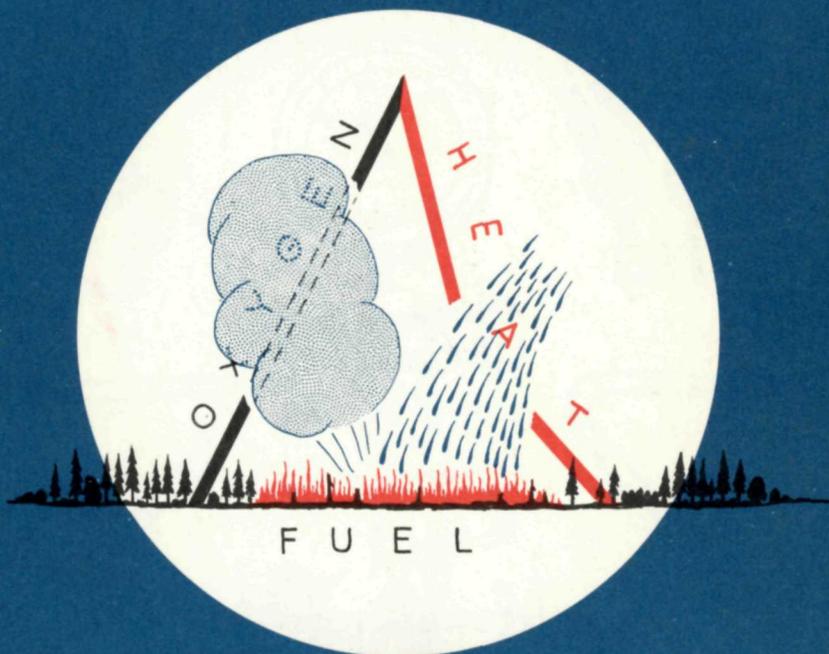
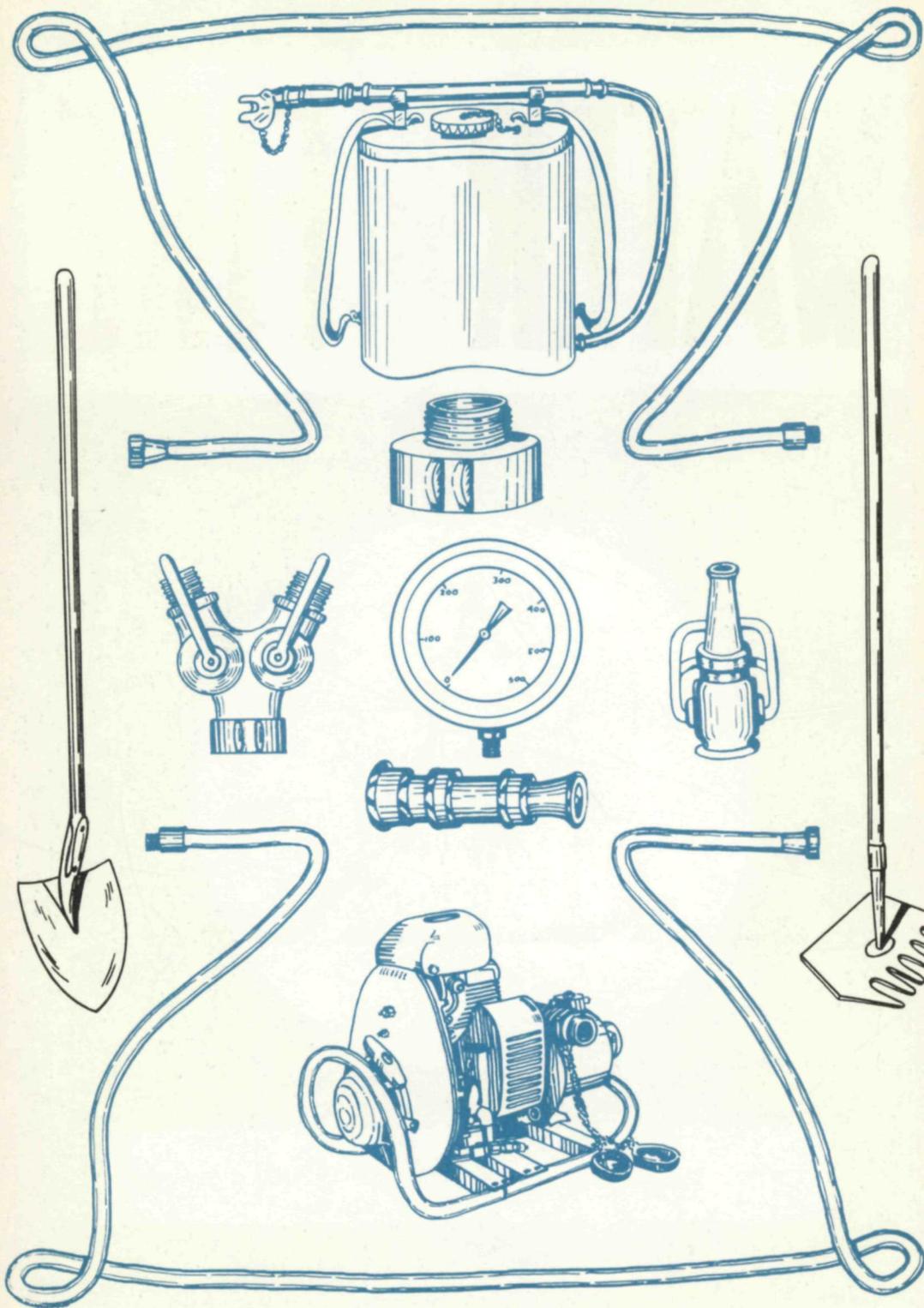


WATER vs. FIRE



FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE



WATER vs FIRE

FIGHTING FOREST FIRES WITH WATER

**Revised
1973**



**FOREST SERVICE—U.S.D.A.
NORTHEASTERN AREA
STATE and PRIVATE FORESTRY
6816 Market St., Upper Darby, Penna.**

ACKNOWLEDGMENTS

This booklet was first 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 Pacific Southwest 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.

STANDARD FIRE FIGHTING ORDERS

1. Keep informed on FIRE WEATHER conditions and forecasts.
2. Know what your FIRE is DOING at all times—observe personally, use scouts.
3. Base all actions on current and expected BEHAVIOR of FIRE.
4. Have ESCAPE ROUTES for everyone and make them known.
5. Post a LOOKOUT when there is possible danger.
6. Be ALERT, keep CALM, THINK clearly, ACT decisively.
7. Maintain prompt COMMUNICATION with your men, your boss, and adjoining forces.
8. Give clear INSTRUCTIONS and be sure they are understood.
9. Maintain CONTROL of your men at all times.
10. Fight fire aggressively but provide for SAFETY first.

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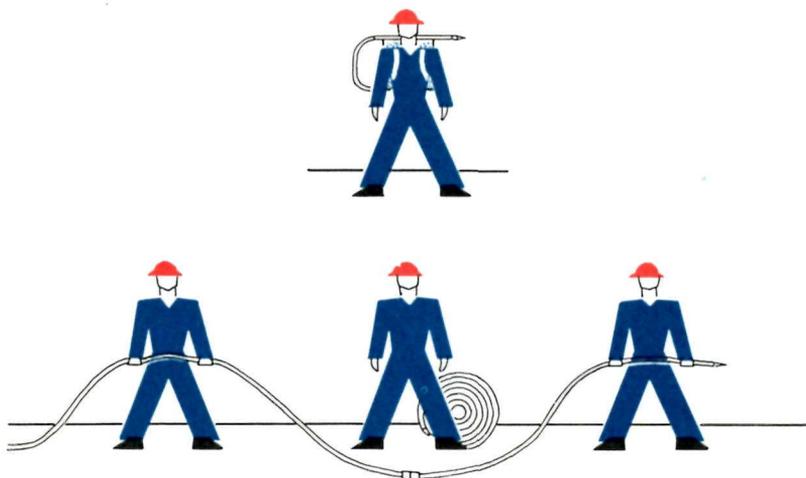
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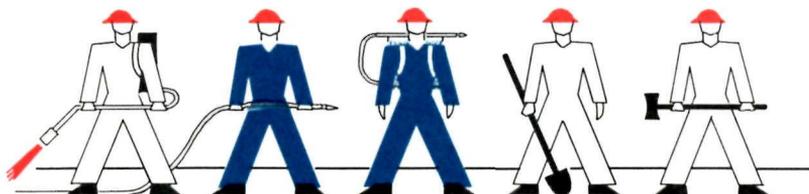


The pictures on this page represent men who will work with WATER to suppress FIRE burning in forest areas. There may be any number of men, depending on fire conditions. This booklet assumes that you are one of them—also that you may be all of them in turn. Sometimes you'll be the whole team all by yourself—but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



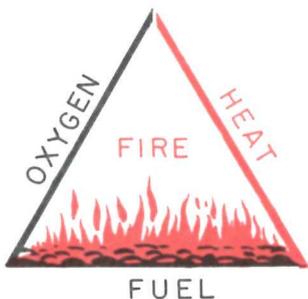
THERE'S LOTS OF SWEAT IN FIRE YET and there probably always will be. Nobody is going to argue that one—but you can save buckets of it if you save water all the way. If the fire isn't out when you run out of water, you're going to have a long way to go with a shovel; and it's hard work—remember?

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 grassland 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.



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. Here are a few to remember—

- If possible, the power company should deactivate lines in the fire area that may endanger firefighters. All men should be cautioned against directing water streams into high-tension lines. It is dangerous to stand under high-tension lines in dense smoke and heat, as they can arc to the ground. Men should avoid any electric wire on the ground and call power company specialists.
- Hold tankers at a reasonable distance from hot-burning fires. Use hose to reach fire edge and keep tankers in a maneuverable position.
- See that tanker crews wear protective clothing and that nozzle men wear goggles.

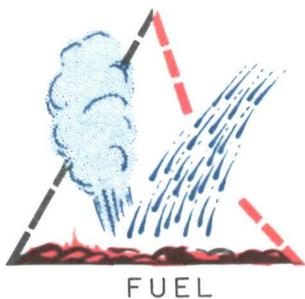


FIRE DOESN'T LIKE WATER MUCH. Water can be a mighty formidable enemy of fire as you can see, if you consider the triangle on the left. There is usually plenty of fuel around. There's plenty of oxygen too—if there wasn't, you'd be gasping like a goldfish on dry land by now. The heat bar of the triangle 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

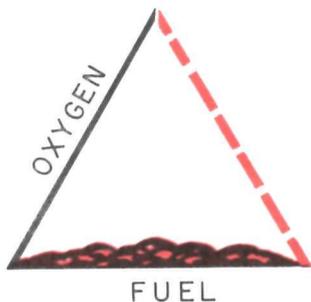
form a closed Triangle Corporation called FIRE. One of the best ways to break it down is to

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.

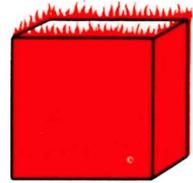
The same is true on the fire line. It'll take *very little water* to cover volumes of fuel—especially if you break the water up into a *spray*—because then many single droplets can cool many units of fuel—simultaneously.

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

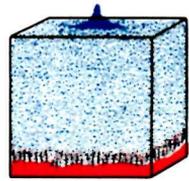
Burning litter, grass or duff,
NOT TOO LITTLE—JUST ENOUGH
Logs that smoulder, trees and such,
NOT TOO LITTLE—NOT TOO MUCH.



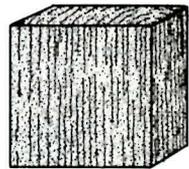
THIS IS
1 VOLUME OF WATER



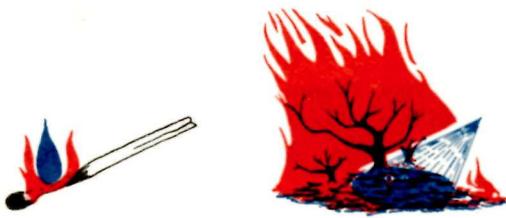
THIS IS
300 VOLUMES OF
BURNING FUEL



IF~
PROPERLY APPLIED,
1 VOLUME OF WATER

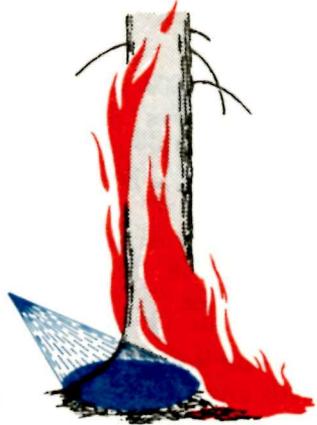


CAN EXTINGUISH
300 VOLUMES OF
BURNING FUEL.

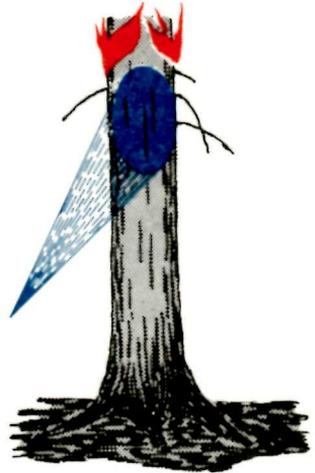


A LITTLE SPRAY GOES A LONG WAY toward knocking down a lot of flame, *if* you put it where it will do the most good. The tiny drop of water put out the burning match because you hit the base of the flame. Where there's smoke there's fire; where there's fire there's burning fuel, and it's always at the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

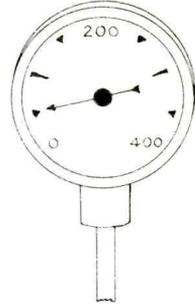
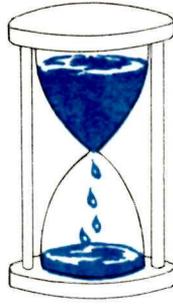


to

land

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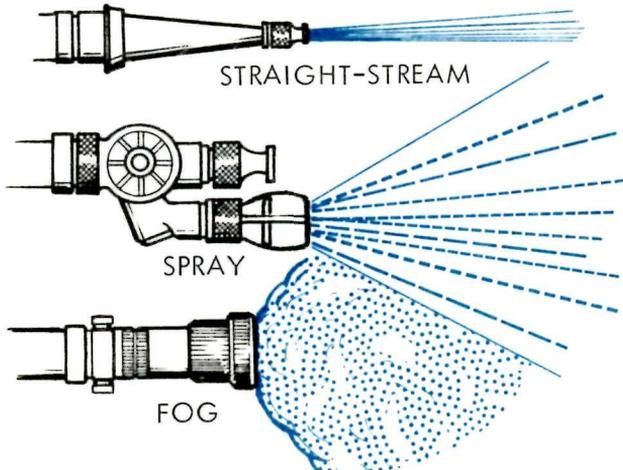


TIME WAITS FOR NO MAN—neither does fire. Water gets away just as fast unless you prove who's boss and control it. Whenever your water supply is limited, there are three gadgets you must be master of—your *pressure gauge*, your *nozzle*, and your *shut-off*.

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.

SELECT THE RIGHT NOZZLE





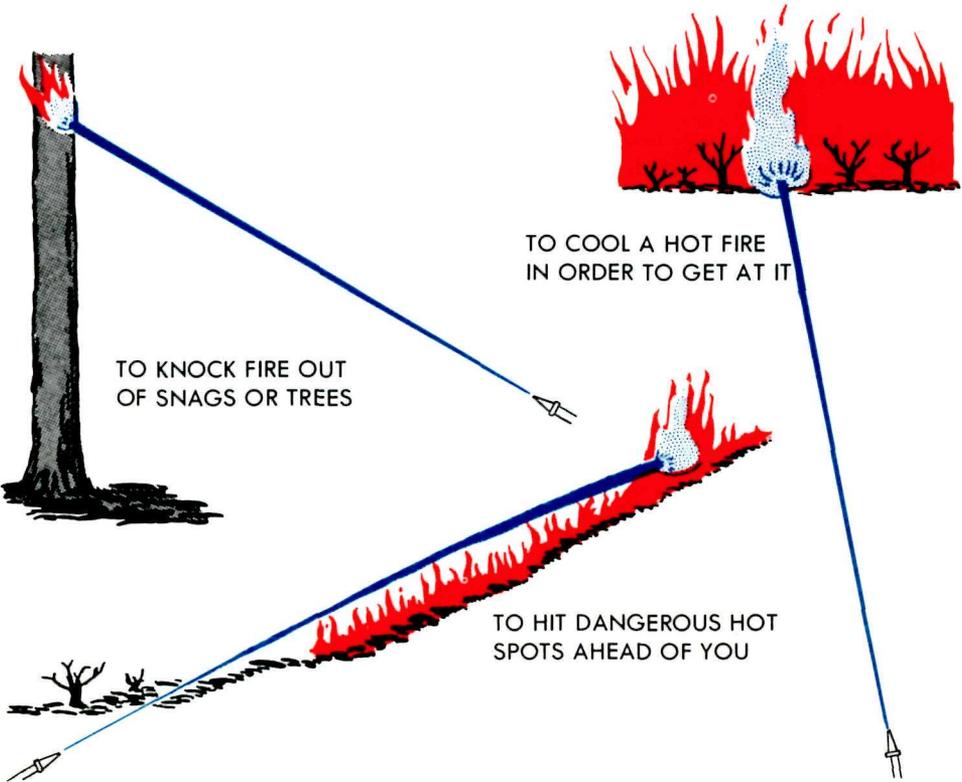
MORE FIRE TAKES MORE WATER—less fire, less water. Simple, huh? But if you're the kind of guy who's slow to change, you're going to waste a lot of water on a little fire, or a big fire will get bigger for want of enough water—adjust as you spray. Make your water match your fire.



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,

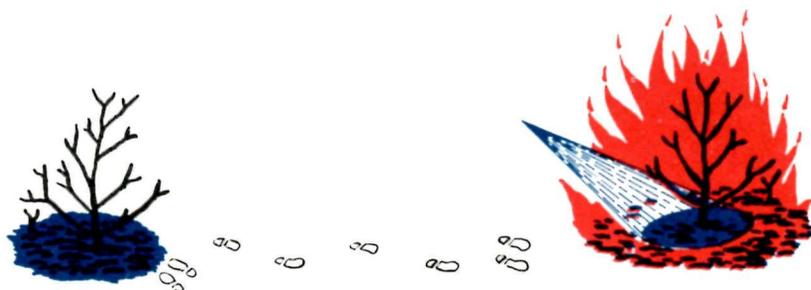
use that straight stream reach

only when you need it:

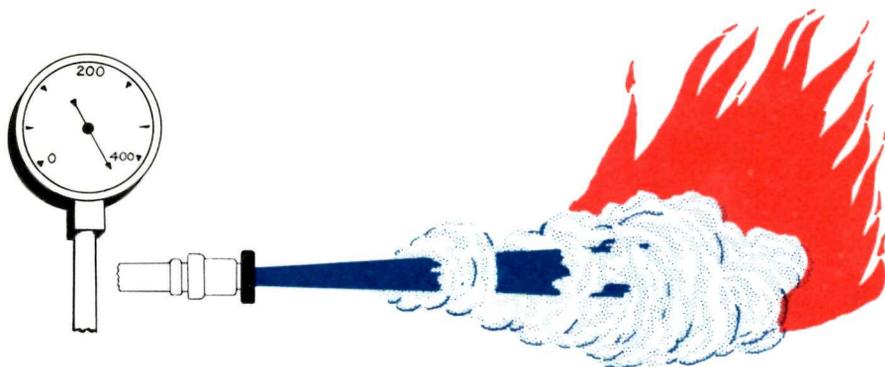


If you would water use with care;
Spray the fuel and not the air.

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

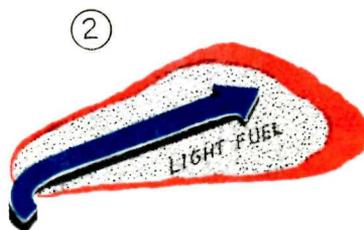
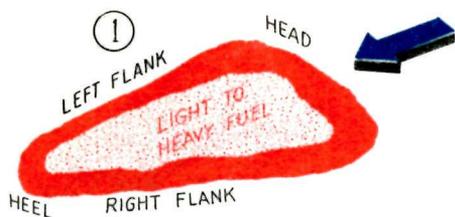


There's an “on-again-off-again-Finnigan” technique that pays high dividends in water saved. On the fire line squirt a little water at the base of the flame—shut it off—or move along. If the flame bounces back, give it more—but squirting water *intermittently on and off* gives you a better chance to use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



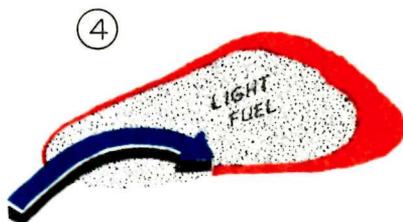
WATCH THIS ONE—some nozzles at high pressures actually deliver *air* as well as water on the fire—which has the effect of fanning the flame into action instead of knocking it down. When that happens, lower pressure.

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

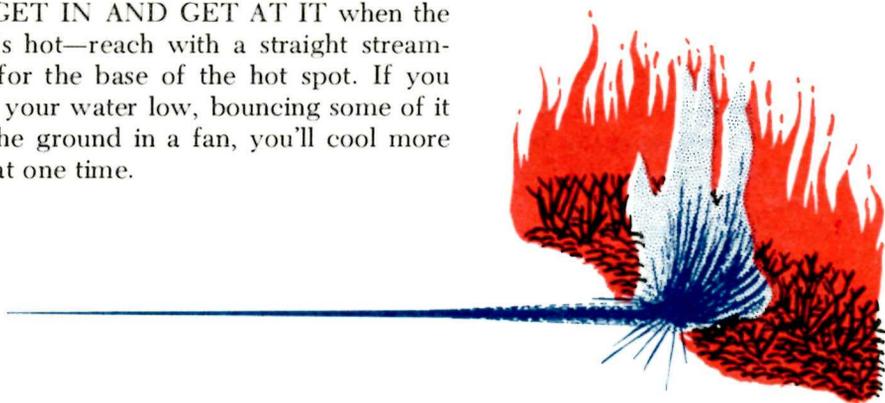


THE FIRE IS SMALL—you have water. You're lucky—because with water you can often hit the fire head (1), which is the fastest way to stop it. Sometimes in light fuel you can avoid heat and smoke by going in at the heel and attacking the head from inside the burn (2). But most often the best strategy is 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 the 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.

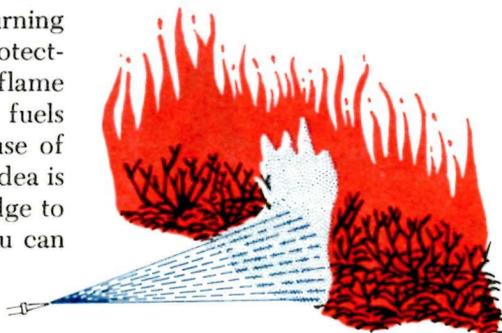


TO GET IN AND GET AT IT when the fire is hot—reach with a straight stream—aim for the base of the hot spot. If you keep your water low, bouncing some of it off the ground in a fan, you'll cool more fuel at one time.

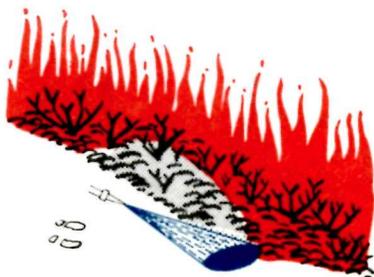


Keep moving in fast and—

CHANGE TO A SPRAY OR FOG 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—



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—

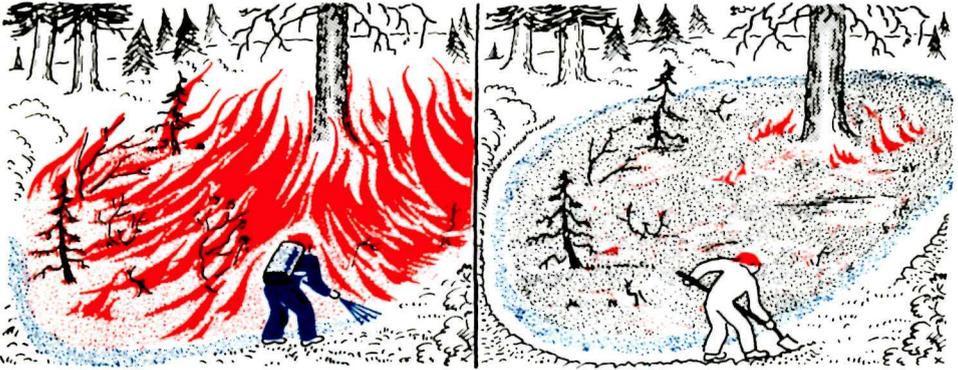


Knock the flame—be sure you do.
A job half done is wasteful too.

INITIAL ATTACK

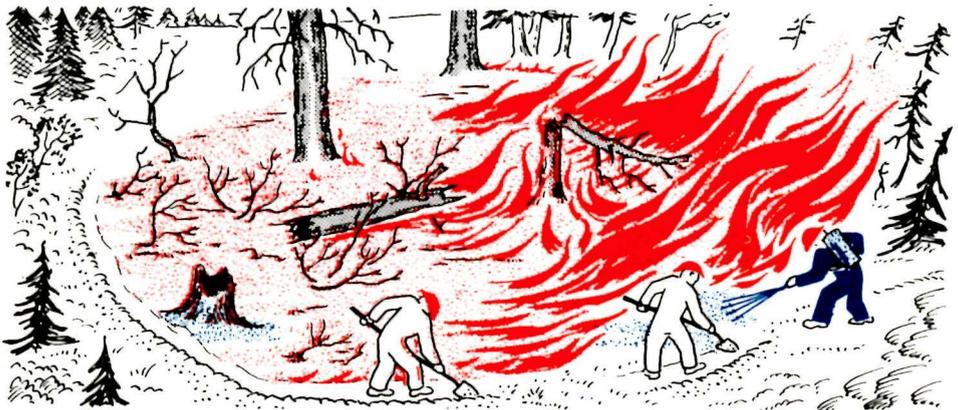
WE'VE GOT A FIRE! And it's up to you to catch it. Old smoke-eater or greenhorn, you have two things in common: training in fire strategy, and water. Too late to read this booklet again now—so tuck its helpful hints under your hard hat—and hit that fire!

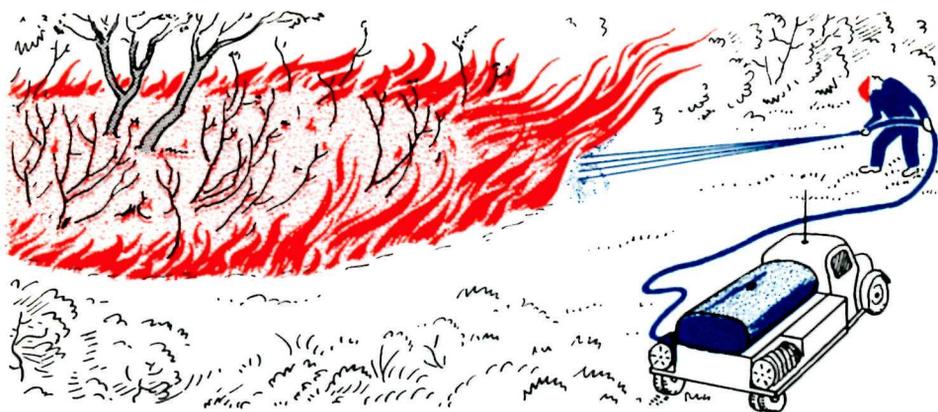
Valuable things are sometimes heavy. Gold, for instance. A backpump full of water can be worth its weight, too—if you're alone on initial attack especially.



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.



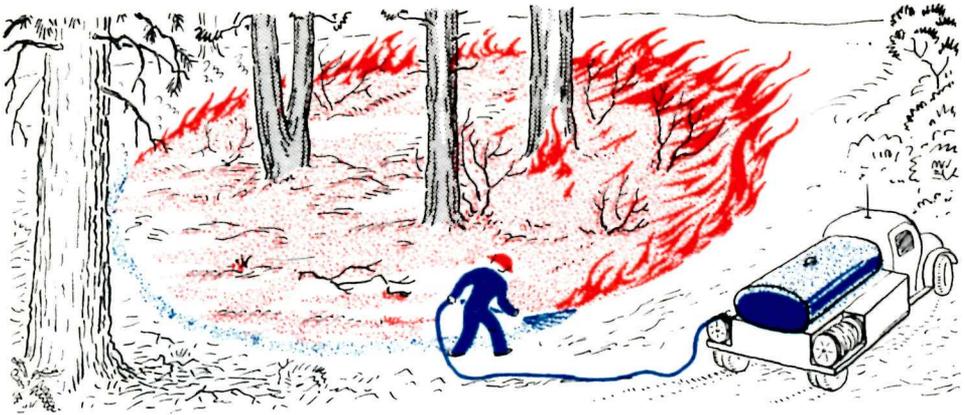


TANKERS ARE NICE TO HAVE AROUND. Roads make driving easier, but it's surprising where a tanker with a full load of precious water will go without one. Watch for stumps or rocks if you're doing the driving. You'll want to be able to take the rig back with you. As nozzleman, backed up with plenty of water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

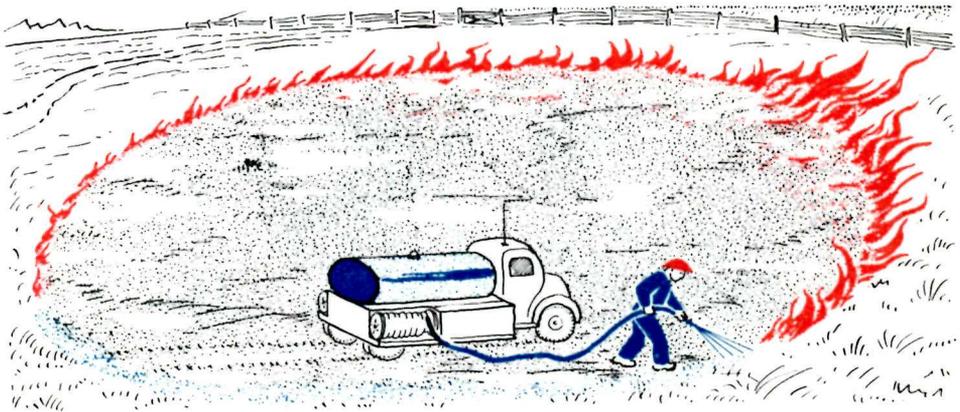




YOU'RE RACING THE FIRE on a flank attack. The tortoise won his race because the hare took a nap. A hot fast fire in heavy fuel can be put to sleep with water—but only to sleep. Knock it out faster than it can run ahead in order to pinch it off and stop it. Watch your water supply—and watch behind. Hot 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 fire line with hand tools 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—

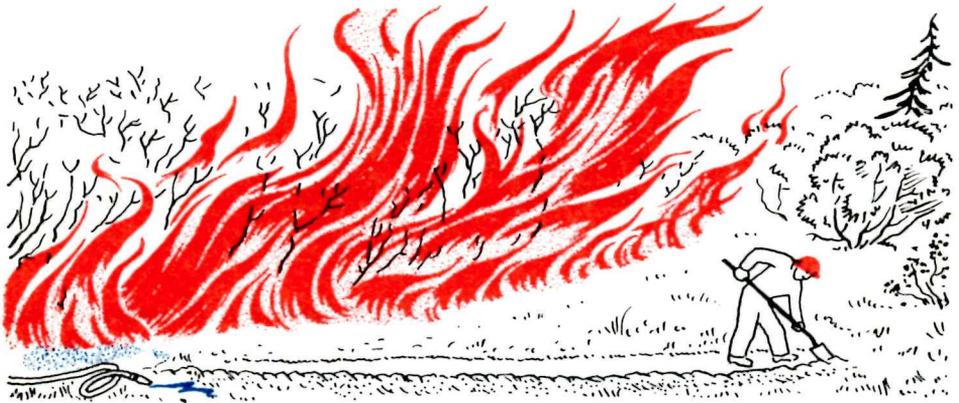
The man who burns one quickly knows
He's waterless without the hose!



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.

LARGE FIRES



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?

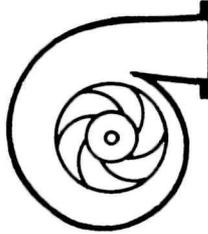
Attacks with stationary tankers and hose-lays are made when terrain or dense cover make it impossible to drive close enough to use the live-reel hose. As pumper operator you are responsible for keeping water going to the fire. Keep in touch with the hose crew, too. They must know how much water is available at all times.



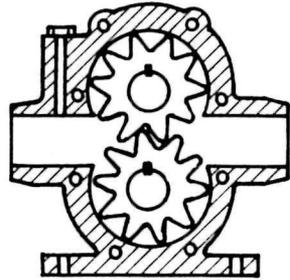
PORTABLE PUMPERS

SELECT THE RIGHT PUMP

. . . Performance,
GPM @ PSI, driven
by engine or vehicle,
weight, cost, etc.



CENTRIFUGAL



POSITIVE
DISPLACEMENT

Centrifugal Pumps

Advantages

- Pressure can be changed by adjusting rpm.
- Volume can be changed by adjusting psi and rpm.
- Relief valves not required.
- Dirty water and small particles can be passed without damage.
- Refill performance good.

Disadvantages

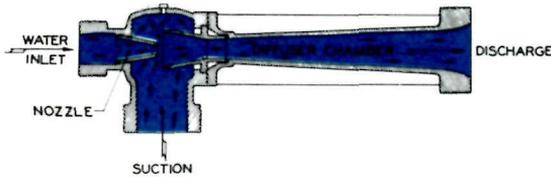
- More power required for higher pressures.
- Primer usually required.
- To avoid heating bypass is required when no water is moved.

Positive Displacement Pumps

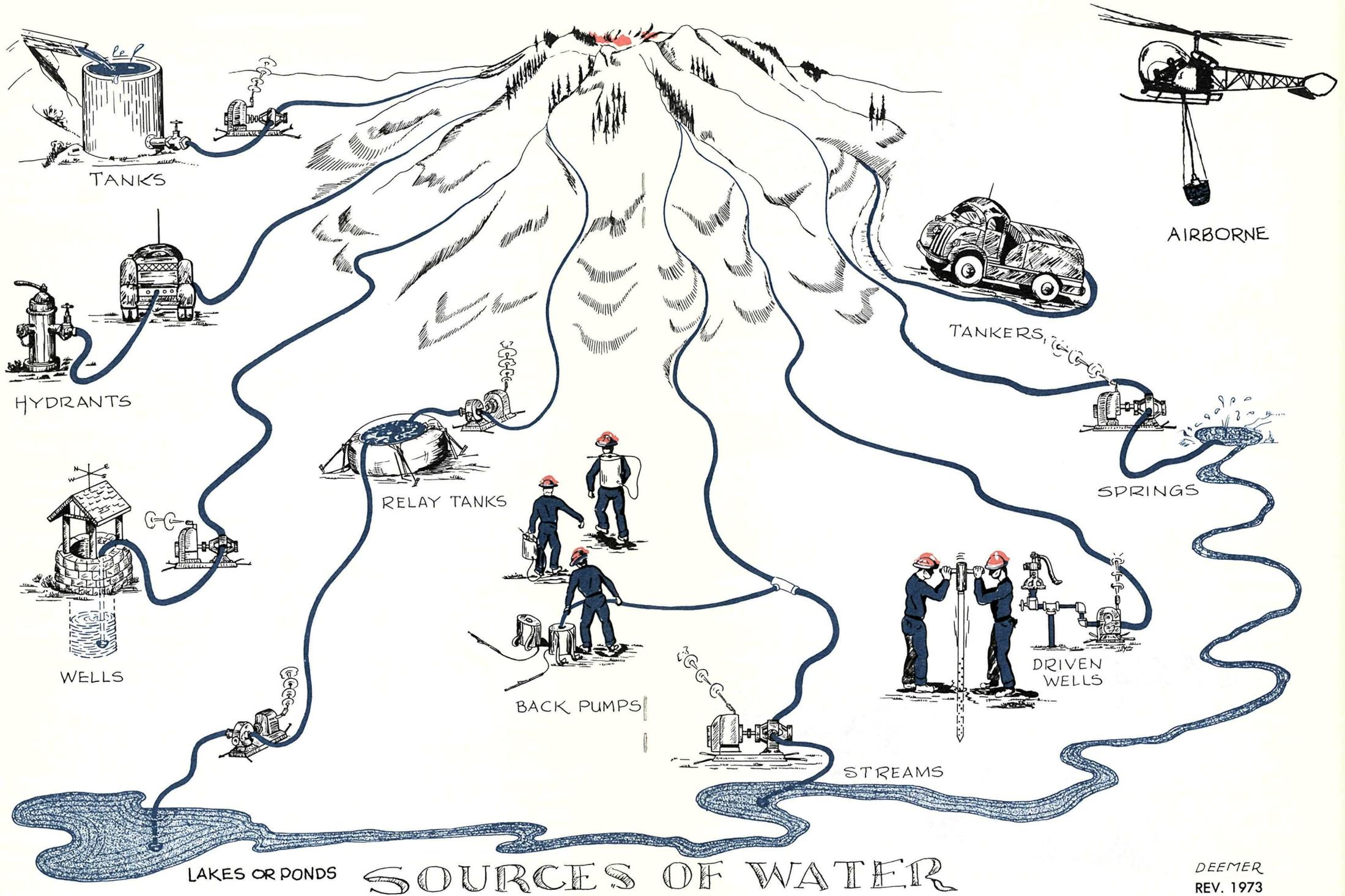
- Higher pressures can usually be produced with less power.
- Primers usually are not required.
- Damaged by dirty water.
- Relief valve required.
- Fixed output and psi performance not easily changed.
- Refill performance is low.

WATER EJECTOR

If water sources cannot be used because of the suction lift or off-road conditions, a hydraulic ejector may assist materially. This simple 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 and passes through a nozzle restriction as a high-velocity stream, as shown in the straight-type ejector illustrated below. 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.



The ejector can be used advantageously in situations where drafting becomes critical, on lifts of 18 or 20 feet, as in deep cisterns or off comparatively high bridges. In other situations, where there is not too much lift but where the tanker or portable pumper cannot be spotted in easy drafting hose reach, an ejector can be used up to several hundred feet from the pumper. A few small leaks in the hose are not critical, since the entire hose lay to and from the ejector is under pressure, not vacuum. For short lifts, especially with centrifugal pumps, it will probably be more efficient to draft.



BACKFIRING



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 slop 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.

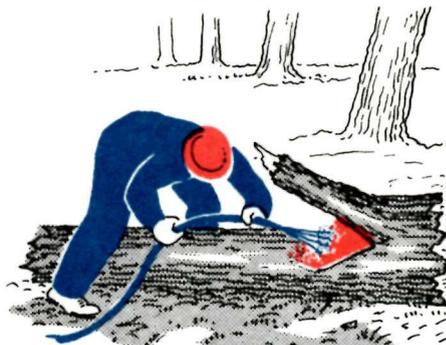
EQUIPMENT MAY VARY AND CHANGE BUT THE PRINCIPLES GOVERNING CONSERVATIVE WATER USE ARE ALWAYS THE SAME.

MOP-UP



ONE UNIT
OF WATER TO

300 UNITS
OF FIRE IN MOP-UP



WORK CLOSE

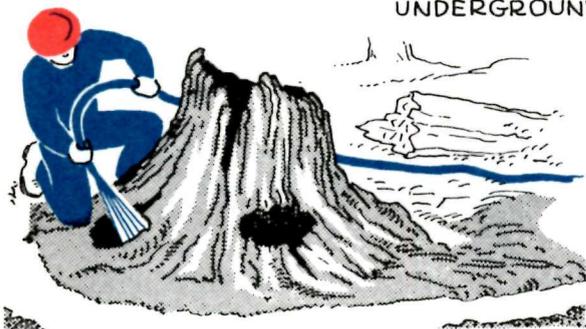
IT'S HEAT YOU'RE AFTER in mop-up—and it's hard to see because there often isn't much flame or smoke. There will be glowing and smoldering, but you'll have to look for hidden hot stuff. Find it—dig it—turn it—spray it with cooling water.

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. Where water is scarce, don't waste it 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 —



KICK UP AND COOL
 HOT SPOTS

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.

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



Sometimes water modifiers can be a big help in mop up—see details page 36.



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.

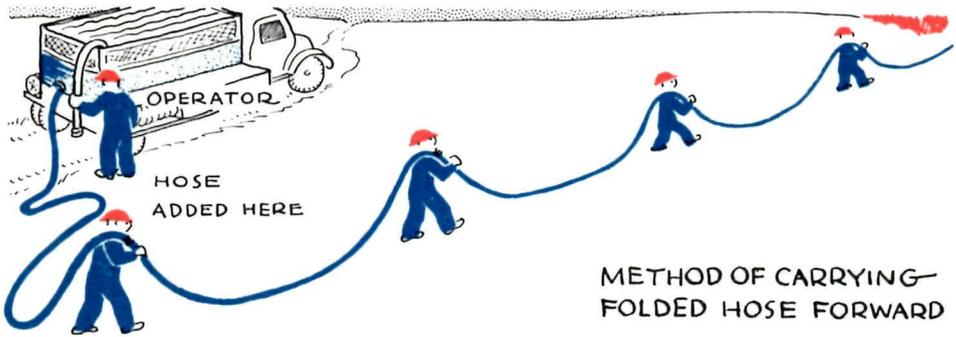
DON’T dump the water you have left over at the end of a mop-up job. Fires have a way of being unexpected and it’s a good idea to have some water in your tank at all times. It’s better than having to turn to with a shovel on the way home. Keep your hose and nozzle ready for use, too.

HOSE—LAYS

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. 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.

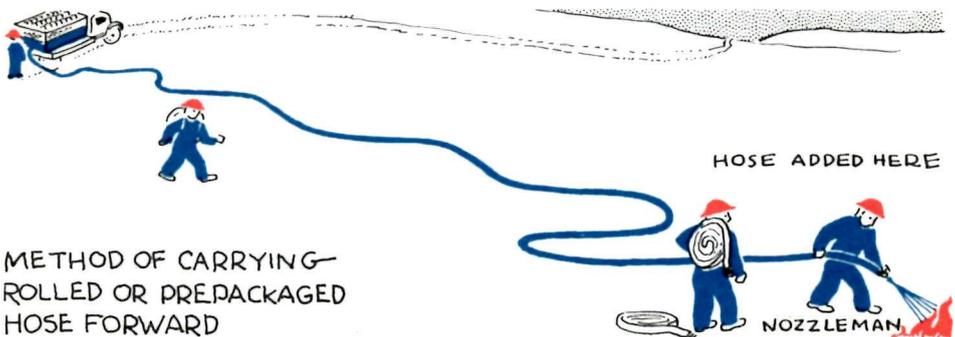
Fire tankers can carry hose several ways—sometimes it is coupled and folded so it can be pulled out in a continuous length; it may be prepackaged on packboards or in knapsacks; or it may be carried in single lengths in rolls that are coupled as the hose is laid.

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 crew.



In mountain fire fighting, rolled hose or hose prepackaged on packboards or in knapsacks is easier to handle than folded hose. It can be carried by one man through brush and trees or up steep slopes.

As a member of a team laying 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.



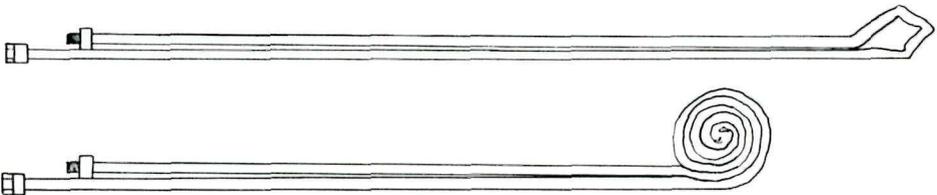


DON'T SWEAR at the coupling. Learn the trick of holding the hose in position with 3 fingers of each hand while using your thumbs and index fingers to turn the female collar. A little graphite will help make the turning easier. Never use oil or grease. They are hard on hose and are apt to pick up dirt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

Practice coupling and uncoupling hose. Speed in laying hose depends on team-work 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.

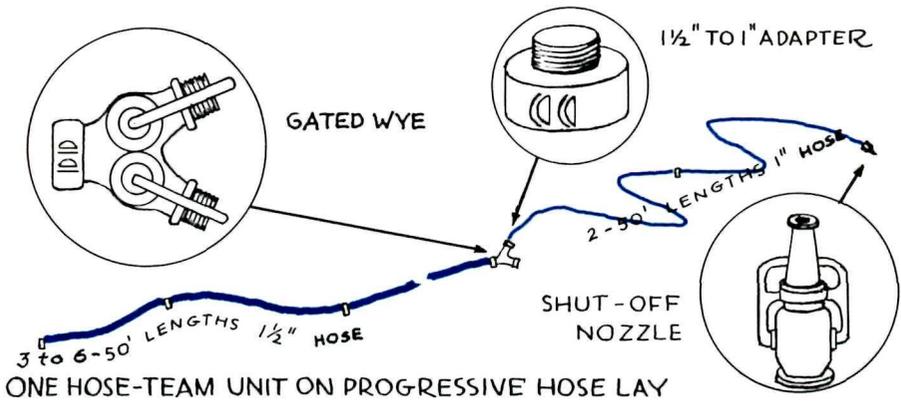
Neatly rolled hose which can be quickly and easily put into service adds speed to a hose team too. Roll it this way:



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.

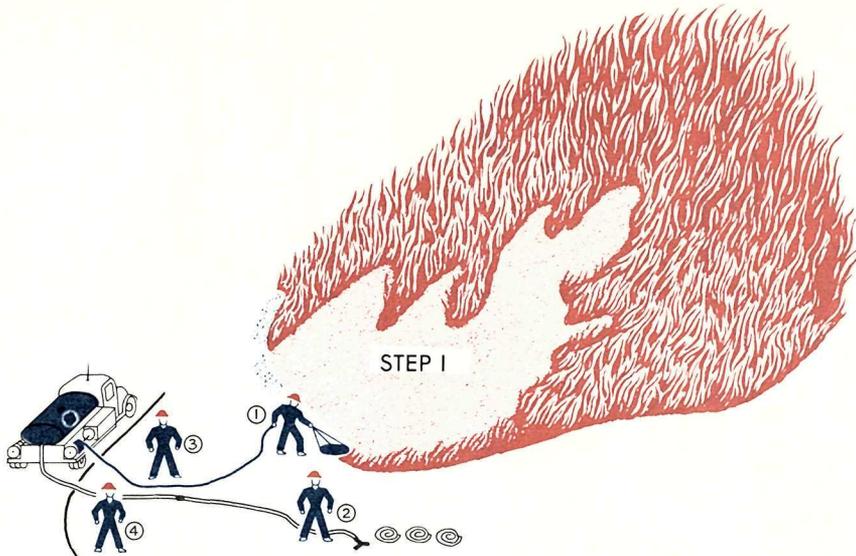
HOSE-LAYS GROW in length according to the distance from the water source to the fire edge and according to the size of the fire perimeter. Some grow simply by the addition of one length of hose after another. Others are a more complex hose network serviced and connected by a variety of equipment, including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



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 hoseline 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.

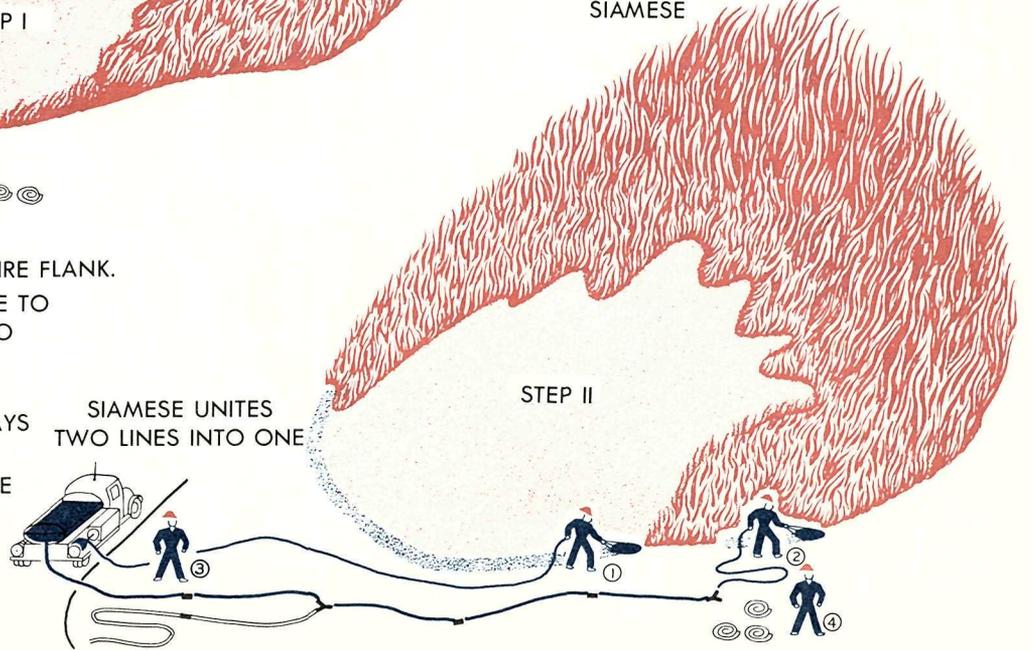


STEP I

NOZZLEMAN(1) USING LIVE REEL HOSE, MAKES HEEL OF FIRE SAFE.
 OPERATOR(3) AND HELPER(4) CONNECT TWO LENGTHS OF 1½" HOSE TO TANKER.
 NOZZLEMAN(2) CARRIES THREE ROLLS OF 1½" HOSE, SHUT-OFF NOZZLE, AND GATED WYE TO END OF THE TWO COUPLED LENGTHS AND ATTACHES GATED WYE IN REVERSE, TO ACT AS A SIAMESE

STEP II

NOZZLEMAN(1) PROCEEDS ALONG FIRE FLANK.
 NOZZLEMAN(2) ATTACHES 1½" HOSE TO SIAMESE, 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 HOSE FORWARD AND HELPS COUPLE IT.

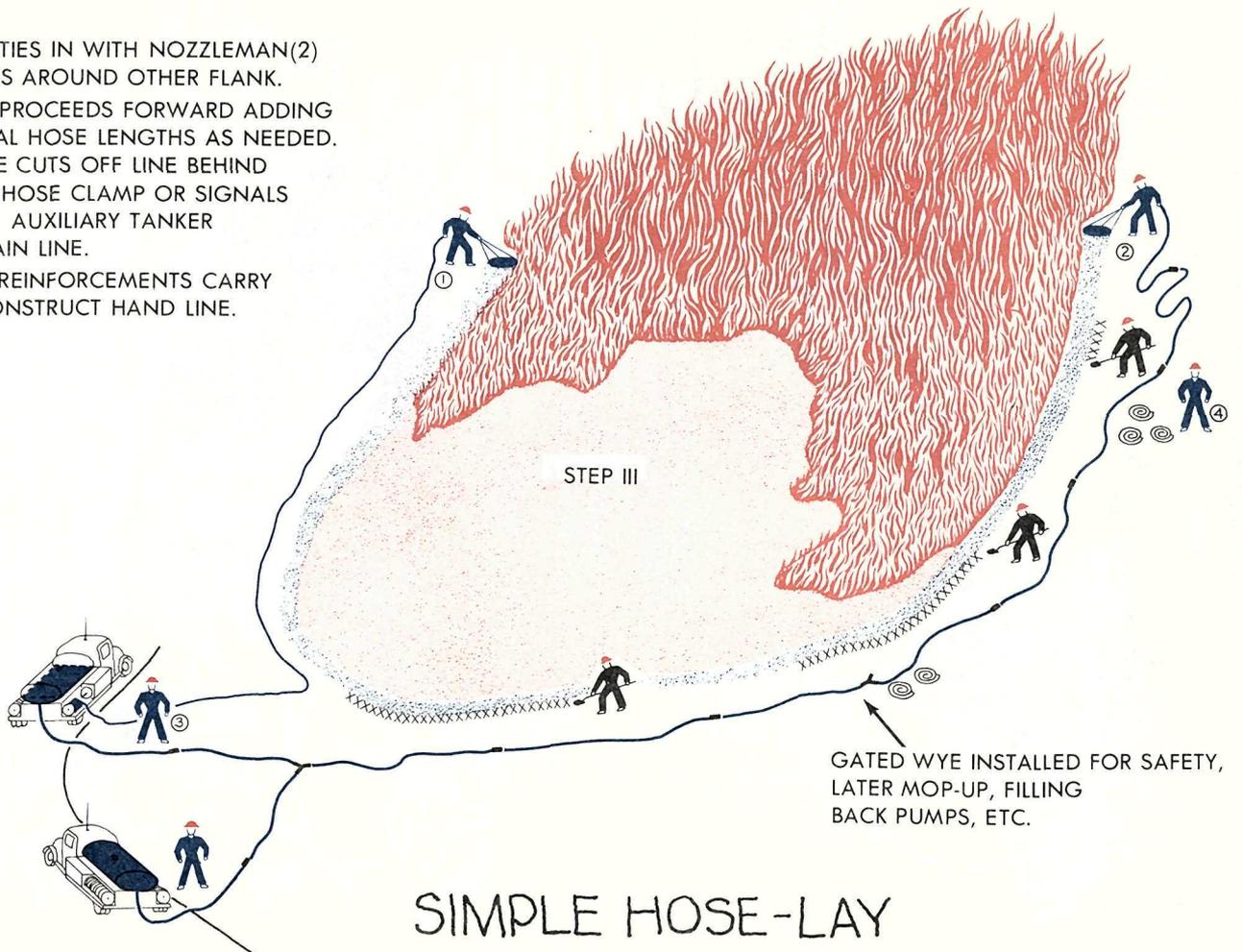


SIAMESE UNITES TWO LINES INTO ONE

STEP II

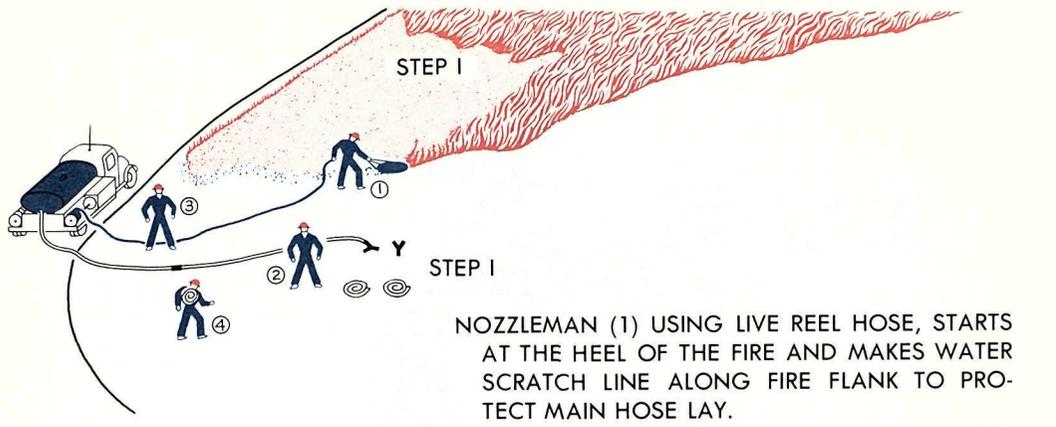
STEP III

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 CONSTRUCT HAND LINE.



GATED WYE INSTALLED FOR SAFETY, LATER MOP-UP, FILLING BACK PUMPS, ETC.

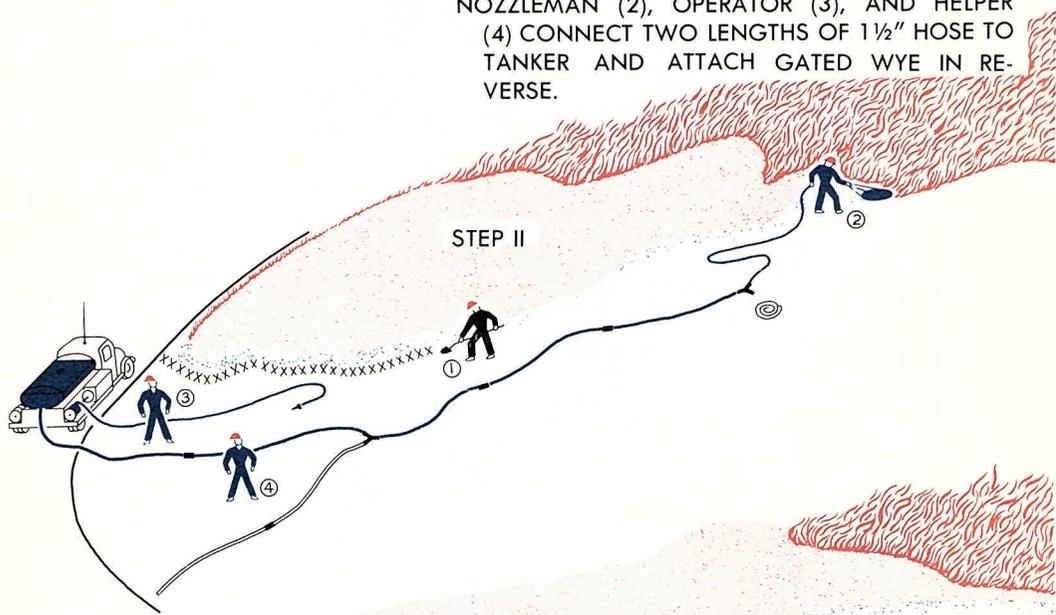
SIMPLE HOSE-LAY



STEP I

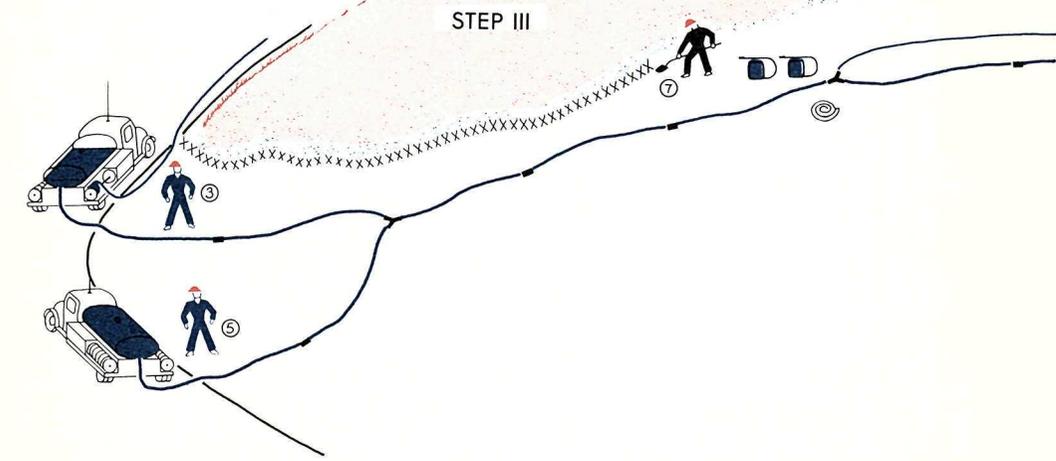
STEP I

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" HOSE TO TANKER AND ATTACH GATED WYE IN REVERSE.



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 1½" LINE AND CONNECTS TWO LENGTHS OF 1½" HOSE TO REVERSED GATED WYE FOR AUXILIARY TANKER.
 NOZZLEMAN (2) AND HELPER (4) LAY AND CONNECT ONE HOSE TEAM UNIT (PAGE 27) AND PUT IT INTO ACTION.



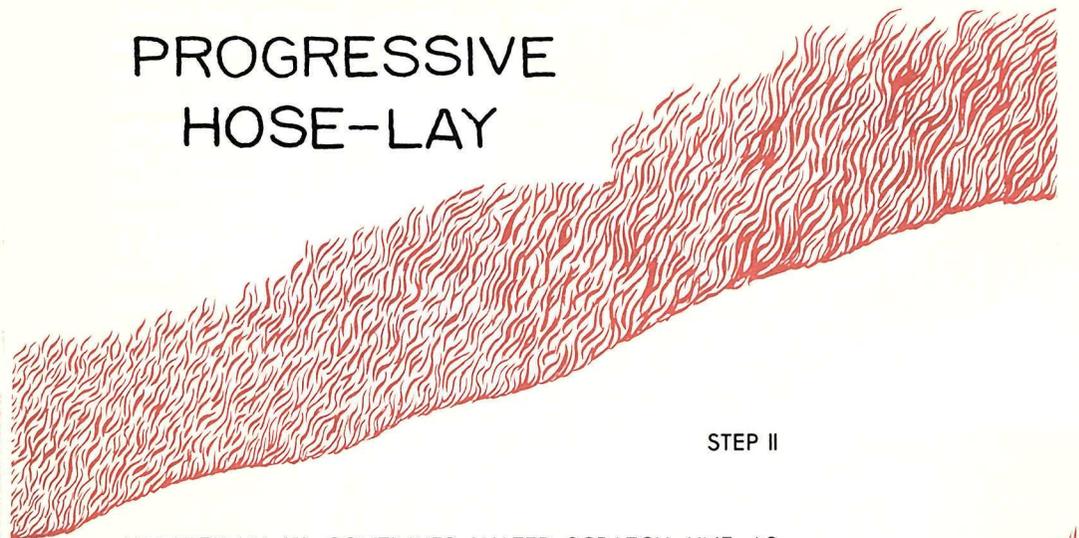
STEP III

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 32 AND 33). ONE MAN (9) STANDS BY AS RELAY PUMP OPERATOR.

PROGRESSIVE HOSE-LAY



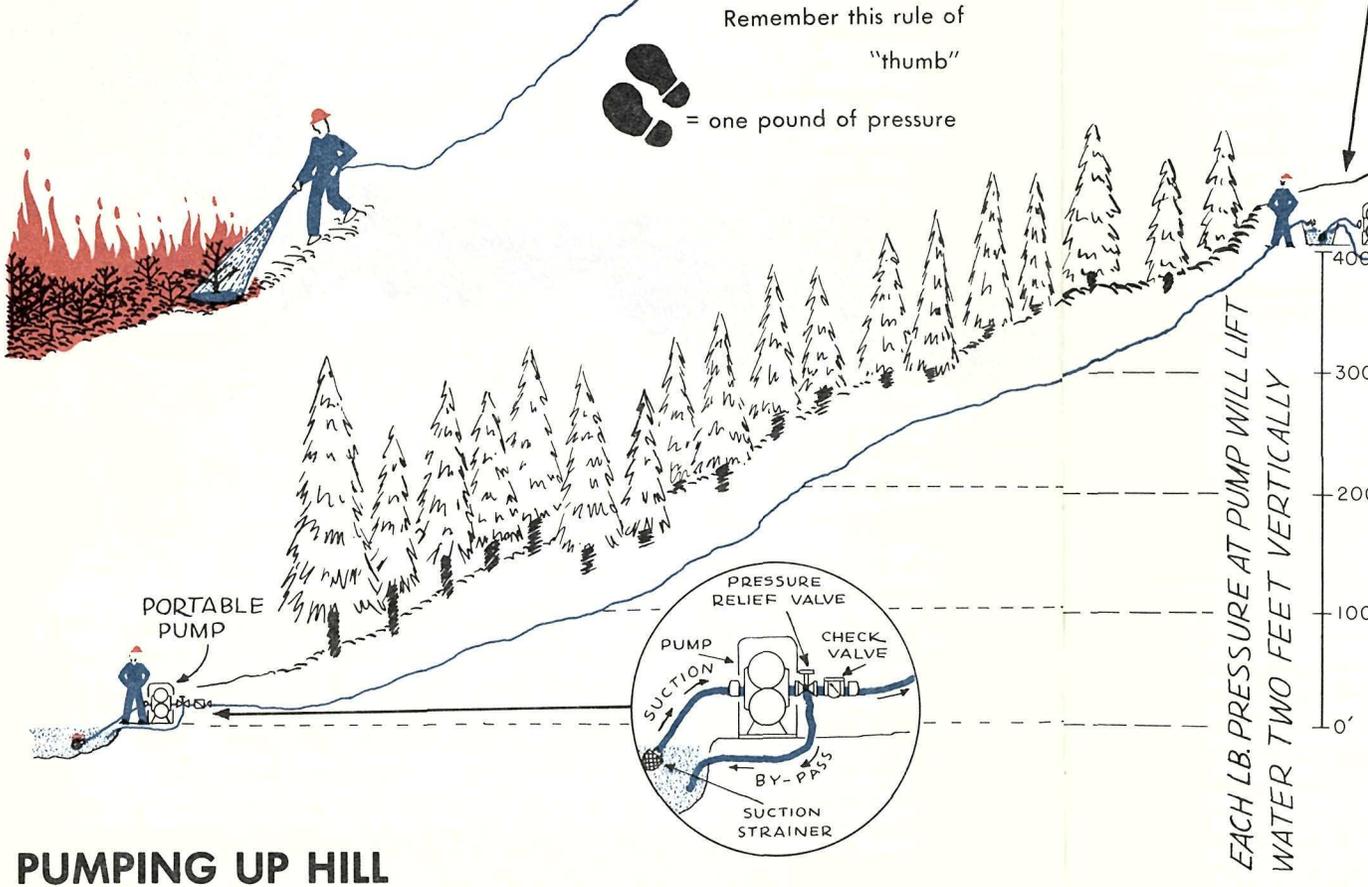
STEP II

DOWN HILL

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.



PUMPING UP HILL



Remember this rule of "thumb"
 = one pound of pressure

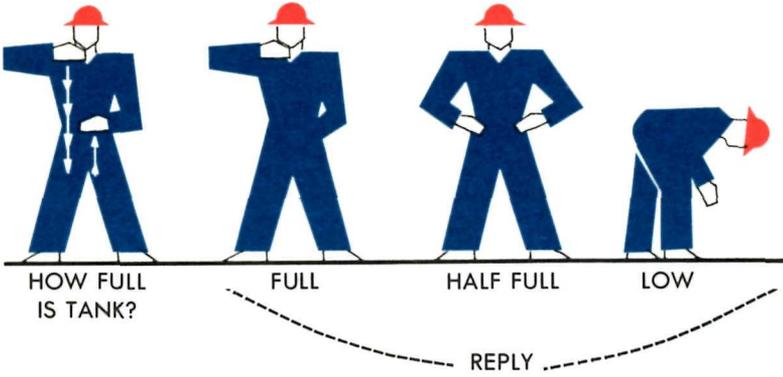
EACH LB. PRESSURE AT PUMP WILL LIFT WATER TWO FEET VERTICALLY

POUNDS PUMP PRESSURE NEEDED TO GET DIFFERENT NOZZLE PRESSURES

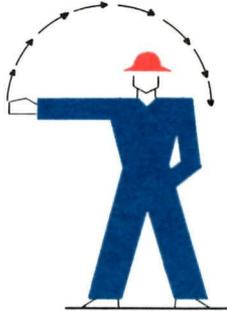
FEET RISE	NOZZLE PRESSURE—P.S.I.				
	50	75	100	150	200
50	70	95	120	170	220
100	95	120	145	195	245
150	115	140	165	215	265
200	135	160	185	235	285
300	180	205	230	280	330
400	225	250	275	325	375
500	270	295	320	370	420

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.

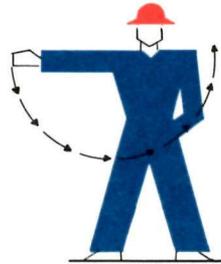
There are safe working pressures for both pumps and hose. They may not be the same—but when the limit of either one is reached, install a portable "booster" pump and relay tank as pictured. Use *all* the fittings as shown in the circles.



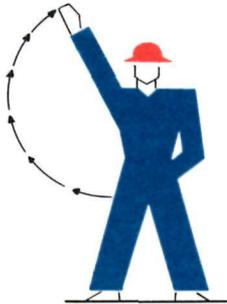
DELIVER WATER AT NOZZLE



INCREASE PRESSURE



DECREASE PRESSURE

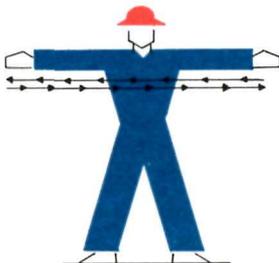


MORE HOSE



BROKEN HOSE

HAND SIGNALS



SHUT DOWN



ROLL UP HOSE

Equipment for 1/2-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 Gated wyes, 1½"	75 Hose washer, 1½"
15 Adapters, 1½" to 1"	75 Hose washer, 1"
18 Spanner wrenches, 1" & 1½"	30 Hose, 1" x 50'
15 Shut-off, 1", with straight & spray nozzles	75 Hose, 1½" x 50'

Equipment for each hose-team unit:

NOZZLEMAN:

- 1 Knapsack
- 1 Gated wye, 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 Hose, 1" x 50'

HELPER:

- 1 Packboard
- 4 Hose, 1½" x 50'

Equipment for one booster-relay unit:

1 Portable pumper	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

FREQUENTLY USED MEASURES

1 stat. mile equals 5,280 feet	1 acre equals 300 ft. by 145.2 feet
1 chain equals 66 feet	1 sq. mile equals 640 acres
1 acre equals 10 sq. chains	1 side square acre is 208.7 feet
1 acre equals 43,560 sq. feet	1 U.S. Gallon equals 231.0 cu. inches
1 acre equals 100 ft. by 435.6 feet	1 U.S. Gallon weighs 8.335 lbs.
1 acre equals 150 ft. by 290.4 feet	1 cu. ft. equals 7.481 gallons
1 acre equals 200 ft. by 217.8 feet	1 cu. ft. of water weighs 62.4 lbs.

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, or peat and muskeg. It can be a big help on mop-up. Compared with plain water

- Penetration into wood is 8 times greater.
- Penetration into charcoal is 6 times greater.
- Surface spreading on wood is increased 2 to 8 times.

Problems

Most wet water agents are corrosive unless they contain an inhibitor and inhibitors are toxic so avoid consumption or skin irritation. Use an agent which is approved by your agency and flush out tanks, hose and accessories after use.

VISCOUS WATER AND GEL is plain water thickened by adding a small amount of a viscosity agent to make it absorb more heat. They can be of great value in pre-treatment of control lines or in heavy fuels. Compared with plain water, it has these advantages

- Sticks more readily to forest fuels
- Spreads out in a continuous coating
- Sets up a layer 3 times thicker
- Absorbs more than 3 times more heat

Disadvantages

- Lack of penetration
- Friction in hose
- Slippery
- Corrosive

Again only approved chemicals should be used and agency directions on use and flushing should be followed.

FIRE RETARDANTS

Short-term—Depend primarily on cooling action to slow fire spread. Best used in direct attack.

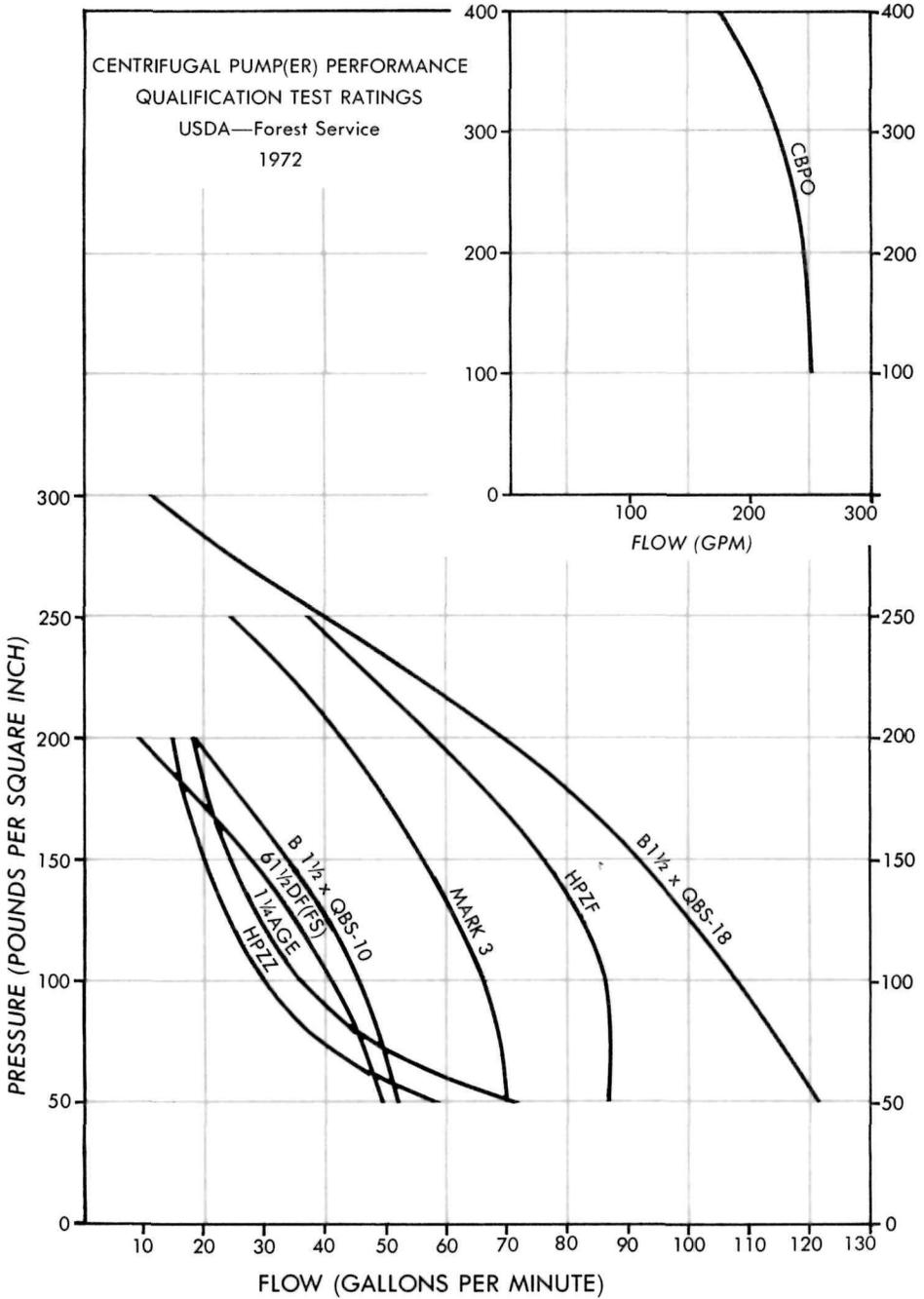
Long-term—Depend primarily on chemical action to slow or stop fire spread. Can be used in direct or indirect action with equally good results.

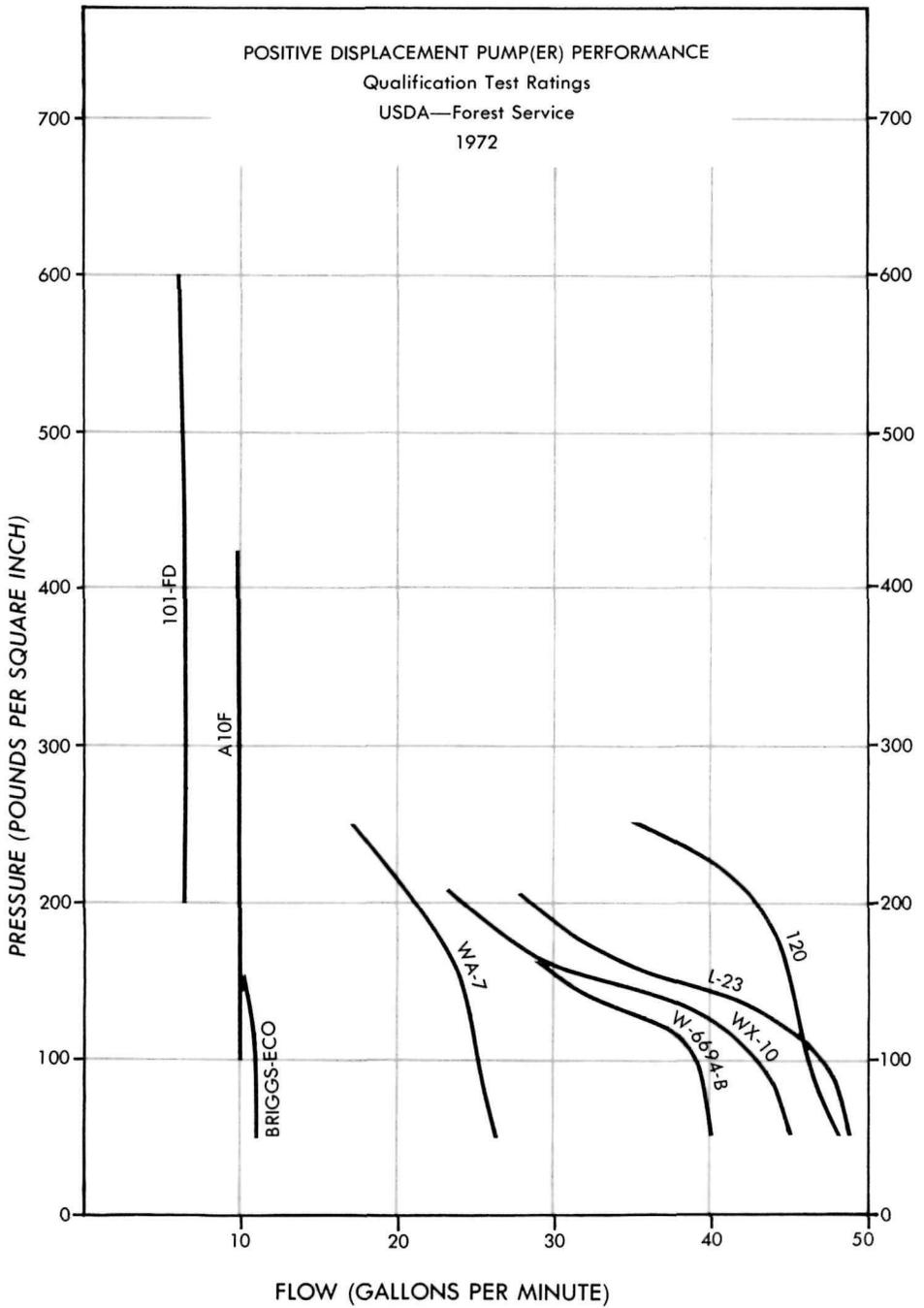
USEFUL INFORMATION
FRICION LOSS IN LBS. PER SQ. INCH (P.S.I.)
PER 100 FEET OF FIRE HOSE

FLOW-GALLONS PER MINUTE	RUBBER OR LATEX LINED						UNLINED OR LINEN			
	5/8"	3/4"	1"	1 1/2"	2"	2 1/2"	1 1/2"	1 1/2"	2"	2 1/2"
6	11.5	5.6	1.4							
12	45.0	19.5	4.9				1.0	1.4		
18	100	41.0	10.5	1.4			1.9	3.0		
24		67.0	17.5	2.4			3.2	5.1	1.3	
30		100	26.5	3.6			4.8	7.8	1.9	
36			37.0	5.0	1.3		6.6	11.0	2.7	
42			49.0	6.7	1.7		8.8	14.5	3.6	
48			61.5	8.5	2.2		11.0	18.5	4.5	1.5
54			78.0	10.6	2.7		13.5	23.0	5.6	1.9
60			95.0	12.7	3.3		16.5	28.0	6.8	2.3
72				18.0	4.6	1.5	23.0	38.0	9.6	3.3
84				24.0	6.1	2.0	30.5	50.0	12.7	4.3
96				30.5	7.8	2.5	38.5	66.0	16.5	5.5
108				38.0	9.8	3.2	48.0	82.0	20.5	6.8
120				46.0	12.0	3.8	58.0	100	24.5	8.4
144				64.0	17.0	5.4	80.0		34.5	11.7
180				96.0	26.0	8.2			52.0	18.0
240					44.0	14.0			88.0	30.0

SOLID STREAM NOZZLES
REACH OF STREAM—IN FEET (Approx.)

NOZZLE PRESSURE P.S.I.	NOZZLE DIAMETER								
	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	3/4"	1"	1 1/2"
10		30'	33'	35'	36'	40'			
20		43'	47'	50'	53'	57'			
30		52'	56'	59'	63'	66'			
40		58'	62'	66'	70'	73'			
50		63'	67'	71'	75'	78'			
60		66'	71'	75'	79'	82'			
70		69'	73'	77'	82'	86'			
80		72'	76'	80'	84'	88'			
90		74'	77'	82'	86'	90'			
100		75'	79'	83'	87'	92'			
110		76'	80'	84'	89'	93'			
120		77'	81'	85'	90'	94'			
140		78'	81'	85'	90'	94'			





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.

