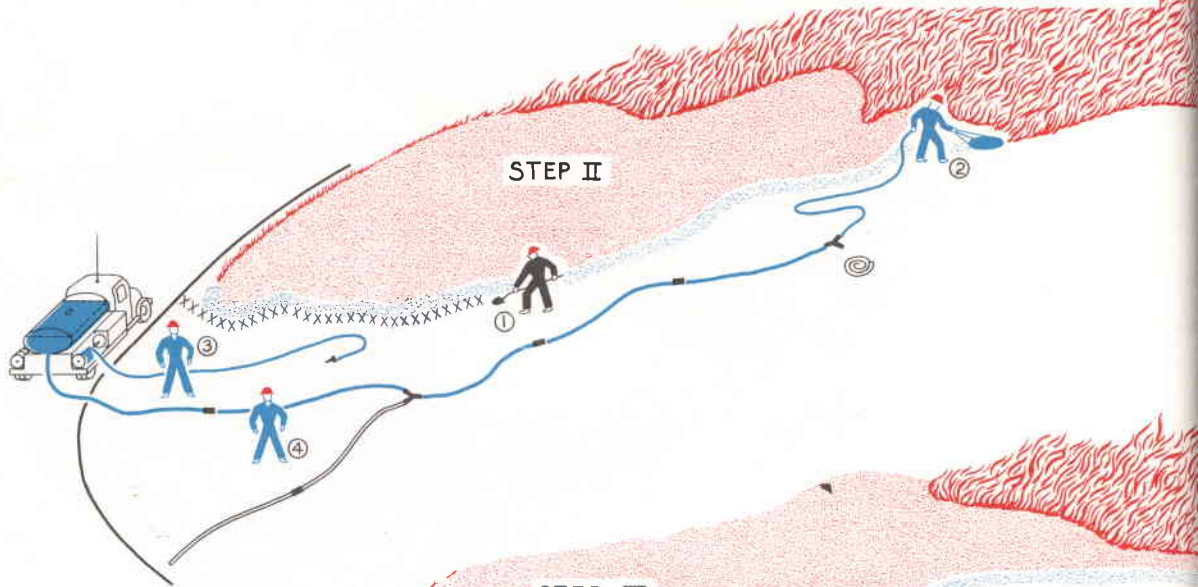
# SIMPLE HOSE-LAY



**STEP I**

NOZZLEMAN (1) USING LIVE REEL HOSE, STARTS AT THE HEEL OF THE FIRE AND MAKES WATER SCRATCH LINE ALONG FIRE FLANK TO PROTECT MAIN HOSE LAY.

NOZZLEMAN (2), OPERATOR (3), AND HELPER (4) CONNECT TWO LENGTHS OF 1½" C.J. HOSE TO TANKER AND ATTACH SIAMESE IN REVERSE.



**STEP II**



**STEP III**

# PROGRESSIVE HOSE-LAY

## STEP II

NOZZLEMAN(1) CONTINUES WATER SCRATCH LINE AS FAR AS LIVE REEL HOSE WILL REACH; THEN SHUTS DOWN AND BUILDS HAND TOOL LINE.  
OPERATOR(3) CHARGES  $1\frac{1}{2}$ " LINE AND CONNECTS TWO LENGTHS OF  $1\frac{1}{2}$ " C.J. HOSE TO REVERSED SIAMESE FOR AUXILIARY TANKER.  
NOZZLEMAN(2) AND HELPER(4) LAY AND CONNECT ONE HOSE TEAM UNIT (PAGE 25) AND PUT IT INTO ACTION.



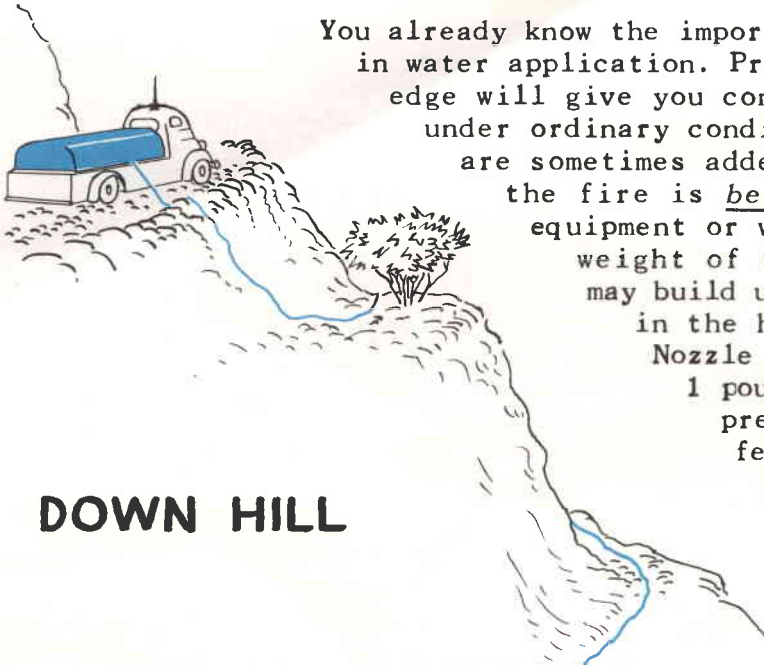
## STEP III

OPERATOR(5) CONNECTS AUXILIARY TANKER TO LEG OF MAIN LINE.  
ADDITIONAL TWO OR THREE MAN TEAMS (6) LAY AND PUT INTO ACTION SUCCESSIVE HOSE-TEAM UNITS.  
AS TEAMS FINISH THEIR WATER SCRATCH LINES THEY MAKE THEM SAFE BY BUILDING HAND TOOL LINE(7) AND PROCEED TO MOP UP OR ASSIST IN CARRYING HOSE FORWARD(8).

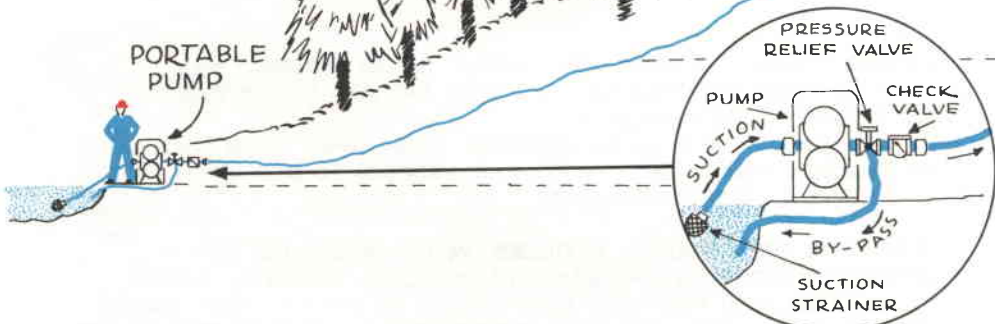
IF ELEVATION OR DISTANCE REDUCES WATER PRESSURE BELOW EFFECTIVE WORKING PRESSURE AT NOZZLES, TWO MEN INSTALL RELAY TANK AND PORTABLE PUMP(PAGES 30 AND 31). ONE MAN(9) STANDS BY AS RELAY PUMP OPERATOR.

You already know the importance of pressure in water application. Practice and knowledge will give you control of pressure under ordinary conditions—but there are sometimes added problems. When the fire is below your pumping equipment or water source, the weight of the water itself may build up enough pressure in the hose to break it.

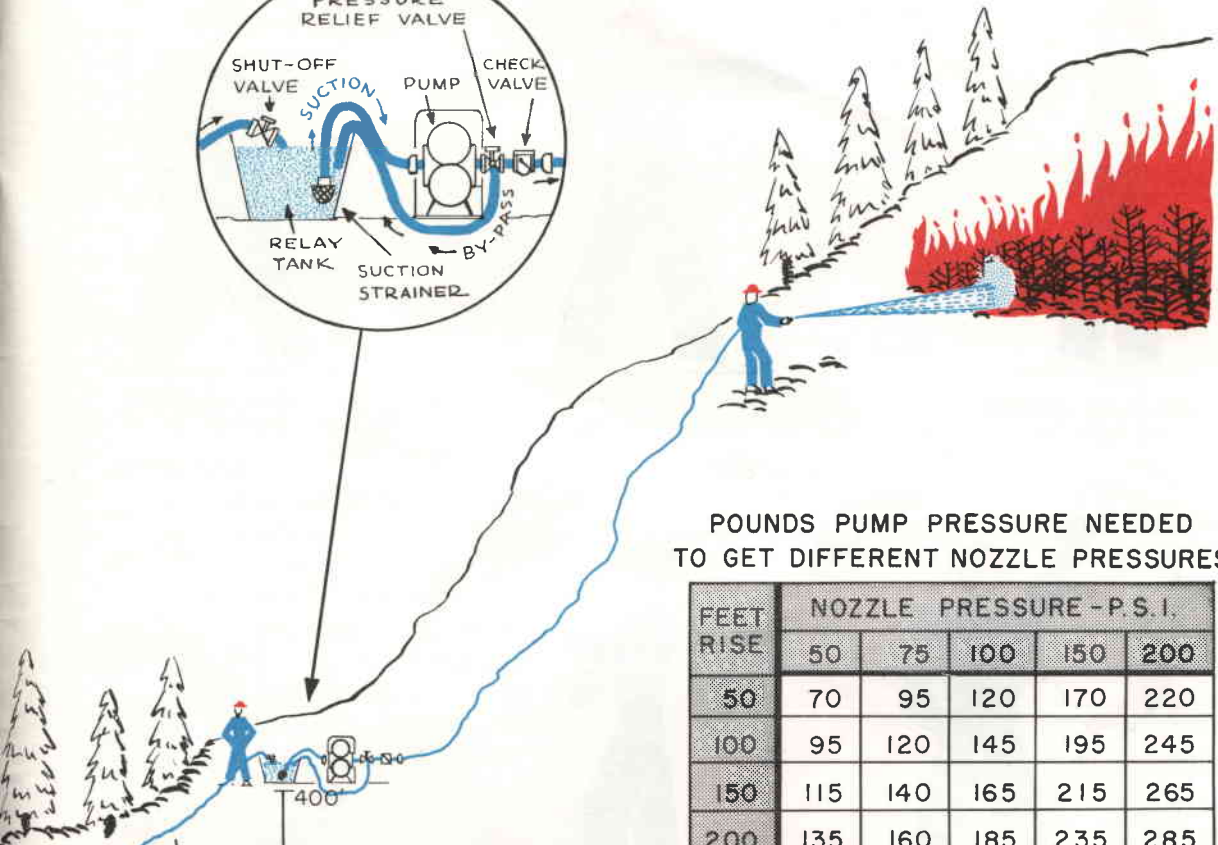
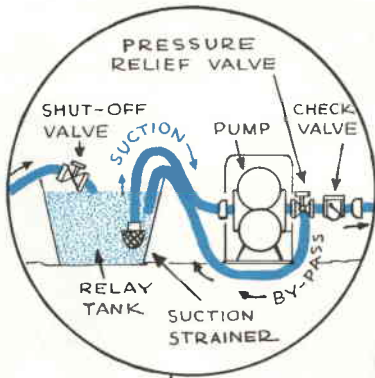
Nozzle pressure is about 1 pound more than pump pressure for every 2 feet that the nozzle is below the pump.



## DOWN HILL



## PUMPING UP HILL



POUNDS PUMP PRESSURE NEEDED TO GET DIFFERENT NOZZLE PRESSURES

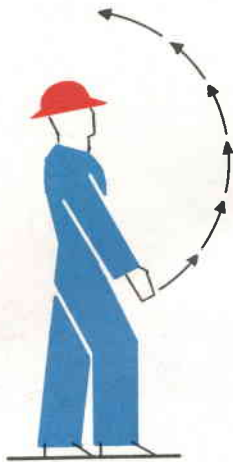
FEET RISE	NOZZLE PRESSURE - P.S.I.				
	50	75	100	150	200
50	70	95	120	170	220
100	95	120	145	195	245
150	115	140	165	215	265
200	135	160	185	235	285
300	180	205	230	280	330
400	225	250	275	325	375
500	270	295	320	370	420

EACH LB. PRESSURE AT PUMP WILL LIFT WATER TWO FEET VERTICALLY

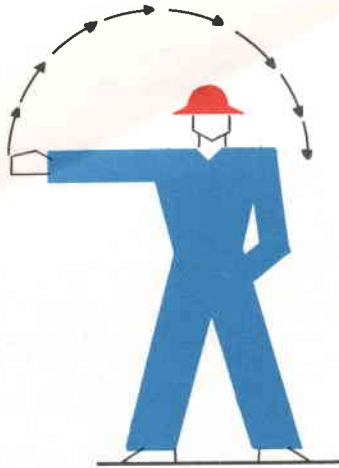


Because water is heavy, more pump pressure is needed to get it to the nozzle when the nozzle is above the pump—to find how much more, use the above table.

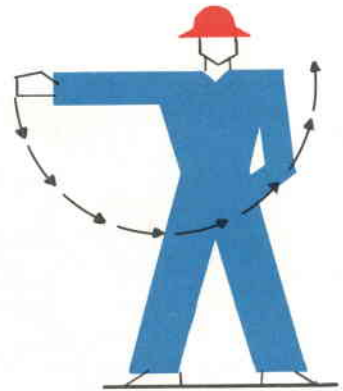
There are safe working pressures for both pumps and hose. They may not be the same—but when the limit of either one is reached, install a portable “booster” pump and relay tank as pictured. Use all the fittings as shown in the circles.



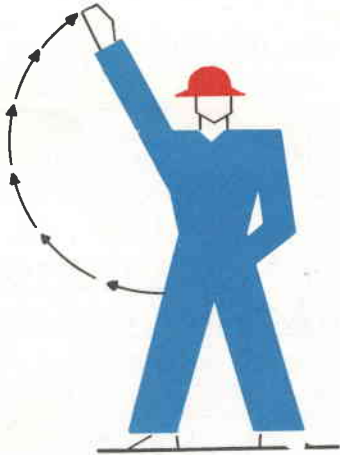
DELIVER WATER  
AT NOZZLE



INCREASE  
PRESSURE



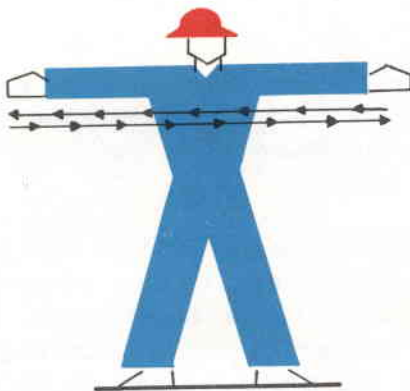
DECREASE  
PRESSURE



MORE  
HOSE



BROKEN  
HOSE



SHUT DOWN



ROLL UP HOSE

## HAND SIGNALS

## EQUIPMENT FOR ½-MILE PROGRESSIVE HOSE-LAY

### Total equipment for 15-hose-team units:

15 - Knapsack	2 - Shut-off, 1½"
15 - Packboard	1 - Check & bleeder valve, 1½"
16 - Siamese valve, 1½"	75 - Hose washer, 1½"
15 - Adapter, 1½" to 1"	75 - Hose washer, 1"
18 - Spanner wrench, 1" & 1½"	30 - CJRL hose, 1" x 50'
15 - Shut-off, 1", with straight & spray nozzles	75 - CJRL hose, 1½" x 50'

### Equipment for each hose-team unit:

#### NOZZLEMAN:

- 1 - Knapsack
- 1 - Siamese valve, 1½"
- 1 - Adapter, 1½" to 1"
- 1 - Spanner wrench, 1" & 1½"
- 1 - Shut-off, 1", with straight  
& spray nozzles
- 4 - Hose washer, 1½"
- 4 - Hose washer, 1"
- 2 - CJRL hose, 1" x 50'

#### HELPER:

- 1 - Packboard
- 4 - CJRL hose, 1½" x 50'

### Equipment for one booster-relay unit:

1 - Portable pump	1 - Check & bleeder valve, 1½"
1 - Suction hose, 1½"	1 - Pressure relief valve, 1½"
1 - Suction strainer	1 - Spanner wrench, 1½"
1 - By-pass hose	1 - Packboard
1 - Canvas reservoir	- Pump motor fuel

APPROXIMATE DISCHARGE RATE IN GALLONS PER MINUTE

Nozzle size in GPM at 100 PSI	Nozzle pressure in pounds per square inch				
	50	100	150	200	250
2	1.0	2.0	2.8	3.3	3.9
3 <u>1/</u>	1.7	3.0	4.0	4.7	5.4
4	2.4	4.0	5.1	6.1	6.9
5 <u>2/</u>	3.1	5.0	6.3	7.4	8.5
6 <u>3/</u>	3.8	6.0	7.5	8.8	10.0
7	4.5	7.0	8.7	10.2	11.5
8	5.2	8.0	9.9	11.5	13.0
9	5.9	9.0	11.1	12.9	14.6
10	6.6	10.0	12.3	14.3	16.1
11 <u>4/</u>	7.3	11.0	13.5	15.7	17.6
12	8.0	12.0	14.7	17.0	18.2

- 1/ "Forester" #3 spray tip.
- 2/ 1/8-inch straight stream.
- 3/ Garden hose medium spray.
- 4/ "Fognozi" 4-hole spray tip.



MINUTES TO DISCHARGE 100 GALLONS OF WATER

Nozzle size in GPM at 100 PSI	Nozzle pressure in pounds per square inch				
	50	100	150	200	250
2	100	50	36	30	25
3 <u>1/</u>	60	33	25	21	18
4	42	25	20	16	14
5 <u>2/</u>	32	20	16	14	12
6 <u>3/</u>	26	16	13	11	10
7	22	14	11	10	9
8	19	12	10	9	8
9	17	11	9	8	7
10	15	10	8	7	6
11 <u>4/</u>	13	9	7	6	6
12	12	8	6	6	5

1/ "Forester" 3 spray tip.

2/ 1/8-inch straight stream.

3/ Garden hose medium spray.

4/ "Fognozl" 4-hole spray tip.

CHECK YOUR water-use ability often. But, in the fire fighting business—with or without water—it also pays to gain in:

KNOWLEDGE of fire behavior and strategy.

SKILL in handling tools and equipment.

CONFIDENCE in your ability and

JUDGMENT of fire conditions.

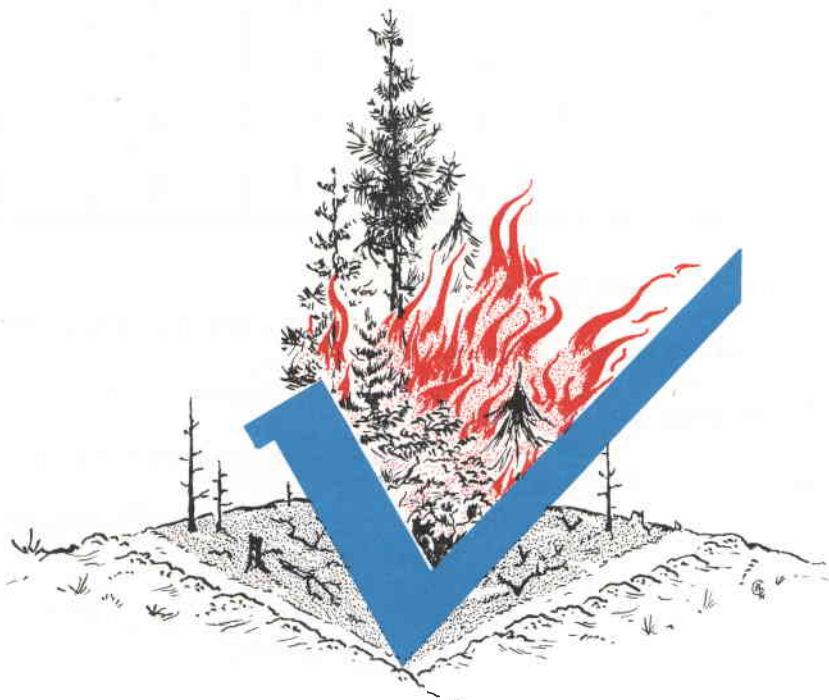
SPEED of attack and control.

TEAMWORK at all times.

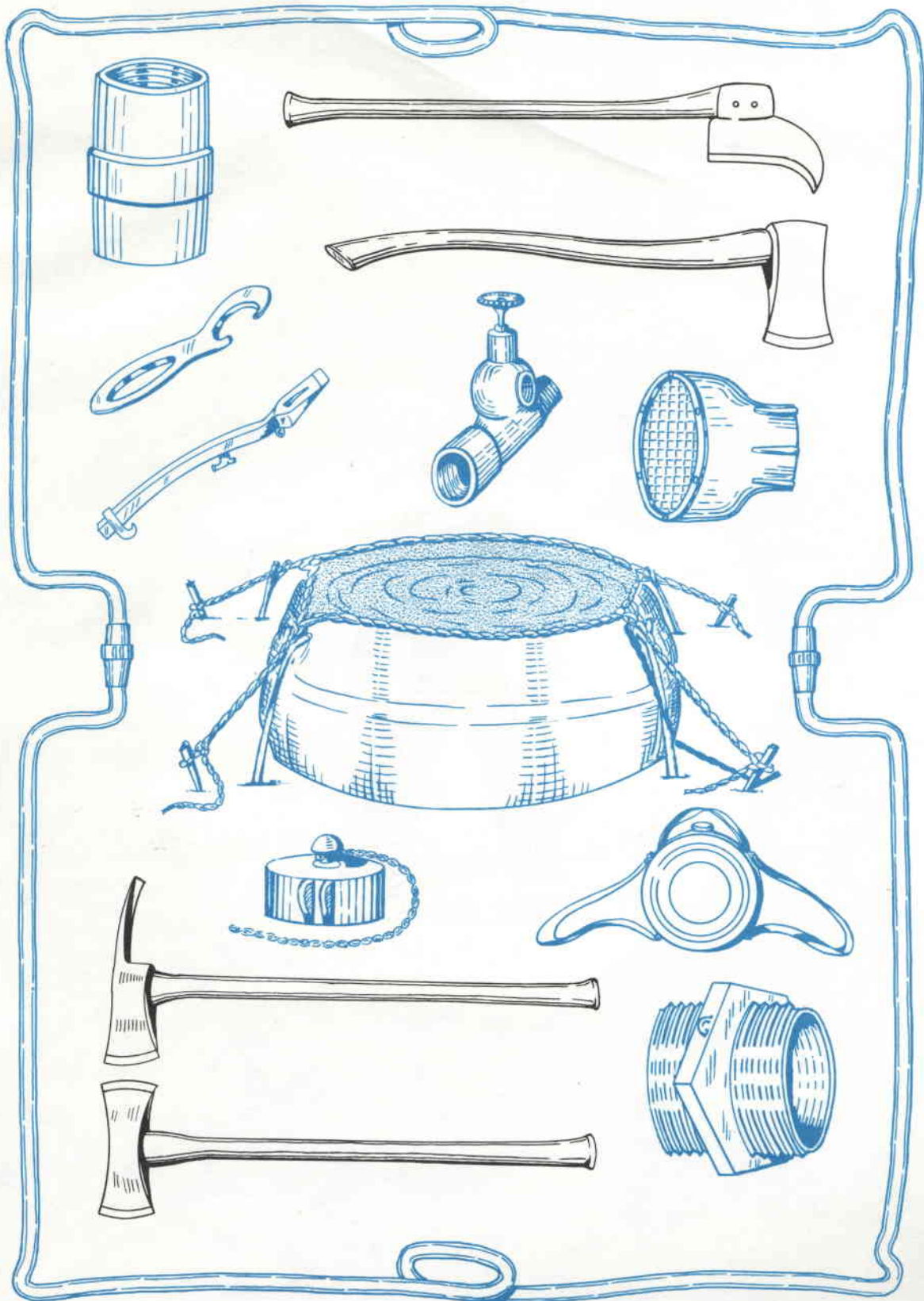
And even though—

WATER CHECKS FIRE AND GAINS YOU TIME—

Be sure to—



DOUBLE-CHECK IT WITH HAND-TOOL LINE.



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