Vol. 8 APRIL and JULY 1947 Nos. 2 and 3

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

FIRE CONTROL NOTES - Vol.8 - Cop.2
April and July 1947 - Nos. 2&3

Name	Date
~~[illegible]~~	
~~[illegible]~~	
~~[illegible]~~	
~~[illegible]~~	
~~[illegible]~~	
~~[illegible]~~	

Volume 8 Numbers 2 and 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1947

Contents

FIRE CONTROL IN RESOURCE MANAGEMENT

A. A. Brown

Assistant Chief, Division of Fire Control, U. S. Forest Service

Some observers at the recent Forest Congress were impressed by the undue degree to which we have separated protection of our forest resources from fire, insects, and diseases from the other management phases of the job. Others have felt that there is a conflict in some of our present conceptions. This question is highly important to the proper balance of effort in our Land Management job as well as to the continued sound progress of the protection phases of the job. Some stock taking seems in order.

The methods, policies, and traditions of modern forest-fire control began in the West. They strongly reflect the influence of huge areas of back country and of unmanaged, abused or extensively managed forest areas. The fire problem in such country is big. Men are often pitted against great forces of nature and are challenged to increase their stature figuratively to contend with them. So the conflagration fire involving many thousands of acres and the periodic threat of complete disaster tend to dominate thinking and planning.

The bigness and the challenge of such problems have contributed much to the quality and resourcefulness of Forest Service personnel from the start. In popular fancy, and even among the ranks of foresters, this kind of fire control has impressed itself as the whole of the job. It has been an easy step from this conception to the belief that forest fire control when fully perfected can consist everywhere of a specialized protection service to be provided by technicians, like a fire chief and his crew in a big city. With that done the householder can go happily about his other affairs and simply buzz twice if he needs a fireman.

A good many silviculturists and other resource specialists and even some administrators now take this view, and see no reason to concern themselves with fire control. Perhaps the highly developed technical phases of the fire control job and the specialized equipment which have rapidly evolved have contributed to this viewpoint. Such things encourage the comforting belief that it is a specialist's job and the responsibility could very well be disposed of by "contracting" for the job on a routine basis. This kind of thinking ignores the intimate relationship both between fire and the existing forest and between fire and the job to be accomplished.

Fire, for the most part, was the eventual harvester of the timber crop in the virgin forest. Allied with storm, flood, insects, or disease, it removed the old and started the new. Such old relationships are faithfully reflected by the characteristics and prevalence of many of our most valuable species. When man became the harvester, these old relationships were disturbed. The immediate effect was to greatly in-

crease the occurrence and effect of fire. The combined effect of fire and man's harvesting activities produced consequences which made the control of fire essential to stability.

Most present day forest units have a fire history reflecting these disturbed relationships. Over whole regions, fire in the recent past has determined the condition and present value of the forest resource. It has been decisive too in determining the productivity of forest sites and in the selection of species that now prevail. In turn, fire history has limited and continues to affect the whole social and economic pattern of the region concerned.

As fire-control measures become more efficient the significance of fire to the forest seems less important. But success only in reducing the areas burned each year does not relegate such things to the past. Fire has such varied effects under different conditions that simple exclusion may not be enough to enable skillful silvicultural or other management. There is increasing evidence that advanced practice is likely to call for some use of fire as a tool of management in order to then reestablish some of nature's old relationships. The forest manager must understand these relationships to his forest before he can manage it successfully.

Several principles are involved in relation to his over-all job.

In extensive management of wild land, fire has to be controlled. Alone, that is a sufficient basis for building extensive systems of fire control and for judging results only in terms of percent of protected area disturbed by fire in any given period. No fine distinctions are needed in an aggressive policy of controlling fires that start. The necessity of preventing man-made fires has also been generally accepted. On such premises our forest fire control policy and progress have been built. It has been patterned to the problem of holding down heavy fire losses on extensively managed or badly managed areas of wild land. In such areas, existing fire risks and fire hazards had to be accepted as a part of the fixed problem and the organization and methods had to be designed to fit.

Now that intensive management of a rapidly increasing portion of timber, range, wildlife, and watershed lands is becoming a fact, some changes in the manager's relationship need to be recognized. On really intensively managed areas, the magnitude of the fire job is no longer fixed. Methods within the manager's control can eliminate the old threat of complete disaster and can even cut down the size of the job so that his management organization can handle it. This process is never concerned solely with fire. It is less spectacular but more realistic than the alternative of building an independent fire organization capable of meeting the worst that nature and management together can produce.

Forest fuels are the most important factor in this relationship. The amount of fuel that is allowed to accumulate and its continuity are recognized by fire control men everywhere as fundamental in determining the cost of effective fire control and in fixing the losses that are bound to occur over a period of years. Lack of utilization of wood on the ground has always created the worst fire liability. Anyone who recalls the great mass of fire-killed debris in the Northwest following the 1910 burns or who has seen the Tillamook burn does

not have to be reminded that great areas of such debris set the stage for conflagration fires. Good management of timberlands will not allow such hazards to persist.

Similarly, traditional methods of clear cutting of Douglas fir in the Northwest create unmanageable fire hazards so long as great masses of wood representing vast storehouses of heat energy ready for the fuse are permitted. Wasteful clear-cutting of mature hardwoods and the great volume of dry fuel left behind have in the past created abnormal fire hazards in the Northeastern and Lake States. Similarly great open clear-cut areas fully exposed to sun and wind, even where natural forest fuels are light, create unnatural or unnecessary special hazards.

Some recent thinking has confused these relationships. The term "custodial" has been applied to the extensive type of management in which activities are restricted to protecting the area and building improvements. Such management was set off as the opposite to the ideal of a fully managed forest area. In promoting progress toward such an ideal, there has been a tendency to discredit the former as a part of the pioneering state which has now passed. In that process forest fire control became identified as part of the custodial job and even labeled as "custodial" in nature.

It is unfortunate that fire cannot be neatly catalogued as a "forest resource" in the effort to get foresters to give more thought to on-the-ground management, but protection enters so strongly into every phase and responsibility of that management that it has long been accepted as the first step.

Fire liabilities and probable losses depend in part on management practices on the ground and human risks and incendiary motives are apt to reflect administrative policies. The responsibility for successful results cannot for such reasons be closely confined to a small specialist group. Every forester of necessity must be something of a fireman. Undue emphasis on the operation or engineering phases of fire activities reduce this feeling of responsibility and in the long run tend to narrow the field of activity and opportunity of the forester.

Certainly "resource management" independent of any responsibility for active protection is hardly worthy of the name. If a distinction between degrees of extensive and intensive operation and management does need to be made it needs also to be applied to the practice of forest fire control. There is a pressing need to fully develop what may be termed "intensive management fire control." The status of the area manager is directly concerned. He cannot very well pass this responsibility to someone else if he aspires to be the real manager of resources on his unit.

The measures identified with intensive timber management which can reduce the fire potential that must otherwise be accepted in extensively managed areas, consist of good accessibility, small management units, close utilization, selective cutting where practicable, control of insect and disease epidemics, and some use of controlled fire. Comparable measures in raising the level of management of some other forest resources can also exert a profound effect. Increased employment of forest workers is also a characteristic of intensive management. Most of the employees, who under old methods had to

be recruited and employed for fire control duties only, then become available within the area. In such ways the size of the fire job itself and the means of dealing with it then come progressively within direct control of the manager. To the degree this occurs, the chances taken and the losses that result become his direct responsibility. Insect and disease losses have a similar relationship.

In exercising "intensive management fire control" or "intensive management protection," skillful use of fire becomes an appropriate tool of management subject also to close control and adaptable to many purposes. The use of fire to reduce the amount of hazardous fuel following timber cutting is an early tradition of the Forest Service. Methods and costs in excess of the risk involved properly brought the practice of piling and burning slash into disrepute under many conditions. Under intensive management no fixed formula will serve. Intensive utilization and selective cutting will drastically reduce the need of such measures. But where they are needed, cost limitations become less exacting.

But use of fire only to reduce fire hazards is self-limited. No extensive burning of a forest area for the sole purpose of hazard reduction can be justified under intensive management. Such large scale operations must have positive value in promotiing other purposes of resource management as well. The degree to which "prescribed" burning can or should be utilized for seedbed preparation, control of diseases, control of tree species, etc., is as yet only partially explored in most forest regions. It represents a field requiring the best talents and joint effort of both the silviculturist and the fire control specialist. The term implies intensive management.

For an indefinite period ahead the powerful challenge of the big fire and of the heroic measures it calls for, will continue to characterize the more extensively managed forest areas. All successful measures so far developed and many more will need to be pressed into service to meet it successfully. It justifies much specialization. But the rapid expansion of intensive management brings new and more intimate relationships between fire control and the rest of the management job. Both fire control men and resource managers will do well to recognize these new relationships and to join forces in advancing "intensive management protection."

FIRE CONTROL LOGISTICS

FRANK J. JEFFERSON

Assistant Regional Forester, Region 5, U. S. Forest Service

In military circles logistics is defined as that branch of the military art which embraces the details of the transport, quartering, equipping, and supply of troops in military operations. This holds true whether the undertaking be on land, air, or sea.

Fire control logistics requires the same undertakings but may be more simply defined as the art of delivering manpower and matériel already planned for in the right quantities in the right places at the right time. Failure in any one of these elements simply means that all the high-powered knowledge of strategy, of fire behavior, etc., that may be brought to bear upon a fire suppression problem by the highest ranking brass hat in any Fire Control Service will come to naught unless someone somehow accomplishes all the essentials to consummate his plan. The fire boss calculates that with thus of men, this of tractors, and that of tankers he can control the fire on this ridge. But it is not going to end a fire at a planned time unless that part of the organization responsible for accomplishment of logistics puts the essential elements for control at the spot designated at the time and in the quantity prescribed by the fire boss. The fire boss, however talented, is at the mercy of the practical application of logistics to the problem with which he is faced. It is the quality of applied service of supply or logistics that determines whether we get a fire in its early stages, have an extra period fire, or have one of those monstrosities that hangs on for days until finally strangled by the weather or its own gyrations.

In military circles the art of logistics ranks high in the training of every officer; months are spent on indoctrination in its intricacies. Officers are drilled, drilled, and redrilled in what constitutes the numerical human components of a squad, company, regiment or corps and what the essentials to the movement, equipping, and operational sustenance of each unit are. Minute details such as the number of watches and compasses that are essential per unit are calculated. Map requirements are similarly closely calculated. It is important that every officer responsible for logistical action understands completely how many trucks are required and how many men are needed to load and unload them for a given movement within a given time for each unit of command, and what the command requires in the way of field equipment, mess equipment, rifles, revolvers, and other implements of war. He must also understand what the attritions of war action calculably are, and that he make provision for current replacement to offset this attrition. The problems in this field are materially different between ground, sea, and air forces; in fact, so different in some respects as to be almost opposites.

We in the Forest Service must deal with all three; primarily, ground requirements; secondarily, air—which in some quarters is crowding close to the ground requirements in volume; and, thirdly, sea, as exemplified by the Lake States situation, actions on Lake Chelan, Coeur d'Alene, Pend Oreille, and Mount Shasta. We have not yet, however, sufficiently comprehended the sharp differentiations that exist in the logistical technics applicable to the three methods of transport. In the cataloguing of matériel and manpower required for an attack under each of the three methods of approach we have progressed. In training of men in the technics of logistics we have done practically nothing. We still largely depend upon pinch hitters for chiefs of staff and, practically, pretty much still follow the tradition of early days when somebody said, "Hey, Bill, there's a fire on Sauerkraut Ridge," and Bill proceeded to round up all available men, shovels, axes, and hoedags and headed them toward the fire. This is admittedly somewhat of an exaggeration because we have developed to a point where we recognize the No. 0 ladies' shovel as a more effective fire-fighting tool than a No. 2 shovel and far more effective than a square-pointed D-handled scoop shovel. But more important (and granting that fires can be put out with scoop shovels) we have not yet made a dent in the art of getting the right things in the right quantities in the right places at the right time.

The fire boss contemplates use of an RD-7 angledozer or power-operated plow. Due partly to lack of equipment, more often due to lack of ingenuity in the art of substitution, the desired machine power arrives hours too late to fit his plan. Manpower desired by the fire boss at a given time arrives hours later than contemplated, because somebody lacked the courage to say, "Boss, we appreciate your desire but it just ain't attainable within your timing. Will you please refigure how many men and angledozers you would like to have 7 hours later." Delivery of manpower, supplies, and equipment is often delayed because someone failed to realize just how many pieces of transportation equipment would be required and at what time in order to attain the desired time objective. Break-downs and resultant delays occur because someone failed to appreciate the simple fact that with a given amount of transport equipment there is an inevitable percentage of failure. If the objective is to be attained, adequate swing equipment must be on the spot to offset these initial break-downs. With line equipment such as angledozers and tank trucks this failure to calculate probabilities exists, and jobs are planned with no consideration for the equipment break-downs inherent in the operation. Fire lines are lost because the one angledozer provided broke down. Sound application of logistics would have assigned at least two, and perhaps three, to the job. Men are walked energy-destroying miles when simple consideration of the logistical requirements dictated establishment of pack-train camps or perhaps man-pack camps to insure that all the potential energy of the crew was expended upon fire control effort and not uselessly frittered away on walking forth and back to trucks and thereby wasting the most effective hours of the day.

In many respects the application of the art of logistics by the back-country fire fighter of 40 years ago was far superior to the general practice of today. He knew that his fire was in tough country, that

he would have a hard time getting to it, and that he would have to do his best with the little he could bring to it. Consequently, his application of logistics summed down to the simple matter of how he could get to the fire the most effective supplies, equipment, and manpower with the few mules available. Today in an era of rubber and gas, with countless trucks and the hope, however fruitless, of more and more trucks and more and more men we have practically lost the art of simplicity in organizing for and executing fire control actions. Our thinking and procedure have become complex and often bog down under their own weight, predicated too often upon the mass movement of hundreds of men and tons of supplies to the nearest point within road distance of a fire. What happens from then on is in the lap of the gods. If the fire stays close to the road, well and good; if it reaches into the hinterland, a catastrophe may result if our application of the art of logistics does not apply all of the technics available in the fields of air, water, truck, mule, and man-back transportation. Yet we do not give men the benefit of planned training in this art.

We watch the clock too closely in determining when shifts should start (6 o'clock breakfast) and fail to appreciate that victory is gained by taking the enemy when he is weak; the important point of having the right forces in the right places at the right time and in the right quantities. We fuss because we cannot have men and supplies at the time that we would like to have them, failing to appreciate that the first element of the fire boss job is to realize just what the availability of these resources is and to plan and replan control action in accordance with these facts, which the logistician must deliver to him coldly and dependably.

This is a brief summation of the elements in the science of applied logistics for which chiefs of staff and others with similar duties have a most important responsibility. It is up to them to know the possibilities of procurement of all the various implements of fire control desired by the fire boss and keep him honestly apprised as to the time that their placement upon the fire line may be positively expected. It is the job of the logistician to give the fire boss the facts about the essentials and thus give him ample opportunity to prepare plans based upon these facts. Altogether too many fires are not controlled within the planned time limits. In the main this failure is much more due to ignoring or not realizing the import of the logistical facts in the situation than to the acts of God in the form of wind, behavior, etc., that are all too frequently blamed.

732984—47——2

MOBILE 25-MAN OUTFIT

John B. Fortin

District Forest Ranger, Ouachita National Forest, U. S. Forest Service

The desirability of a mobile 25-man outfit had been recognized on this forest for several years. Specifically, the features wanted in such an outfit were as follows: (1) Compactness to permit mounting on a standard long base stake-body truck, (2) complete cache of hand tools for 25 or more men, (3) facilities for cooking and serving meals in the field, as close to the fire as possible, (4) emergency rations, (5) communication facilities, (6) water tank, pump, and hose. This need was finally filled during the very dry and hazardous spring of 1943 by attaching 2 fire boxes and a pump and tank assembly to a stake-body truck.

The tank has a capacity of 165 gallons. On it is mounted a live reel with 500 feet of ¾-inch garden hose. At first a hand force pump was used, but this was later removed and a Panama pump with power take-off was installed under the truck cab. A drain on the tank permits filling backpack pumps when other water is not available. This is a very desirable feature in areas where streams go dry during certain periods of the year and water must be hauled to the fire. A 25-foot, noncollapsible intake hose is used for filling the tank.

The contents of the two fire boxes are as follows:

Box No. 1

4 double bit axes.	2 hazel hoes.	8 files.
2 brush hooks.	2 mattocks.	1 camp cook stove.
24 council tools.	4 timber carriers.	2 gallons kerosene.
2 crosscut saws.	4 potato hooks.	2 first-aid kits.
6 canteens.	2 shovels.	6 seals.

Pencils, time slips, map, signs

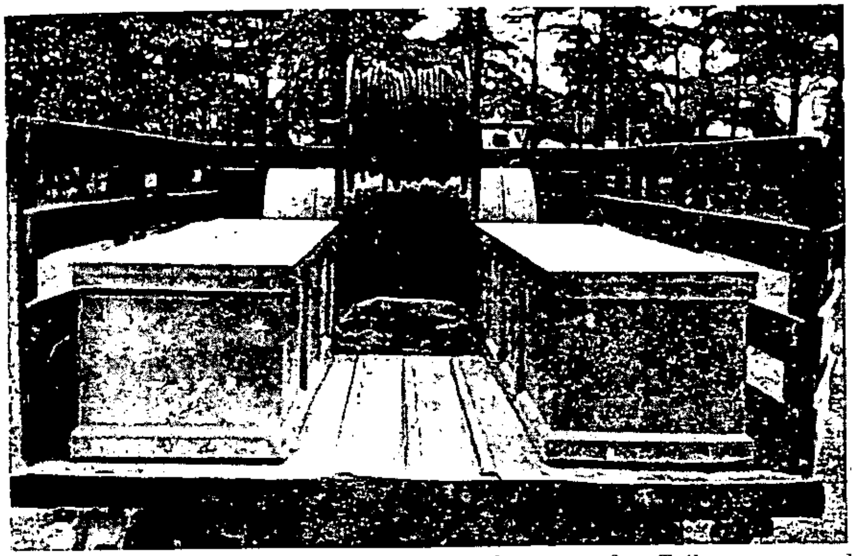
Box No. 2

4 backpack pumps.	1 roll-top table.	1 portable radio.
6 lanterns, kerosene.	1 fly, tarpaulin.	1 roll (½ mile) emergency telephone wire
4 lanterns, gasoline.	25 K rations.	2 wrenches, adjustable.
2 electric headlamps.	25 canned rations for cooking.	1 each pliers, hammer, hand saw.
1 knapsack.	1 100-foot rope.	
8 canvas buckets.	1 portable telephone.	
1 mess outfit, 12-man.		

The roll-top table listed in box No. 2 consists of slats of ½ by 1½ by 38 inches to which has been tacked light canvas or other suitable fabric. When rolled out on the ground or on supports, it provides a clean surface on which to serve meals. Because of its roll-up feature, it occupies comparatively little space in the firebox.

Many of the fires on this forest are close to traveled roads or logging roads which give access by truck to at least part of the fire line. This permits placing the crews close to the fire with a minimum of foot travel and feeding them there.

During a period of long drought, a fire occurred on September 17, 1943, in an area of heavy slash on the Mena District. A strong wind blew sparks as much as 150 yards causing spot fires in the dry duff. The ranger had a choice of trying to hold the fire on a very poor logging road at the foot of a slope or falling back to the top of a ridge. He determined to hold the fire at the logging road. The hose and pumper were brought into play to cool the fire as it approached the road so that a line could be built. The numerous spot fires caused by sparks jumping the road were extinguished quickly with the hose. Without the aid of this mobile outfit the fire could never have been held along the rudimentary road. What could have very easily been a 500-acre fire was held to 60 acres. The men were fed right at the fire line with food stocked in the truck cache.



Arrangement of tank, hose reel, and boxes of 25-man outfit. Tailgates are used when truck is in motion.

Another typical fire on which this outfit proved its usefulness occurred on August 20, 1944, on the Mena District. Fuel moisture was down to 4.1 percent and a fresh wind was blowing when a fire was reported in an area of heavy slash and high grass. Only 12 men were available for immediate dispatch. When the crew arrived at the fire it found that an old overgrown logging road paralleled part of the head and one side of the fire. The crew was too small to split into 2 parties because of the intensity of the fire. One hoseman and the truck driver managed to hold part of the head and the side of the fire along the logging road. This permitted the remaining 11 men to be used in force where the truck could not maneuver. Without the truck, the ranger figured he would have lost at least 300 acres. Actual loss was 60 acres.

Other instances have proved conclusively the usefulness and versatility of this equipment since it was first assembled, with the result that similar units have been provided for the other districts on this forest.

A DUAL PURPOSE HAZARD REDUCTION BURNER AND FOAM UNIT

A. B. Everts

Forester, Snoqualmie National Forest, U. S. Forest Service

Hazard Reduction Burner

Many fire control officers are familiar with the hand pump, air-pressured Hauck torch. When working properly the Hauck is a good torch. The principal difficulties are its rapid loss of pressure, which makes frequent pumping necessary, and the clogging of the small discharge orifice.

Believing that the employment of an improved burner and a method of maintaining constant pressure would overcome these faults, the men of the Snoqualmie National Forest constructed an automatic unit.

A 40-gallon, 185-pound test galvanized high-pressure hot-water tank was purchased and hooked up as shown. Nitrogen, an inert gas, was used for pressure. The pressure in the nitrogen tank (2,000 pounds) was reduced to an operating pressure of 35 pounds by the use of a reduction valve. An 80-foot length of ½-inch hose was connected to the burner, a KER-O-KIL model No. 44. This burner, like the Hauck, requires preheating before it will generate properly. The kerosene burns at 2,000° F. and produces a flame 24 by 44 inches. According to the manufacturer, the burner consumes 2 gallons of kerosene per hour. Our tests, however, indicated 1½ gallons per hour as being more nearly correct.

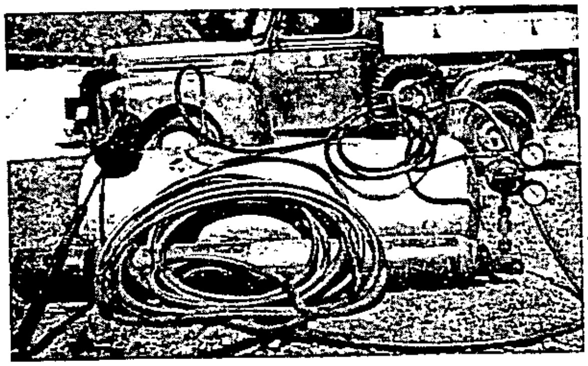
Loaded on a pick-up, or, better yet, a 4 by 4, the unit can be used on most pine operations. It is of value on roadside hazard reduction in the Douglas-fir type. The unit was used hour after hour on slash disposal last fall without any clogging or other difficulties. According to our figures, one 40-gallon tank of kerosene will serve the burner for approximately 60 hours. One cylinder of nitrogen will furnish sufficient pressure to expel three 40-gallon tanks, or 120 gallons total. The cost of recharging the nitrogen cylinder here in Seattle is $1. Thus, the operation cost is less than ½ cent per hour for the nitrogen.

Because of the low rate of fuel consumption, friction loss is negligible. If a burning unit only is desired, a standard 85-pound test tank is sufficient. A 20-gallon tank would operate for approximately 30 hours. In our work the larger, heavier tank was used, however, so the unit could be used for foam during the fire season.

A Foam Unit

In using foam, much higher tank pressures are needed. The friction loss in small hose is high, and to produce good foam, nozzle pressures of 30 to 100 pounds are necessary, with the foam quality increasing at the higher pressures.

The two types of foam in use today are chemical and mechanical. Chemical foam is a powder. The equipment for its use is rather complicated and will not be discussed here. Mechanical foam is a liquid and can be premixed with water at the rate of 6 gallons of solution to 94 of water. A specially designed foam nozzle must be used. This nozzle sets up a whirling motion of the water and foam solution which picks up air at the back end of the nozzle and produces foam. Foam nozzles come in sizes from the small plastic type, used on this unit, to 2½-inch sizes, producing 1,200 gallons or more of foam a minute. At 100 pounds nozzle pressure, a foam and water mixture will produce about 10 times the capacity of the container. That is, a 500-gallon tank truck with a 6 percent liquid foam solution will produce approximately 5,000 gallons of foam.



Left, nitrogen-pressured kerosene-burning hazard reduction unit. Right, the unit converted to foam. The foam clings, smothering the fire and preventing reignition.

In theory, foam is best for oil and gasoline fires since it can be applied quickly in large quantities, blanketing out the oxygen and smothering the flames. Its use on forest fires needs to be more thoroughly tested. David P. Godwin reported on its use in Aerial and Chemical Aids, Fire Control Notes, December 1936. Improved methods of handling foam have been devised since then. The writer is of the opinion that foam has a place in forest fire fighting, especially in the light fuel areas, mainly because of its volume increase. Is 5,000 gallons of foam more effective than 500 gallons of water? If so, how much? These are questions needing an answer.

On account of its cost, foam should not be premixed in the tank truck because then it has to be used. A method of quickly forcing the foam liquid into the tank when needed can be simply devised. Foam prices are quoted all the way from $10 to $25 per 5-gallon can. It has been sold on surplus sales for as low as $1 per can.

Foam has one quality that cannot be overlooked; that is, its clinging characteristic. It can be applied to a wall or other part of a building and it will cling for several hours. The value of this property can best be realized by quoting from The Use of Fog and Foam by Small Fire Departments, by Walter W. Stephen, in the January 1946 issue of Fire Engineering. This article states:

A hose and chemical truck from an industrial plant went 4 miles out into the country to a cross-roads community in response to a phone call. It was found

that a fire, starting at one end of a row of five small one-story, frame, shingle-roofed dwellings, had involved two, and seemed certain to destroy all of them. There was no source of water, nor any apparent way to fight the fire.

There was, on this piece of apparatus, a 40-gallon foam extinguisher. This was operated, and covered the exposed side and half of the roof of the third house with foam; these surfaces were scorching and smoking and about to "light off." The blanket of foam remained in place and protected and saved this house and the other two dwellings beyond it, while the first two that were on fire burned to the ground. The point about this case is that it was a peculiar and unusual one of the use of foam on a class I fire.

The operating data on the unit as shown is as follows: 2½ gallons of liquid foam solution was poured into the tank and the rest of the tank filled with water and recapped. A small, plastic foam nozzle was substituted for the burner. Pressure was increased to 125 pounds. The foam produced was measured out in 30-gallon garbage cans. The unit operated for 22 minutes and produced 370 gallons of foam. This is at the rate of better than 16.8 gallons of foam per minute with the water consumption at slightly under 2 gallons per minute. There is little mechanically that can go wrong; no pumps or motors; no moving parts. Such a unit, mounted in a pick-up or 4 by 4 should work out well on light fuels.

If nitrogen is difficult to secure, other pressure mediums can be used. Carbon dioxide can provide pressure for the foam unit. It will not operate the burner, however, because so much of the carbon dioxide is absorbed into the kerosene that the mixture will not burn. Compressed air should work with either the burner or the foam. Oxygen should never be used. It is dangerous when used with oil of any kind.

Caught—Three Firebugs.—"On Jakes Branch, Ranger, and looks like 2 sets," the Pilot Mountain lookout reported to the Pisgah Ranger at 9:05 p. m. on April 14, 1946. At 9:10 p. m. the lookout reported 2 more fires and at 9:15 p. m. another 2. In all a total of 10 fires were set over a distance of 4 miles. Crews quickly suppressed the fires and the damage caused by all of them was small, but the fact that firebugs were loose in the woods during a period of high fire danger caused considerable apprehension.

By 1 p. m. on April 15, the ranger had called all crews in from the field to stand by at the depot. At 2:15 p. m. the Pilot Mountain lookout reported 2 fires set on the Rosman Road, and at 2:25 p. m. 2 more; over a distance of 10 miles a total of 8 fires were set along this road. Again quick suppression kept the fires small. At 7 p. m. 2 more fires were set along the Rosman Road, and at 9:15 p. m. 2 more fires were set in the Jakes Branch area. The last 2 burned 8 acres. The 22 fires burned 30 acres of National Forest land, and suppression costs amounted to $198.

But the fire setters, whom we will call X, Y, and Z, had been careless. It was found that X's car had been identified on Jakes Branch on April 14, and that Y and his car had been identified near the fires on April 15. The ranger sent for the F. B. I. On April 16 Agent Ingram and the Pisgah Ranger questioned the drivers of the extractwood trucks along the Rosman Road and received the following signed statements:

First driver: "I passed Y and Z near Alligator Rock and just above where I passed them was a small fire which me and my helper put out."

The helper: "I was with the first driver when we passed Y and helped fit the fire, but I was a deserter and have a dishonorable discharge from the Army so what I seed ain't no good."

Second driver: "I passed Y and Z at 6:30 p. m. on April 15, and then passed two fires that had just been set."

Third driver: "I passed Y and Z about 6:15 p. m. and they were out of their car, which was parked alongside the road. When I came past this same place next morning, I found a fire had been set at this spot."

(Continued on p. 21)

KILLING BRUSH WITH 2,4-D

ROBERT K. BLANCHARD

Forester,[1] *California Forest and Range Experiment Station*[2]

2,4-D is a member of the group of new wonder chemicals which includes DDT, penicillin, and the sulfa drugs. They all have remarkable powers to kill specific organisms which are either harmful or troublesome to mankind, but they all have their limitations. Certain serious diseases are cured by the drugs as if by magic. With DDT flies can be driven from their favorite habitats, and dandelions wither and die if sprayed with 2,4-D. But people still die of infectious diseases, we still have hords of insects, and we can safely predict that we will continue to have troublesome weeds and brush.

2,4-D is the abbreviated name of a chemical compound called 2,4-dichlorophenoxyacetic acid, but the pure acid is not much used in practice because it is only slightly soluble in water. Instead, more soluble compounds are prepared with the acid, and for a given content of the parent acid they appear to be equally effective.

The most outstanding properties of 2,4-D are its toxicity in very small quantities and the fact that the chemical stimulus moves downward in the plant along with food manufactured in the leaves. Mustard seedlings in grain fields can be killed with as little as a pound of 2,4-D per acre without affecting the grain. 2,4-D is noninflammable, noncorrosive to equipment, and is nonpoisonous to animals; but the oil solutions may irritate the skin of some individuals. In addition, it is easy to handle and use as compared with certain other herbicides, and it does not deteriorate under normal storage conditions.

Just why 2,4-D is so poisonous to plants and why it kills some plants and not others is a mystery. A few days after susceptible herbaceous plants are treated with 2,4-D, the leaves and stems twist and curl. In a few more days the stems and even the roots swell and split as a result of the abnormal growth. In about a month the plants are usually dead. Only a few woody plants show these so-called formative effects to any extent.

2,4-D does have a sterilizing effect on soil regardless of statements to the contrary which appear on the labels of some products. It is only temporary, however, for the chemical is effectively leached out by a few inches of rain.

[1] Acknowledgment is made to L. P. Winslow of the Blister Rust Investigations office at Berkeley, Calif., who conducted the fall field tests and to H. R. Offord, in charge of that office, for his hearty cooperation on this project

[2] Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California, at Berkeley, Calif.

Experimental Work

In view of these remarkable properties of 2,4-D, the Experiment Station in the fall of 1945 undertook a study of the effect of 2,4-D on the brush species of California. The purpose of the initial phase of the experimental work was to determine over a representative geographical range what species of brush can be killed by 2,4-D. One or more test sites was selected on the Angeles, San Bernardino, Sierra, Eldorado, Lassen, Shasta, and Klamath National Forests to include about 40 kinds of brush. The work was started in the fall of 1945 and was continued after the start of new growth in the spring of 1946. Application of the spray was made by square-rod plots at the rate of 10 gallons per square rod. The sodium salt of 2,4-D was used in concentrations of 0.04, 0.08, and 0.12 percent acid. The spray equipment consisted of a tank truck equipped with a power take-off pump. A pressure of 100 to 125 pounds was used with a No. 5 disk nozzle which gave a rate of delivery of about 1 gallon per minute.

The results of the fall work were poor because the brush was then in a state of dormancy. The spring spraying killed the leaves of most species treated. Even in the case of those classed as resistant, the succulent growth of the current season was killed regardless of the stage of development. Some nonsprouters were killed outright, but the sprouters sent out suckers from the crowns and the bases of the stems. In no case was a 100-percent kill of foliage obtained.

Table 1 is a list of species with common and scientific names giving the susceptibility of each to 2,4-D as indicated by the tests conducted in May and June 1946. High susceptibility means that 80 percent or more of the leaves were killed by the strongest spray although in some cases the stems were still green 3 months after treatment. Resistant species are those in which the old leaves were not affected by the treatment. Those of moderate susceptibility lie somewhere between these limits.

TABLE 1.—*Susceptibility of the foliage of California brush species to 2,4-D*

SPECIES	SUSCEPTIBILITY to 2,4-D
Adenostoma fasciculatum (greasewood or chamise)	High.
Aesculus californica (California buckeye)	Do.
Amorpha californica (California amorpha or mock locust)	Resistant.
Arbutus menziesi (Pacific madrone)	High.
Arctostaphylos patula (greenleaf manzanita)	Moderate.
A. viscida (whiteleaf manzanita) [1]	High.
Artemisia arbuscula (low sagebrush) [1]	Do.
A. cana (silver sagebrush) [1]	Do.
A. tridentata (big sagebrush) [1]	Do.
Baccharis pilularis (kidneywort baccharis or coyote brush)	Do.
Castanopsis chrysophylla (giant evergreen chinquapin or golden chiquapin).	Resistant.
Ceanothus cordulatus (mountain whitethorn ceanothus)	High.
C. crassifolius (hoaryleaf ceanothus)	Do.
C. cuneatus (buckbrush ceanothus) [1]	Do.
C. divaricatus	Do.
C. integerrimus (deerbrush ceanothus)	Do.
C. prostratus (squawcarpet ceanothus)	Resistant.
C. velutinus (snowbrush ceanothus or tobacco brush)	Moderate.

TABLE 1.—*Susceptibility of the foliage of California brush species tó 2,4-D*—Con.

SPECIES	SUSCEPTIBILITY to 2,4-D
Chamaebatia foliolosa (bearmat)	High.
Cytisus scoparius (Scotch broom)	Do.
Eriodictyon californicum (California yerbasanta)	Do.
Garrya sp. (silktassel or quinine brush)	Do.
Lithocarpus densiflora (Tanoak)	Do.
Pachistima myrsinites (myrtle or Oregon boxwood)	Resistant.
Photinia arbutifolia (Christmasberry or toyon)	High.
Pinus ponderosa (ponderosa pine)	Moderate.
P. sabiniana (Digger pine)	Resistant.
Prunus emarginata (bitter cherry)	Do.
Pseudotsuga taxifolia (Douglas-fir)	Moderate.
Quercus chrysolepis (canyon live oak or maul oak)	Do.
Q. dumosa (California scrub oak)	High.
Q. kelloggii (California black oak)	Do.
Q. wislizeni (interior live oak)	Resistant.
Rhamnus californica (California buckthorn or coffee berry)	High.
Rhus diversiloba (Pacific poisonoak)	Do.
R. laurina (laurel sumac)	Do.
R. trilobata (skunkbush sumac or squaw bush)	Do.
Rubus ursinus vitifolius (grapeleaf California dewberry)	Resistant.
Salix sp. (willow)	High.
Sambucus glauca (blueberry elder)	Do.
Umbellularia californica (California laurel or bay)	Moderate.
Vitis californica (California grape or wild grape)	High.

[1] Nonsprouters which were killed.

The results obtained in this preliminary work are not satisfactory as an answer to the question, "Can brush be killed with 2,4-D?" They are nonetheless encouraging, for although all species sprouted, all individuals did not. Low California scrub oak (*Quercus dumosa*), for example, had only a few feeble sprouts 3 months after treatment with 0.12 percent spray. The problem resolves itself into one of finding out when, what, where, and how to treat.

The following recommendations are made on the basis of the work reported here and the work of other investigators in the East. It is along these lines that future work will be done at this Station.

Procedure for Treating Brush With 2,4-D

1. What to treat:

a. Sprouting species.—Spray only low growth (not over 3 feet high) or stumps. Higher brush should be chopped followed by treatment of the stumps. 2,4-D does not move downward effectively over distances in excess of 3 feet.

b. Nonsprouters.—Susceptible species of any size can be killed, but if the brush is high, chopping in the first place is probably a more satisfactory method of control. The best results have been obtained on brush 3 to 4 feet high because it is easier to spray thoroughly. Thorough spraying of tall brush is difficult to accomplish and expensive in labor and material.

2. How to treat:

a. Brush (sprouting or nonsprouting).—Thoroughly spray foliage with a water solution of 0.2 percent acid which is 2,000 parts per mil-

732984—47——3

lion. (See tables 2 and 3 for mixing solutions.) *Every Leaf Must Be Wet With Spray.* It is necessary to add a wetting agent to the spray so that the drops will not roll off the leaves. For small-scale work, "Vel," "Dreft," or "Swerl," nationally advertised soap substitutes, are satisfactory wetting agents when used at the rate of about 1 cupful to 5 gallons of spray.

b. Stumps.—Wet the freshly cut surfaces with 1.0 percent solution in kerosene using a 2,4-D ester (described below). Only kerosene should be used as a carrier because it is the least poisonous (of the regular petroleum products) to plants. If a toxic oil (virtually all petroleum products except kerosene) is used, the oil itself will quickly kill the conducting tissues and the 2,4-D will have little effect. For treating stumps in trail work, 10 percent kerosene solutions can be applied with a paint brush or a household fly sprayer. Very little is required, but the sapwood should be thoroughly treated.

3. When to treat:

a. Brush.—Brush must be treated while it is in full leaf and physiologically active. This is usually between the end of the flush of spring growth and early July. The best time is shortly after the end of the spring growth. Spray in a warm period when the daytime temperatures are above 70° F. and when the foliage is dry. Rain which occurs more than 6 hours after treatment will have little effect.

b. Stumps.—Stumps should be sprayed or painted immediately after cutting. If, however, some time has elapsed, the bark should be frilled all the way around with an axe and the chemical applied to these fresh cuts as well as to the old cut surface. The lower the stumps are cut, the better. The effective season for treating stumps is not known, but it probably extends from the beginning of the growing season to midsummer.

A certain amount of sprouting is to be expected after any chemical treatment of brush. Such sprouts should be given a follow-up treatment with water spray within a few weeks after they appear.

Commercial 2,4–D Preparations

2,4-D is manufactured in two general chemical forms, salts and esters. The salts (sodium, ammonium, and triethanolamine) are soluble in water. The esters (methyl, isopropyl, and butyl) are soluble in oil and are marketed in oil solutions containing emulsifying agents. They can therefore be used with either oil or water as a carrier.

The cost per pound of 2,4-D acid in the form of salts is about half as much as in the form of esters. The triethanolamine salt is the cheapest of all and is available in solutions containing 20- and 40-percent acid by weight. The other two salts are sold in the form of powders. One product contains 60 percent acid by weight, another, 77.5 percent. The 60 percent salt contains a wetting agent but in insufficient amount for glossy-leaved plants. The esters are all sold in liquid form. The methyl ester is available with 20 percent acid content by weight, the butyl ester with 32 percent. (The latter contains 40 percent of the ester compound.)

These products, except the isopropyl ester which is not yet available in commercial lots, are sold in wholesale quantities by the manu-

facturers and are generally available at chemical and spray material supply houses. An increasing number of preparations containing 2,4-D are also sold in seed and hardware stores under a variety of trade names.

Special wetting agents for spray work are available. They are all good but one should be sure that they can be used with 2,4-D. Some of those containing "stickers" gum up tank and spray equipment and are not recommended. "Tergitol" is a satisfactory product. Directions for use are given on the packages, but if the 2,4-D product already contains a wetting agent, less of the supplementary spreader should be used. Too much wetting agent causes excessive drip from the leaves and is therefore wasteful.

TABLE 2.—*Weight in ounces according to acid content of 2,4-D product required for 0.2 percent spray solutions* [1]

Volume (gallons)	Weight by 2,4-D acid content percents—				
	20	32	40	60	77.5
	Ounces	*Ounces*	*Ounces*	*Ounces*	*Ounces*
5	6. 5	4. 15	3. 3	2. 20	1. 7
10	13	8. 3	6. 5	4. 4	3. 4
50	64	41. 5	32	22	17
100	128	83	64	44	34

[1] For a 1-percent spray, use 5 times the weight listed for the desired volume.

TABLE 3.—*Approximate amount of 2,4-D liquid product required for mixing 0.2 percent spray solutions*

Volume (gallons)	2,4-D acid content	Cups of 2,4-D product	Volume (gallons)	2,4-D acid content	Cups of 2,4-D product
	Percent	*Number*		*Percent*	*Number*
6	20	1	6	40	½
5	32	½	7	[1] 60	½

[1] Powder form.

The recommendations made here are for the general guidance of field men who are planning limited experimental work. Practical ways in which 2,4-D can be applied to the general problem of brush-control cannot yet be well defined. Still to be determined are the concentrations and rates of application as well as the best season for treatment for each species. It is expected that spraying with concentrated solutions at a low volume rate per acre will prove cheapest, but this method requires special equipment. Some tests have been made by others on brush using 2,4-D as a dust, but the results have not been as good as with sprays.

In spite of the mediocre results obtained to date, the outlook for successfully controlling certain kinds of brush with 2,4-D is good. The Bureau of Entomology and Plant Quarantine has obtained very good results with certain species of *Ribes* and are planning to use considerable quantities of 2,4-D during the 1947 season for *Ribes* eradication work. The price of the chemical is an obstacle at present, but it is almost certain to go down as production increases.

REGION 6 EQUIPMENT DEVELOPMENT LABORATORY

THEODORE P. FLYNN

Engineer, North Pacific Region, U. S. Forest Service

The Equipment Development Laboratory at Portland, Oreg., had its start on October 4, 1935, when F. A. Silcox, then Chief of the Forest Service, approved a proposal by T. W. Norcross, Chief of the Division of Engineering, that suggestions for equipment improvement and development be referred to the Chief's office for consideration, and that approved projects of Service-wide benefit be financed.

The laboratory began work in 1937, under the supervision of the Regional Engineer in Portland. Concerned primarily with road construction and maintenance equipment, the work included testing, improving and developing equipment for fire control and other Forest Service work.

For several years, construction of models as well as design was done by laboratory engineers and mechanics. Later the laboratory personnel and equipment were moved to Sellwood, in south Portland, where the equipment repair shop is located. Construction work is now done by the shop mechanics, the laboratory development work being confined to design and testing. However, a section of the shop is devoted especially to work on laboratory projects.

Over the years the laboratory has built up a technical library, and it is on the mailing lists of a large number of firms, who contribute up-to-date material regularly, particularly on metallurgy and mechanical design. The library and the advice of laboratory engineers are, of course, available to departmental shop personnel and others.

Objectives of the laboratory are (1) to promote commercial manufacture of successfully developed items, so they will be available for purchase at lower prices by the Forest Service and others needing them; and (2) to contribute to the improvement of commercial equipment on the market, so that it will better meet the requirements of the job.

Problems encountered at the laboratory are of wide variety, relating to many kinds of equipment. Called the largest logging tractor in the world, a 46,500-pound giant popularly known as the "Tomcat" was designed, constructed, and put into successful operation by laboratory personnel. At the other extreme is the "Beetle" trail-tractor,[1] weighing less than 2,000 pounds, probably the smallest bulldozer-equipped full-crawler tractor ever constructed. In between is the larger trail tractor,[2] about 4,500 pounds, which was one of the earliest developments.

---

[1] FIRE CONTROL NOTES, July 1946, p. 1.
[2] FIRE CONTROL NOTES, April 1940, p. 93.

Throughout a period of nine years, the laboratory has handled or taken part in over 300 development projects. Many, of course, were small items of local interest or need. The "batting average" on these projects has been high; only a little over 10 percent were failures because they did not meet requirements or failed to receive popular approval.

The largest manufacturer of crawler tractors in the country has adopted some of the principles of the "Tomcat" on a new test model now in the field. The "Beetle" is already in quantity production, with prospects of a much larger market outside than inside the Forest Service. And the Oliver Corp. is now in quantity production of a light tractor, patterned after the original trail tractor, which has sufficient ruggedness, power, and stability for fire line construction. There is considerable demand for the heavy-duty brush mower outside the Forest Service, but it is not yet being manufactured commercially, although a mining company in Alaska has constructed brush mowers for its own use from laboratory plans.

Rock blade development at the laboratory stimulated the production of a land-clearing blade now being manufactured and sold in large numbers. Laboratory engineers have also helped develop and improve power chain saws, now in wide use by loggers. Three of the most successful chain saw manufacturers made many of their early tests in the laboratory yard and were aided by suggestions from laboratory engineers.

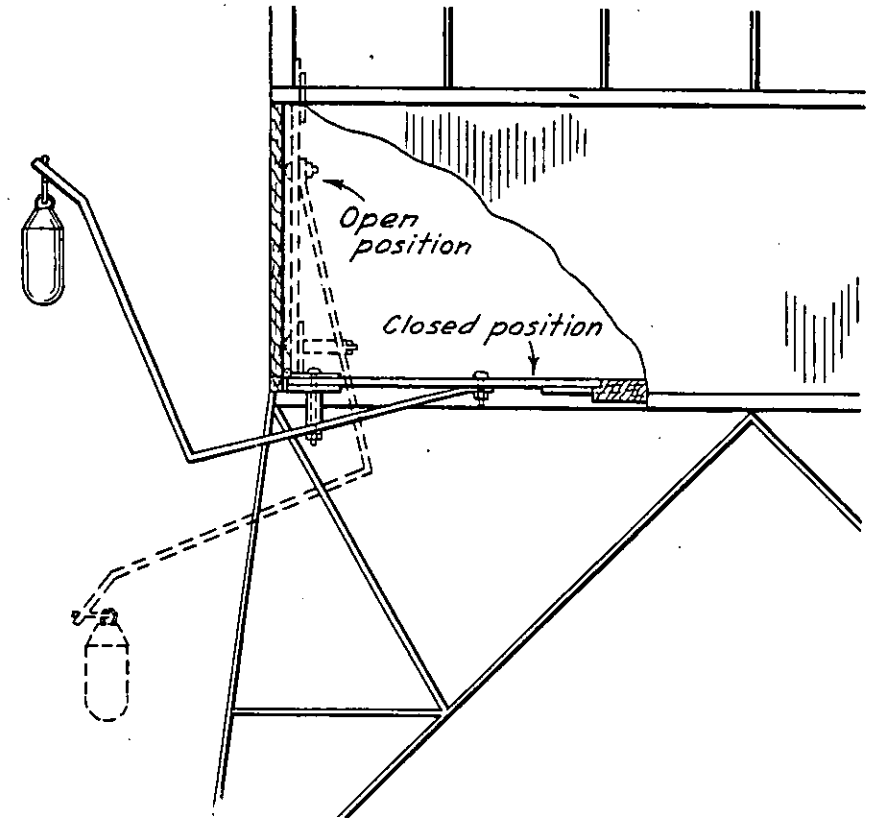
During the war, the Army found two important laboratory developments valuable. When the need arose for a light, narrow tractor to be transported by airplane, Forest Service trail tractor plans and a model were quickly made available; the airborne tractor, known as the Clarkair, was soon in production and more than 8,000 were manufactured under Army contracts. The snow-tractor, developed for use on Mount Hood, was tested by the Army along with commercial makes, and a contract for similar snow-tractors was let to a Portland manufacturer.

In addition to its work for the Divisions of Engineering, Fire Control, Timber Management, and Range Research during the past 2 years, the laboratory has been called upon for advice by foresters and loggers in various parts of the country. This service involves the writing of many advisory letters every year. Each development project must, of course, be financed by definite allotment of funds, but it is possible to furnish information and advice without cost if they do not involve work on the drafting board.

TOWER DOOR COUNTERWEIGHT

Favre L. Eaton
Assistant Supervisor, Helena National Forest, U. S. Forest Service

Opening the trap door in the floor of a lookout tower cab has been made easier and safer by the installation of a simple counterweight suspended on a side arm. Being able to open with one hand the



overhead door of a lookout cab 20 to 100 feet off the ground is a big help to a towerman, especially when carrying anything. The door will remain open or closed, as desired, when the counterweight is used.

Such a door opener was designed by Lookout Ralph F. Eaton, made in a local shop at a cost of $3, and installed in a few minutes. He used

an inverted 5-inch motor piston as a counterweight in order that extra weights could be placed inside the piston if any were needed. It is believed iron sash weights would prove the cheapest and best appearing weight.

The device consists of a rigid arm constructed of 2-inch angle iron welded at a 90° to 100° angle, one end bolted to the underside of the trap door, and the other end, on which the weight is fastened, extending upward and outward alongside the lookout cab. The horizontal iron bolted to the trap door is 2 feet in length, and the nearly vertical iron holding the weight is 3 feet long from angle to weight fastening. A window-sash weight of 8 or 10 pounds is fastened to the upright angle iron by the use of an eyebolt. For a very windy lookout, an additional angle iron should be welded to the arm near the angle formed by the horizontal and vertical irons, and bolted to the door as a side brace to offset vibration. Aluminum paint can be used to dress up the device and protect it against corrosion.

(Continued from p. 12)

The F. B. I. agent and Ranger then proceeded to the home of Z and in the presence of his father took down his sworn statement that he was with Y when Y set the fires on the 15th and that both X and Y had asked him to go with them and set fires on the night of the 14th. Further investigation found that another witness had identified X's car on April 14 as the only car that had passed where the fires were set.

On the 17th Federal warrants were taken for X and Y and both men were arrested and placed in jail. On the 18th trial was held before U. S. Commissioner Kizer in Brevard, N. C. Z could not be found, and the trial was postponed until May 3. Again Z could not be found and the trial was held without him. The Commissioner placed Y under $1,500 bond to appear before Federal Court in May. A true bill was obtained for X before the Federal grand jury, but at the May court Z again failed to appear. On May 18 after court adjourned Z came before Commissioner Kizer and said he had been "hid out" by X, Y, and a brother of theirs. The Commissioner took a signed statement and mailed it to the District Attorney.

An F. B. I. agent was sent out to arrest the three brothers for intimidating a Government witness. At the trial, Z denied everything he had said in his sworn statement, and the Commissioner dismissed the case. Again a true bill was obtained from the grand jury and the three brothers were charged with intimidating a Government witness. At the November term of Federal Court everybody but Z appeared; this time he was in Florida. The Government proceeded to call the case without him. However, X and Y were getting uneasy. A jail sentence looked almost certain for Y, and possibly for X, so their lawyer asked to plead Y guilty and take a nolle contendre for X, if the court would fine them $200 and place them on probation instead of sending them to jail. The District Attorney accepted this compromise and the case never came to trial. Y paid a $200 fine (cost of suppressing fires) and was given a 6 months' jail sentence suspended on 18 months' probation. X received the same sentence and probation. The third brother pleaded guilty to the charge of intimidation of a Government witness and was also given a 6 months' jail sentence suspended for 18 months.

Lawyer fees, fines, and the time spent fighting the charges in this case cost the brothers more than $1,000. The probation sentence should keep them well behaved for some time to come. Z still has to face a charge of perjury, as he denied the statement sworn to before the U. S. Commissioner. He also is liable for $1,000 bond for not appearing in Federal Court. The fact that a signed statement is not usable as evidence when denied by the witness under oath, caused considerable work in rebuilding the case, but this illustrates that justice can be obtained if a case is built up and fought regardless of adverse conditions.—BILL HUBER, *Ranger, Pisgah National Forest.*

A FOREST FIRE TRUCK

William H. Smith

District Forester, Pennsylvania Department of Forests and Waters

Forest District No. 14, which is also known as the Cornplanter Forest District, comprises the five northwestern counties of the Commonwealth of Pennsylvania, with headquarters in Warren. As the district does not contain any State forest land or parks, it is termed a forest protection district. For this reason the personnel assigned to the district are able to devote considerable time and effort toward the development of new protection ideas, techniques, and equipment. This article deals with the development and ultimate use of a forest fire truck of which the Department of Forests and Waters can be justly proud.

In the fall of 1942 a ½-ton pick-up truck of the Civilian Conservation Corps' surplus was assigned to this district. Although we had need for the truck as a pick-up, we felt it could be more usefully employed in fire-control work if it were equipped primarily as a forest fire truck.

As is the usual case in building something new, it is built, rebuilt, and changed until you arrive at the product desired. The same was true with this fire truck. It was originally equipped in 1943, at which time a Panama pump was installed, together with the connections to a 110-gallon rectangular tank located directly behind the cab in the truck bed. The 300 feet of ¾-inch hose was carried in a box directly behind the tank. Four spray tanks or cans were carried on the right side, as they are at present.

Later, a false floor was installed. Sufficient tools for 15-man crew were stored under the floor, a gas tank and a tool box on top. A crosscut saw was fitted in slots under the spray tank shelf on the right side of the truck.

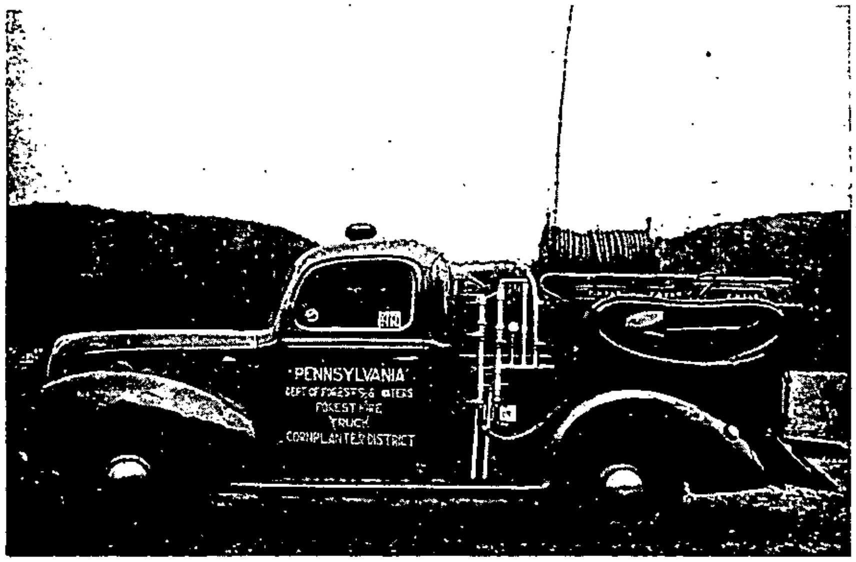
In 1945 the truck was outfitted with a live reel, a siren on top of the cab, and red blinker lights on each of the front fenders. In addition, a shelf for three more spray tanks was put along the left side of the truck, and two additional tanks were placed in the bed of the truck.

At the present time the truck is equipped with the following:

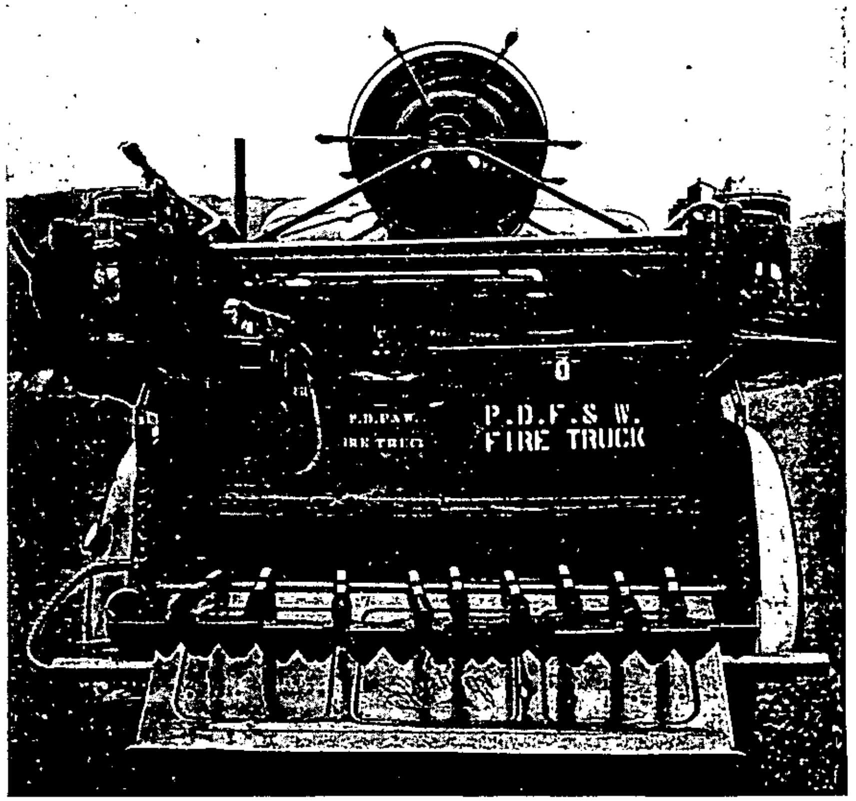
- 1 Panama pump.
- 1 110-gallon water tank.
- 400 feet of hose (100 feet of 1 inch and 300 feet of ¾ inch).
- 7 Indian spray tanks.
- 2 Parco spray tanks.
- 10 Rich rakes.
- 2 double-bitted axes.
- 2 brush hooks.
- 1 crosscut saw.
- 1 short-handled, round-pointed shovel.
- 2 dozen fusees (back-fire torches).
- 12 carbide lights and caps.
- 2 kerosene lanterns.

It also has a bamboo mast used to string up the aerial for the portable radio assigned to the truck. It is expected that in the near future permanent short wave radio equipment will be installed in the truck.

The Panama pump is connected so that it can pump directly out of a stream or from the 110-gallon tank, through the live reel to the hose, or from the stream to fill the tank. It is equipped with a pres-



One-half-ton pick-up equipped with 110-gallon tank, live reel, aerial mast, etc.



Rear view showing placement of spray tanks, boxes, rakes, etc. Note false floor which provides storage space for long-handled tools.

sure gage and a pressure relief valve. Ordinary valves, such as are used on inner tubes, were placed on both the intake and exhaust lines so that all water could be removed from tank, lines, and hose by the use of compressed air.

It is possible to fill spray tanks at the read end of the truck by means of a ¾-inch pipe, installed at the bottom of the 110-gallon tank and reaching to the rear end of the truck. At this point a valve and short hose are attached.

This truck, as it now stands, was outfitted at a nominal cost. The only materials purchased were the live reel, miscellaneous pipe, valves and gages, siren, blinker lights, and overload springs. The Panama pump and hose were obtained from another piece of equipment. The 110-gallon tank had been built by the N. Y. A., and the tools included were standard fire tools, already stocked by the Department of Forests and Waters. Most of the other materials used to outfit the truck were salvaged from worn-out equipment.

Most of the credit for the design, actual work of construction, and outfitting of the truck goes to Forest Inspector Jay S. Pees and the various district foresters under whom he served while the pick-up was being transformed into a fire truck.

The following summary of statistics from the records on the use of the truck during the 1946 spring fire season show that the truck has justified its existence in many respects:

It was used on 31 fires, during which time it was driven a total of 348 miles.

The pump and hose were used 20 times, and an average of 220 feet of hose was laid at each fire.

A total of 1,220 gallons of water was used from the tank, or an average of 60 gallons per fire.

On the 20 fires where the pump, hose, and tank were used, the total area burned was 25 acres, or an average of 1.25 acres per fire. Many of these fires were in places where the quick action of the fire truck prevented large fires from occurring.

Spray tanks were used on 16 of the fires, and rakes and other equipment on 9 fires.

Six buildings were saved at several of the larger fires by keeping the fire from the vicinity of the buildings.

The truck was also used to assist the fire department in combating local grass fires in Warren.

In addition to the work on actual fires, it has a prevention value that cannot be calculated. It is used as a part of the exhibits of the Department at local fairs, etc. Its very existence has done much to carry forward the work of forest fire prevention in this district.

We have learned from experience that the main fault is that the truck itself is not large or heavy enough to carry the necessary equipment. This ½-ton pick-up is not a good type of truck for this purpose. The transverse type of springs tends to cause undue sway when turns are made and is a factor that we have been unable to correct. Heavier springs were installed but they failed to give the necessary stability. The wheels have had a tendency to break when the truck is subjected to travel over rough terrain. The type of truck we believe would be much more satisfactory is a ¾- or 1-ton truck with

dual wheels on the rear, and, if possible, a four-wheel drive. Such a truck equipped in the same manner as the one we now have, would be an ideal fire truck for use in forest fire control in this district.

Although most of the equipment on the truck is demountable, the necessity of having a live reel, tank, and hose semipermanently attached to the truck, limits its use for other purposes, except light hauling and transportation. By semipermanent, I mean that it can be removed if necessary, but does entail considerable work.

This district is fortunate in having more than one forest fire truck in our forest protection organization. Many of our volunteer fire departments and one of the large oil industries have trucks outfitted somewhat like the one described here and used primarily for forest fire control work.

We will be pleased to receive comments on our fire truck, and if additional information concerning it is desired, we shall endeavor to supply it. We feel we have an excellent unit, but realize improvements can always be made.

Alaska Helicopter "First."—On July 12, 1946, the Alaskan Fire Control Service, Bureau of Land Management, used a Sikorsky helicopter in transporting men and equipment to a fire located on the south side of the Tanana River, some 26 miles southeast of Fairbanks, Alaska. The brush and grass fire, starting on an Army bombing range, was inaccessible by foot travel, boat, or regular airplanes. Occurring during a prolonged dry period, the fire quickly grew to class E size and seriously threatened a stand of good white spruce timber along the Tanana River as well as considerable wild game and fur animals. In line with a cooperative agreement between this Service and the U. S. Army Air Force personnel at Ladd Field offered the use of their helicopter to the District Ranger at Fairbanks, Theodore R. Lowell. A shuttle service carried 14 men and their equipment into the fire, flying 7 minutes each way and carrying 2 small men or 1 large man with backpack cans and small tools each trip. Flown into the fire in the late afternoon of July 12, the men brought the fire under control in the early morning of July 13. Without the helicopter to move men and equipment, this Service could not have taken any action whatsoever on the fire. It is felt that although the helicopter is at present a very expensive piece of equipment, its use can be more than justified in a country such as Alaska where the population is small and scattered, transportation routes few, and communication facilities inadequate.—Roger R. Robinson, *Acting Chief, Alaskan Fire Control Service, Bureau of Land Management, Department of the Interior.*

VIRGINIA'S USE OF AIRPLANES FOR FIRE CONTROL

HUNTER H. GARTH

Chief, Division of Forest Protection, Virginia Forest Service

The airplane was first used for fire control in Virginia in the southwest district during the spring of 1945, when a few flights were made by the Civil Air Patrol. These flights were made chiefly by the District Forester in inspecting and supervising the control of going fires. It was found that air observation was effective for this type of work, since the progress of the fire, quickest means of access, and other factors could be readily determined. Break-overs and break-over possibilities also proved to be very easy to detect from the air.

By the time the fire season was over the information had spread over the district that the Virginia Forest Service was using airplanes to spot fires and to catch forest fire law violators. This grapevine element later proved to be the most important factor in the air patrol service and has a tremendous prevention value. The psychological effect of knowing they could be observed from a few hundred feet in the air in otherwise inaccessible areas did a great deal to destroy the feeling of security hitherto enjoyed by illegal brush burners and other forest law violators.

In 1946 air patrol was used on scheduled flights in three districts and occasional flights in two of the other districts. From the few flights made in 1945 it was believed that the potential possibilities were much greater in detection and prevention than in suppression of fires. Therefore the patrols during the last two fire seasons were used principally on those phases of fire control. The days the planes were flown were tied in as closely as possible with the fire weather reports. Flights were made only on class three, and higher, days; but on several days of high class danger weather the wind velocity was such that the pilots would not take the planes up. Consequently on those days it was necessary to rely entirely on lookout towers for detection. For this reason and the cost of operation, the airplanes can only supplement the detection furnished by the towers.

The normal altitude flown in the Piedmont and Tidewater was approximately 1,200 feet, at which height the horizon was generally 36 miles. In the western part of the State the altitude varied with the height of the mountains. Under normal conditions the cruising speed was 75 miles per hour.

Detection

It is not anticipated that air patrol will eliminate the present lookout tower system. However, the air patrol could accurately locate any fire or smoker in those rather large areas between towers that are not covered. Then, by dropping a message to the tower, he would enable the lookout to locate the fire on his map and take the necessary warden action.

Prevention

It was in this phase of fire control that the air patrol was of the greatest value. Instructions were given to drop messages on all people found burning brush prior to 4 p. m. It is difficult to say just how

many of these were knowingly burning in disregard of the law or on the assumption that the wardens traveling the roads could not see them. Apparently the majority of the persons on whom messages were dropped were actually ignorant of the law. Of course the novelty of the idea undoubtedly made many people conscious of the law and has caused much conversation among the class of people who are continually being brought into court for violations. It has been excellent advertising and it is felt that those who were caught deliberately breaking the law will refrain from doing so again because of the large number of small yellow planes similar to the patrol planes that are flying from time to time.

The message dropped consisted of a weighted envelope about 5 by 7½ inches containing a message blank asking them to be careful with

Envelope with streamer used for dropping messages, and the material inclosed.

their fire, giving advice on how to control it if necessary. It also has a prevention leaflet with some of the most important fire laws.

The envelope has attached to it a long streamer of bright orange crepe paper which makes it very noticeable while it is in the air and easy to find after it lands. These could be dropped near the fire with reasonable accuracy.

Evidence obtained while the plane was in the air led to several convictions. However, the lack of communication between the plane and the organization on the ground makes evidence hard to get because of the time element. To get names and other evidence for conviction the plane would have to return to its base and telephone the location of the fire to a warden, who would then have to drive to the scene of the fire.

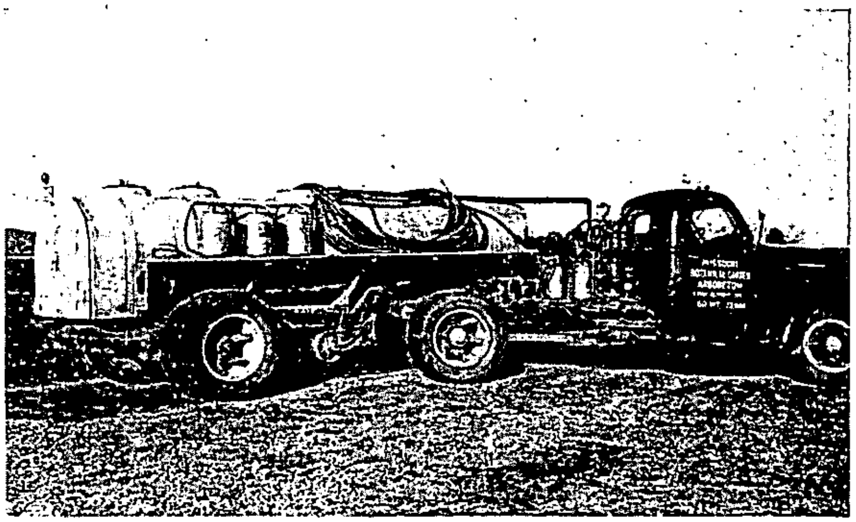
This year it is hoped a better system of communication will be worked out between the plane and the warden organization, whereby quicker action can be taken on both law violations and going fires.

A RURAL FIRE FIGHTING TANKER

AUGUST P. BEILMANN

Manager, Missouri Botanical Garden Arboretum, Gray Summit, Mo.

The arboretum of the Missouri Botanical Garden is located on the northern edge of the Ozark uplift near Gray Summit in Franklin County. It is not very far from that part of Missouri which "burns" every year. In addition to a tendency of the natives to set fires, there are other possible sources of fire: Two State highways, two county roads, and a railroad. Since the whole arboretum contains only 1,674 acres, it is obvious that fire control work must be good and the detection and dispatching must be as efficient as possible. A cooperative agreement has been worked out with the townspeople under which they furnish some manpower and the arboretum furnishes the



Tanker of the Missouri Botanical Garden Arboretum.

equipment. By the terms of the agreement, every woods, field, or building fire within the school district is the concern of this fire department. A telephone system is used for alarm as well as dispatching.

The equipment in use is unconventional and was designed with the thought that water would not be available unless hauled to the fire. To provide water a 1,025-gallon trailer-mounted tank, divided into four compartments, is used. An International DS–40, 161–inch wheel base truck is used as a tractor. This is equipped with low-speed gear and the dual axle is an underdrive rather than an overdrive. Two pumps are mounted behind the cab. One is a Novo diaphragm, powered by its own motor. This pump is capable of draughting water from ponds and cisterns but so far has not been used for that purpose. The other pump, used for fire fighting, is operated from a transmission take-off shaft. It is a 3-cylinder Deming rated at 22 gallons per

minute at 400 pounds pressure. Four hundred feet of half-inch high-pressure hose is coiled on the side of the tank. Two adjustable fog guns of the type commonly used for orchards and one solid stream gun as used for high shade trees are always coupled and ready for use. Although used only to a limited extent, the high-pressure fog seems most effective in grass fires, and appears to be equally effective on fires in woodlots and buildings. The tank holds sufficient water to operate two hose lines at maximum pressure for 40 minutes. In addition to this, six back pumps are mounted on the catwalks.

This represents a cooperative effort to develop rural fire fighting equipment in the more thickly populated sections where water is generally not available and where the usual high-capacity pumps of the metropolitan area are at a disadvantage.

Effectiveness of Aerial Detection.—In the July 1946 issue of FIRE CONTROL NOTES, William G. Morris discussed results of studies being made of the effectiveness of aerial detection. This article has attracted the attention of fire men interested in possibilities of replacing fixed lookouts by aerial control. Morris' reply to an inquiry on the part of Mr. E. W. Loveridge of the Forest Service sums up some of these questions and may be of general interest. In the article in question Morris reported that only 7 of 14 test smokes were detected from the airplane used in the test. Mr. Loveridge wanted to know whether or not adjacent fixed lookouts would have discovered a higher percentage. The following is quoted from Mr. Morris' comments:

"The lookout which normally covers the drainage in which we set the 14 test smokes at various points unknown to the airplane observer was not manned.

"The nearest lookout was 8 miles south of the airport where the test smokes were kept going continuously while the plane circled overhead. The lookout at that station knew that test smokes were being set on the airport field and he was watching for them. He reported that he could not see the smoke until the end of the test when he used binoculars to watch the plane land. This lookout was beyond the range of visibility for the small test smokes that were used as shown by visibility measurements with a Byram haze meter from the airport. The observations of the airplane observer when at an elevation of 6,000 feet and a distance of 5 miles also showed that the smoke could not be seen from the south which was the direction of the lookout. At the time of day the tests were made, an observer south of the smoke had the sun at his back. When the aerial observer was on the north side of the smoke looking toward the sun the smoke was easily visible from a distance of 5 miles.

"The fact that the aerial observers should miss 50 percent of the smokes set at points unknown to them cannot fairly be used to discredit the efficiency of airplanes for detecting smokes. The smoke bombs used in these tests were the standard Forest Service type described in the equipment handbook. They emit a rather small column of smoke which has been judged to be equivalent to that produced by an area of about 10 by 20 feet of burning coniferous forest duff. The smoke continues for only 4 minutes. If the smoke bombs are placed on the ground under a high forest canopy the smoke may not rise about the canopy in the short period that it is being produced. A natural fire burning for a longer time will usually build up a column of warm air which will carry the smoke above the treetops. More than one-half of the smokes missed by the aerial observer in the Chelan tests were set in places where the smoke did not rise into the sunlight above the timber.

"One great advantage which the aerial observer will always have over the fixed lookout is that he can view any given point from different directions so as to have the greatest advantage of the direction of the sun and color of the background."

As stated in Morris' final paragraph, it is possible to get any standard of detection desired by means of airplanes but the questions that need more complete answers are the proper techniques to be used for aerial detection and the relative cost of needed service in a given area by the two methods. As fast as these things can be determined, the choice or combination of methods to be used will no longer be theoretical.—*Division of Fire Control, Washington Office, U. S. Forest Service.*

FOREST FIRES AND SEA BREEZES

G. L. Hayes

Forester, Southeastern Forest Experiment Station, Asheville, N. C.

Spot fires which started upwind from going forest fires have been reported by I. S. Stivers, Forest Ranger for the New York Conservation Department, whose district covers eastern Long Island. They had been observed on a number of occasions, and from a number of different fires.

Suspecting at first that incendiaries were setting fires behind him, Stivers sent patrols upwind from going fires. The patrols found no incendiaries but they did find new fires starting. They, and he, also observed that the smoke column, after rising high in the air, turned and moved back in a direction opposite to the surface winds. The spots were starting from embers which fell from this smoke column.

On other occasions, Stivers wrote, surface winds changed abruptly in midafternoon from a northerly or westerly to a southerly or easterly direction, carrying going fires in an unexpected direction and upsetting suppression plans. A typical case was a fire on Sunday, April 1, 1945, at 2:30 p. m. that started with a northwest wind and began to spread to the southeast. Fifteen minutes later the wind shifted fast to the southwest and sent the fire over the Radio Corporation Communications plant at Riverhead.

The conditions described and the location, on Long Island, indicate that the type of local winds known as sea breezes was responsible for both the upwind spot fires and for the rapid changes in direction of the surface wind. Much has been learned about sea breezes in recent years that should be of very material help in planning fire suppression in such coastal areas as Long Island. Obviously, fire suppression is most difficult when rapid and unexpected changes in wind conditions occur. If the wind shifts can be anticipated, defensive action can be planned in advance.

There is an excellent discussion of sea breezes in the June 1946 issue of the bulletin of the American Meteorological Society under the title "Theory and Observation of Land and Sea Breezes," by Raymond Wexler. As many fire control men in coastal areas may not have access to the Bulletin, the following digest of Mr. Wexler's article has been prepared. The land breeze is not mentioned as it occurs mainly at night and is felt primarily over the water.

Definition and Characteristics of Sea Breezes

A sea breeze is a local circulation in which the wind near the surface blows from the water onto the land and returns at a higher elevation from land to water. During the daylight hours the air is heated more

over the land than over the water. This sets up a local pressure system that induces the warmer, lighter land air to rise and flow seaward and the colder, heavier air over the water to settle and flow landward.

The sea breezes occur on warm days near the shores of large bodies of water. They are strongest and best developed along the seacoasts, but occur also along the shores of bays and large lakes. In the temperate zone the landward flowing wind current may be from 200 to 2,000 feet thick and may reach inland for 20 to 25 miles. Above this is the return current. Under the same conditions it may extend offshore as far as 60 miles over the ocean. In hotter climates or in combination with topographic winds the inland range is extended. The winds from lakes extend shorter distances.

Two distinct types of sea breezes are recognized. The first type develops when there is little or no gradient wind;[1] the second type develops when there is a light offland gradient wind. The first type develops as a small circulation near the shore early in the day, soon after the air over the land has become warmer than the air over the water. With continued heating of the land, the circulation extends progressively farther landward and seaward and grows stronger and deeper. The second type, which is the more common in temperate latitudes, develops over the water and usually comes onto the land suddenly, later in the day. The offland gradient wind holds the colder and heavier sea air back and heaps it up until the force of the wind can no longer hold it. Then the sea air rushes ashore where it is heated until it rises and joins the gradient wind which is blowing out to sea overhead. The typical sea breeze circulation is then established.

The most dangerous part of the sea breeze circulation, from the fire control standpoint, is the front or surface separating the landward blowing sea air from the seaward flowing land air. The reasons are:

1. The winds blow in opposing directions on either side of the front and rise at the front.

2. The front moves. The rate of its advance is less than the velocity of the sea breeze behind it and it decreases as it moves farther inland. When a front moves across a fire, the rear or a flank suddenly becomes the head of the fire.

3. The winds along the front are the strongest and gustiest part of the sea breeze circulation. Initial gusts of the sea breeze as strong as 34 miles per hour have been recorded, whereas the average behind the front is only about 11 miles per hour.

After about a half hour from the time the front has passed, the velocity is usually very constant, with little gustiness. As the higher winds are then flowing opposite to the surface winds, the danger of upwind spot fires is present.

Although the sea breeze blows from water to land, it does not always blow perpendicular to the coast line. It tends to blow perpendicular at first then shift to the right as the day grows older. Thus, along the east coast where the shore is directly north and south it would tend to start as an easterly wind, shifting to southerly. Along the west coast it would tend to start as a westerly wind, shifting to northerly.

[1] The gradient wind is the air movement caused by the prevailing pressure differences in the atmosphere. It is the wind that is usually predicted in the Weather Bureau forecasts.

External Factors Influencing Sea Breezes

Several conditions affect sea breeze formation and behavior.

1. *Character of day.*—As sea breezes occur only when the air over the land becomes warmer than over the sea, clear, hot days are most favorable to their formation. They can and do occur on overcast days but they form later, are milder, and extend inland for shorter distances. In general, the clearer and hotter the day, the earlier the sea breeze will form, the stronger it will get, and the farther inland it will penetrate. With light gradient winds and clear skies, it usually starts about 2 to 3 hours after sunrise and ends within 2 hours before sunset.

2. *Gradient wind.*—Calm conditions, or a light offland gradient wind are favorable for sea breeze formation. If the gradient wind is blowing parallel to the shore or off the water, the sea breeze will not develop.

The velocity of the offland gradient wind affects the time of arrival of the sea breeze and the distance inland that it will move. Under calm conditions, the sea breeze may develop near the shore soon after sunup and move progressively farther inland until the maximum temperature for the day is reached, after which is subsides. The stronger the offland gradient wind, the later in the day the sea breeze comes ashore, and it may never penetrate far inland. In fact, if the wind is strong enough, the sea air cannot leave the water. At Danzig a gradient wind of 22 miles per hour was observed just to balance the force of the sea breeze. The front moved intermittently back and forth across the shore line.

To have a front stall over a fire would create a very bad situation. The winds could be strong, and would certainly be gusty and fluctuate wildly in direction, as the front moved back and forth.

3. *Topography.*—Where there are mountains along a shore line, the sea breeze may combine with an upvalley or upslope wind. Such a combination wind is stronger than a straight sea breeze and may extend much farther inland. If the mountains lay several miles back from the coast, separate circulations may be set up in the morning which will merge after noon. Such a combination in California is reported to establish a continuous flow of wind for as much as 40 miles inland. A similar but less extensive flow takes place between Great Salt Lake and the Wasatch Mountains in Utah.

Along the shores of a bay there may be two components of the sea breeze, one from the bay and the second from the sea beyond. The bay circulation will usually be the first to affect the land but may be replaced later by the ocean breeze, accompanied by a change in wind direction.

4. *Vegetation.*—A heavy vegetative cover retards heating of the land surface. Hence, the sea breeze starts earlier and becomes stronger along desert or semidesert coasts than along heavily forested ones. Likewise, with other things equal, conditions along our coast are more favorable to sea breezes when the vegetation is dead and the leaves are off the deciduous trees than after the fields and woods "green up."

5. *Atmospheric stability.*—An unstable lower atmosphere is more favorable for sea breezes than a stable one. In an unsaturated atmosphere, stability depends on the rate of temperature drop with

increasing elevation. If the temperature decreases more than 5½° F. in 1,000 feet of elevation (or 1° F. in 182 feet), the air is unstable and ascending convection currents develop easily. If it decreases less than this, it is stable and convectional movement cannot take place. Air over the land that is very stable in the morning may, through surface heating, become unstable later in the day, hence the hottest part of the day is most favorable for sea breezes.

6. *Distance from the shore.*—The sea breeze is felt first and has greatest velocity right at the shore. As distance from shore is increased the sea breeze arrives later in the day, has less velocity, and the front moves more slowly.

With so many factors affecting the time of arrival and characteristics of the sea breeze, it is impossible to set up definite rules which will tell when it may arrive or how it will behave for any particular place or day. Where the sea breeze is observed to have important effects on fires, fire control men would profit by observing its characteristics as related to the factors already discussed. Or the local weather forecaster of the U. S. Weather Bureau might be induced to predict the time of arrival, its range inland, and probable velocity at and behind the front.

Revision of Fire Equipment Handbook and Master Specification File.—The Fire Control Equipment Handbook and Master Specification File were compiled in the winter of 1936–37 by a four-man committee at the Forest Service Supply Depot in Oakland, Calif. The specifications became available as fast as they were completed, but the handbook could not be printed and distributed until the spring of 1939. Although the foreword to the handbook provided for periodic revision of both the handbook and the specification file, they became badly out-of-date.

In January–February 1945, the National Fire Control Equipment Committee met and, among other things, designated a three-man subcommittee for revision work. This resulted in a completely revised handbook which was distributed during November and December 1946. A two-man committee was assigned November 1, 1946, for revision of the specification file. These men conferred with fire control and procurement officers at several regional headquarters and with certain manufacturers. They made notes of suggestions for specification revisions, and arranged for data to be sent to the Washington Office for use on this project.

In outlining its work, the committee set up certain objectives with a view to simplifying the specification file and making it of maximum value to handbook users:

1. To eliminate from the file any specification not used, or not likely to be used, in more than one region.

2. To include the full specification, or a reference to an adequate Federal specification, in the handbook description of the item involved.

3. To make all specifications in the file as simple as possible, following a practicable uniform outline.

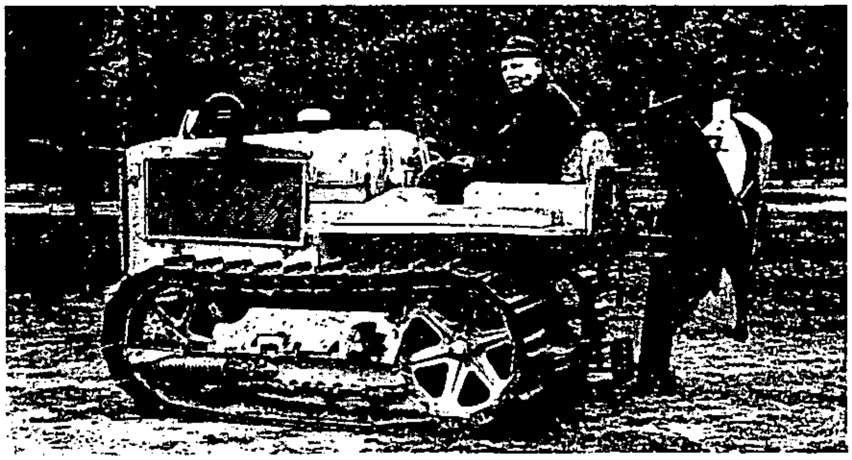
While further revisions of the handbook cannot be made immediately, the committee is making full notes for revisions required by elimination of or changes in the specifications. These data will be available when amended handbook pages are being prepared, which will probably be in the winter of 1947–48. In the meantime the revised specifications are being made ready for requisition, as provided in the handbook foreword.—*Division of Fire Control, Washington Office, U. S. Forest Service.*

THE AAMODT STUBBY PLOW

E. E. Aamodt
Engineer, U. S. Forest Service

The U. S. Forest Service, in cooperation with the Michigan Conservation Department, has designed a low-cost, double-bottom fire line plow which weighs approximately 255 pounds. The beam and coulter are in one piece, 36 by 18 by ⅜ inches and made of mild steel plate.

McCormick Deering plow bottoms, from 12 to 16 inches, can be used interchangeably, thereby adapting the plow unit to any size



Plow hitched to tractor and in raised position for transporting.

tractor. Oliver bottoms or other types of plow bottoms that can be purchased in matched pairs (left and right) will also serve the purpose. Another feature of the plow is that the hitch and depth control arrangement is designed so that the unit may be used with any type or height of tractor drawbar and will also provide adjustment for plowing depth and proper draft.

By mounting a simple hand-operated winch or gear box type hoist on rear of tractor, the plow can be raised or lowered from the driver's seat and readily transported.

The light weight of the plow requires a tractor of only a comparatively small horsepower drawbar pull and, from tests made in various cover types and soil conditions in the Lake States area, has demonstrated its ability to plow a clean fire line furrow.

Fire line furrow plowed in light sandy soil.

The small size and light weight of the plow also permits easy loading and transporting in a pick-up, passenger car-trunk, or on a small trailer.

The Stubby Plow was demonstrated at the equipment development meeting held at Roscommon, Mich., last June and created considerable interest on the part of fire control men.

Chelan Humidity Finder.—Training and inspection trips this season brought to attention the fact that some of our inexperienced Fire Danger Station operators were having difficulty in locating the correct humidity ready from the U. S. D. A. Psychrometer Tables after the necessary computation was made. While illustrating how the correct figure could readily be found by using two sheets of paper as straightedges (one along the air temperature line; the other along the wet-bulb depression column), it occurred to the author that a simple cardboard device would do the job. Thus, the Chelan Humidity Finder was developed. The device is simple to make, easy to operate with one hand, can be left conveniently in the closed book, and will locate the correct humidity figure quickly.

The finder is made of white cardboard in the shape of a carpenter's square, or an L backward. Its base is 1 inch wide by 5½ inches long, with "Air Temperature" lettered on it. The vertical arm is 1 inch wide by 7½ inches long and has "Depression of Wet-Bulb Thermometer" lettered on it. If desired, the word humidity can be lettered just under the angle on the Finder with a small arrow pointing just to the left of the inside corner.

In use, the device is placed on the relative humidity table with the vertical arm on the right side of the proper figure for depression of wet-bulb thermometer, and the base just under the predetermined air temperature. The figure in the angle between the base and vertical arm is the relative humidity. For example: If the depression of the wet-bulb thermometer (Relative humidity table IX, pressure 25.0 inches) is 9.5, and the air temperature is 69° F., the relative humidity is 59 percent.—Simeon A. Beeson, *Fire Control Assistant, Chelan Ranger District, Chelan National Forest, U. S. Forest Service.*

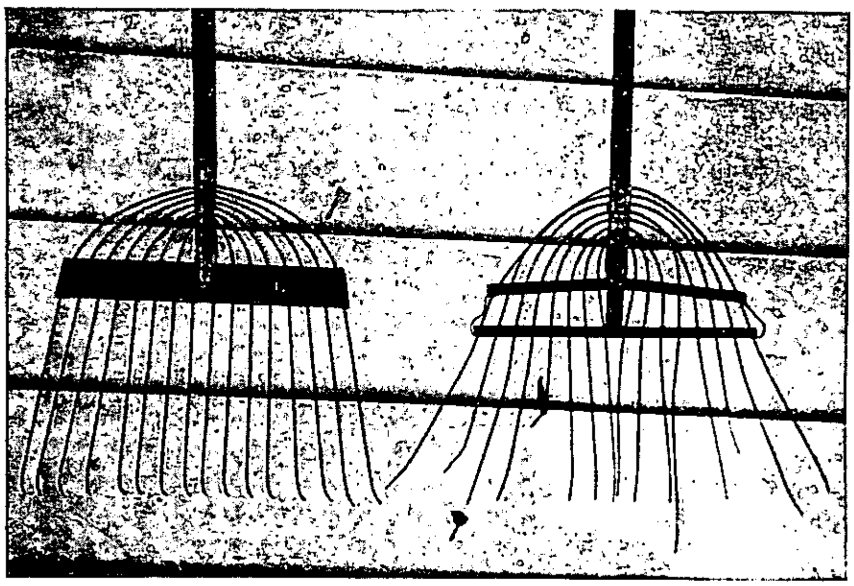
AN IMPROVED BROOM-RAKE FOR LINE CONSTRUCTION

PAUL F. GRAVES

District Ranger, Shawnee National Forest, U. S. Forest Service

An article by Perle Lewis in the July 1946 issue of Fire Control Notes discussed advantages and defects of the broom-rake over other rakes for fire line construction.

An improved broom-rake was put into use on the Shawnee National Forest in September 1946. Its use to date has not been extensive in actual line construction, but it has been given severe field tests in



Broom-rake: Improved (left); old style (right). Condition of old style rake caused by slipping of tines and weak construction.

various fuel types. The defects in the old style broom appear to have been corrected without loss of any of the advantages. The replaceable handle is now tapered fitting into a steel ferrule welded to a heavier crosspiece. This has greatly strengthened the handle attachment to the rake without adding seriously to the weight. Notches and clips on the crosspiece prevent the tines from slipping, which was a major defect of the old style.

The broom-rake is very fast and effective in leaf fuels, but it cannot be used to advantage in sedge and heavy grasses, vines, or briers. Heat of fire and hot ashes removes temper from rake tines and in time ruins the rake.

LIGHT TRACTOR-TANKER *vs.* ¾-TON WEAPONS CARRIER TANKER (FIRE SUPPRESSION WITH HIGH PRESSURE FOG)

J. W. West

Assistant Supervisor, Wasatch National Forest

J. W. Mattsson

Forester, Division of Fire Control, Intermountain Region

Such flash fuels as cheatgrass and sagebrush have increased so rapidly in many areas of Region 4 during recent years that a highly mobile light tanker is one of the Region's chief needs. Fire suppression men have sought a tanker that would meet the following requirements:

1. Be able to leave the road and go into inaccessible country on its power;
2. Be maneuverable under topographic and cover conditions where fires occur;
3. Be rugged enough to stand up under tough demands; and
4. Be readily accessible for holding a fire line or participating in initial attack before ground crews can be dispatched.

To meet this need, a tractor-tanker has been in use on the Wasatch National Forest since 1945. Early in 1946 a weapons carrier (¾ ton, 4 x 4) was converted to a tanker truck and assigned to the Wasatch Forest. This assignment made possible comparison of two kinds of equipment with approximately the same water carrying capacity under similar terrain and operating conditions.

The tractor-tanker, described on pages 41–44 of July 1946, Fire Control Notes, was equipped with two 53-gallon water tanks—mounted one over each track of the crawler type tractor. Other equipment included a Bean Royal 10 high-pressure pump, 200 feet of ¾-inch high-pressure hose, and a Bean No. 685 master fog gun. The weapons carrier was converted by installing a 100-gallon tank, a 200 F demountable Bean pump, 150 feet of high-pressure hose, and a Bean master fog nozzle.

Tests provided the following general observations concerning the operation of these two pieces of equipment:

1. The tractor-tanker is slow in getting to fires when compared to the ¾-ton weapons carrier, mainly because of the tractor-tanker's slow speed of from 3 to 7 miles per hour on its own power. About 15 minutes is also lost in loading and unloading the tractor from the carrier truck. (This 15 minutes is consumed in blocking and unblocking the tractor, chaining it down securely, warming up motor, and getting on and off the truck.) Futhermore, the tractor makes an unbalanced, top-heavy load on the 1½-ton truck, requiring slow and careful driving. To maintain safety, personnel of the Wasatch have to be extremely cautious. The truck travels almost entirely on improved roads on level terrain.

The weapons carrier, however, can travel faster on improved roads than the 1½-ton carrier truck. When it leaves the road, the carrier can travel almost any terrain the tractor can negotiate, and at a much

greater speed. The weapons carrier reaches the actual fire line in much less elapsed time than the tractor, a factor of prime importance in suppressing flash fuel fires.

2. The tractor-tanker ties up two pieces of equipment; itself and the transporting truck. Generally during the fire season the tractor-tanker is kept loaded for quick getaway and thus is unavailable for other uses unless the tanker is unloaded in emergencies.

3. The tractor cannot be used for other project work because it is not equipped with bulldozer and has insufficient power. With a slip-on unit, the weapons carrier can be used for project work during

Three-quarter ton weapons carrier on 47 percent headslope. It stalled at same point going ahead as in reverse.

periods of favorable weather. In 1946 the weapons carrier was used a total of 3,000 miles, with about 1,200 charged to fire suppression, while the tractor-tanker has been used only on suppression.

4. The tractor-tanker is not well-balanced; when climbing it carries all the weight on the rear 1/4 of the tracks. The maximum head slope, or point at which tractor stalls, is approximately 37 percent without pump operating and 30 percent with pump operating. The weapons carrier stalls at approximately 47 percent.

A side slope of 40 percent seems to be the maximum that the tractor can maneuver. If rocks or other obstructions are encountered, especially by the upper track, the tractor tips easily. On slopes of the same type, the weapons carrier tends to slide rather than tip. This is an advantage because the carrier will slide around obstructions rather than climb them and increase the risk of tipping.

5. The tank capacity of the tractor-tanker is limited to two tanks holding 53 gallons each. This is not enough considering the cost of equipment, manpower tied up, and extremely slow time in getting

back to a source of water supply. The weapons carrier can quickly get to a source of water and return. If necessary, its water supply can be increased to 150 gallons. Since the pump and tank is a demountable unit, it could be taken off at a stream or source of water if close to the fire and used like a marine pump. The weapons carrier is then free for other use on the fire.

6. The tractor-tanker unit costs about twice as much as the converted weapons carrier, and its operating cost is much higher.

Region 4 now recommends use of the four-wheel-drive weapons carrier with slip-on pump and tank unit rather than the tractor-tanker. For work in flash fuel fire suppression, the carrier is more efficient and a vast improvement in mobility and general usefulness. Although the tractor-tanker is a good machine, and in 1945 appeared to be the best rough terrain water carrying equipment available the weapons carrier meets the requirements of a mobile light tanker in a much better fashion.

Water Conserving Studies

Since the tank capacity on both the tractor-tanker and weapons carrier is limited, experiments were made with various nozzle openings and pressures to find ways of conserving water. Our work was partially simulated by the article in Fire Protection Notes of August 1946, Vol. III, No. 8, Western Fire Equipment Co. This article opens up the question: Why use high pressures on some types of fuels when lower pressure could conserve water? Table 1 gives the relation between disk size and gallons per minute discharged at various pressures with the Model 685 Bean master fog gun, used on both the weapons carrier and tractor-tanker.

TABLE 1.—*Water discharged by Model 685 Bean master fog gun, at specified pressures and disk sizes*

Disk No.[1]	Rate of Discharge,[2] at—		
	400 pounds	600 pounds	800 pounds
	Gallons per minute	*Gallons per minute*	*Gallons per minute*
3	1. 0	1. 2	1. 4
5	2. 4	2. 9	3. 4
6	3. 4	4. 2	4. 9
7	4. 6	5. 7	6. 7
8	6. 0	7. 4	8. 5
10	9. 2	11. 4	13. 0
12	13. 9	17. 0	19. 9
14	21. 1	25. 8	29. 9
16	31. 7	39. 0	44. 5
18	34. 0	41. 6	47. 9

[1] Disk numbers represent 1/64ths of an inch—that is a No. 3 disk has a hole 3/64 inch in diameter, etc.
[2] Discharge capacities of gun are for adjustment in straight or full stream position wide open. Usual long fog position gives about 20 percent less capacity.

It is evident from table 1 that if we can fight fire successfully with a lower pressure and a smaller disk, the water supply will last considerably longer. For example, with 400 pounds pressure and a No. 6 disk, the water supply will last twice as long as with 600 pounds pressure and a No. 8 disk: 31 minutes compared with 14 minutes, for the 106 gallons of water available on the tractor-tanker. This extra water supply may be just what is needed. If actual tests show that

good streams of water are furnished and a satisfactory suppression job done with a properly designed small tip, then the water supply can be conserved and the efficiency of the unit increased considerably. After a limited number of tests with different pressures and nozzle openings on different fuel types, the region formulated the following general ideas:

1. At high pressures, 600 pounds and above, the strain on hose, couplings, valves, and other fittings is near the critical point. Maintenance costs are high, the chances of a break-down on a fire are great, and on-the-ground repairs are generally impossible.

2. Basic training of nozzlemen should include thorough instruction on the effect of different pressures at different nozzle openings. Nozzlemen generally accept pressure at which pump is already set and use the same pressure and disk throughout the suppression job. Most of the pressure guns are now equipped with quickly interchangeable disks, and it takes less than a minute to change disks. By using the right disk for the fuel type, the nozzlemen have an effective medium for conserving water even without changing pressure. As fuel types change definitely and the cover is not too mixed, the nozzleman can change disks as frequently as he needs to in order to get the most out of the limited water supply available.

3. For light fuels such as cheatgrass and with an $8/64$th-inch disk, 200 to 300 pounds pressure is generally adequate. Tests with smaller disks indicated that there is not a sufficient margin of safety on cheatgrass type with only 200 to 300 pound pressure.

4. For heavy fuels, such as sagebrush and oak, 400 pounds pressure and an $8/64$th-inch disk did the job safely with the least expenditure of water. With still heavier cover type such as thick oak it might be necessary to increase the size of disk or pressure in order to get the stream of water to the source of fuel. Pressure of 200 pounds and a No. 6 or No. 8 disk appeared inadequate for a hot fire, where rate of spread might be faster than rate of suppression.

5. For the tests conducted in sagebrush, cheatgrass, and oak brush, which may not be conclusive, there seems to be no material advantage in using 600 pounds pressure over 400 pounds pressure.

6. Another important consideration, besides the saving of water in using lower pressures, is the increased efficiency of the nozzleman.

At lower pressure he can handle the hose and pressure gun with less strain, direct his stream of water more advantageously, and—if he does misdirect it—wastes less water.

7. A semifog, in the tests conducted, was more effective in extinguishing the sagebrush and cheatgrass fires than a full stream or complete fog. A full stream puts too much water in one place on one small area; a full fog cooled down the outer extremities of the fuel but did not reach down into the heavier fuel underneath, which would immediately blaze up after being left a few seconds. Semifog not only cooled down outer edges, but had mechanical force enough to penetrate into the piles of fuel and duff. Semifog also has an advantage over full fog in that the operator does not have to get as close to the fire in order to direct an effective stream of water on it.

Much more study needs to be given to the effect of pressures and disk openings in relation to fuel types. Our preliminary tests are indicative only; a more detailed study could also be of value in determining the most efficient pressures at various nozzle openings.

Parachuting Heavy, Odd-Shaped Objects.—An irrigation company renewing a dam in remote country on the Bitterroot National Forest hired the Johnson Flying Service to drop some heavy iron parts of the headgate at the dam site. Region 1 furnished parachutes and technical advice and obtained the details of operation given in table 1. The heavy, odd-shaped pieces were dropped from an altitude of approximately 300 feet while the plane traveled at nearly 100 miles per hour. Spotting was good, except that a longer lead should have been given the heavier objects. All landings appeared easy.

It is concluded that heavy, odd-shaped objects can be successfully dropped from a plane by using one or more chutes and discharging the package so it does not roll.—JAMES V. WAITE, *Foreman of Parachute Squads, Northern Region, U. S. Forest Service.*

TABLE 1.—*Object dropped and parachute operation*

Object	Dimension	Weight	Discharge	Parachute operation			
				28-foot chutes	Attachment to object	Estimated distance for canopy to inflate	Estimated rate of descent
		Pounds				*Feet*	*Feet per second*
Gate stopper	3′ 3″ x 3′ 3″ x 7″	585	On edge from greased slide by 3 men. Did not tip or turn over.	[1] 2	At 1 point at rear	[2] 140	[3] 20
Gate frame	3′ 10″ x 3′ 7″ x 4½″	425	On edge from slide by 3 men. Did not tip or turn over.	[1] 2	At 2 points 2½ feet apart at rear of frame. Cargo chute webbing fastened around frame.	[2] 120	[3] 19
Threaded bar	9′ 4″ x 3½″ diameter	250	From door by 1 man	1	Chute webbing on threaded end one-third distance from end so bar would land at an angle with threaded end up to avoid damage to threads. ½-inch rope wrapped around webbing and bar to prevent slipping.	100	17
Angle irons	7′ x 6″ x 6″	150	do	1	At end of irons. Two strand No. 8 wire passed through holes in irons and wrapped with canvas. Chute webbing passed through wire loop.	85	16
Cylinder stand, hollow	Bottom, 2′ 5″ x 12″ diameter; top, 2′ 5″ x 9″ diameter.	100	do	1	½-inch ropes, padded to prevent shearing, passed through holes in top formed 3 loops to which webbing was secured.	85	16

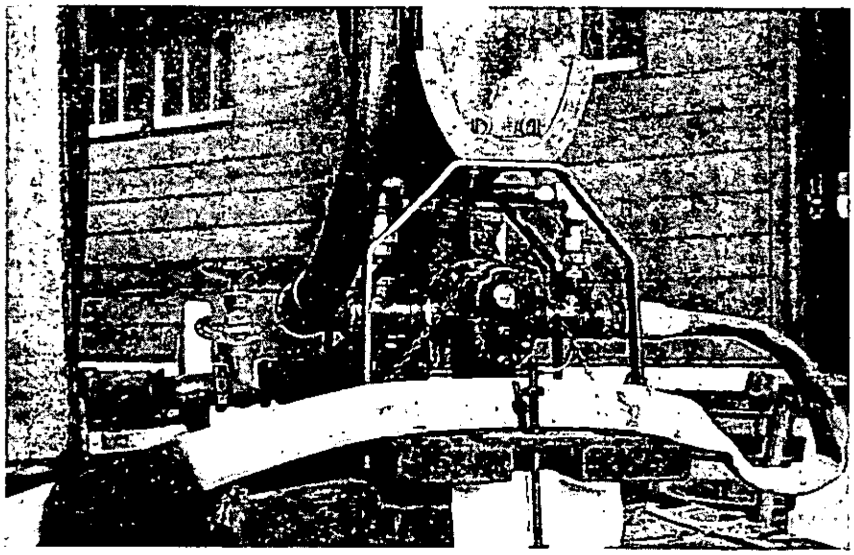
[1] 2 static lines used.
[2] Required slightly longer to open because of weight of object.
[3] Slightly more rapid than normal.

SHASTA COFFIN TANKS AND TRAILER

M. O. ADAMS

Central Dispatcher, Shasta National Forest

Since the beginning of the Forest Service, every man who has combated forest fires has tried to develop new methods of getting water to a fire for suppression and mop-up. Such a problem confronted the firemen on the Shasta National Forest and in order to overcome this, firemen first developed small initial attack tankers that carried a small tank of water under air pressure, which in later years grew to our



Mounted Pacific Pump showing tie-down bracket and bolt.

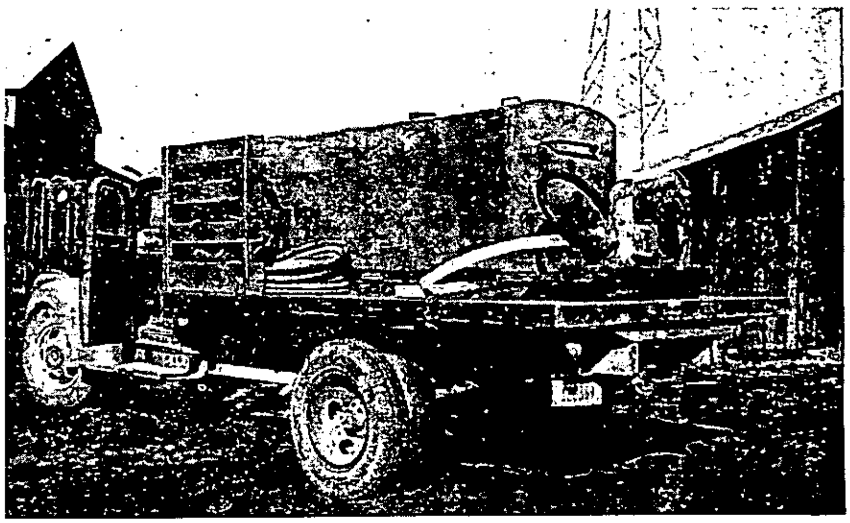
powered pump units. This answered some of their problems but the need for a larger unit developed, and the large 450-gallon primary tanker was placed in service.

As each problem was answered, another developed. We had small initial attack tankers and primary tankers of the larger sizes which, after arriving at a fire that had spread to major proportions in rough terrain, could be used only along roads and in servicing the fire camps. The crew tanker, in many instances, was used to haul water to a certain location on the fire and from there it was packed in back pumps to the fire line. The cost of operation of the unit was high and because of this, separate water supply units and tank trailers have been developed on the forest.

Ranger Oscar Barnum of the Pit District developed the idea of a slip-on supply unit. During the winter of 1937 he obtained a large tank from a logging operator who had used it for sprinkling logging

roads. This tank was mounted on skids. Ranger Barnum then connected a Bingham portable pump to the tank. The completed unit was mounted on a loading platform and whenever the need arose for this unit, a ton and a half stakeside was backed up to the loading platform and the tank unit skidded onto the truck. This tank held approximately 800 gallons of water, and supplied the smaller tankers on a fire. Where a dry camp was established, the tank furnished water for camp needs. During the mop-up stage on a large fire, Ranger Barnum was able to release his initial attack tankers and return those crews to their stations while the large unit remained at the fire with a crew to complete mopping up.

Melvin Barron, former Ranger of the Goosenest District, had also been working on the idea of a large water supply unit that could be



Coffin tank and Berkeley pump.

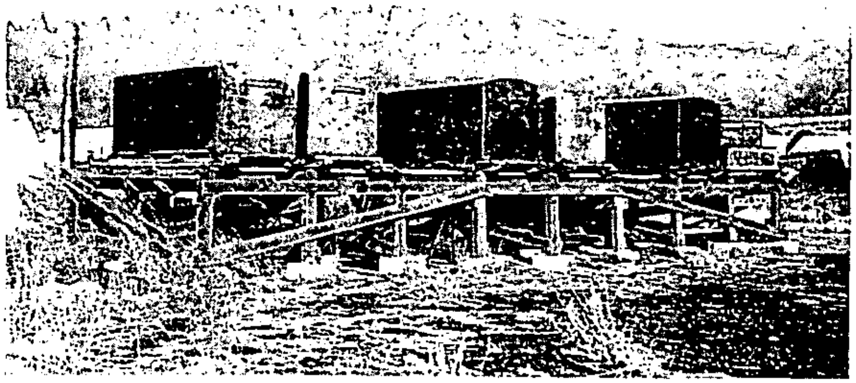
used for any type of servicing and for releasing the initial attack tanker on fires that had gone into the mop-up and patrol stage.

During the summer of 1938 Ranger Barron drew the design of the present Shasta Coffin Tank and had the Klamath Iron Works at Klamath Falls, Oreg., fabricate a 500-gallon tank at a cost of $60. To give it greater stability and also to prevent surging effects, Barron had two baffles installed. He mounted the completed unit on 8- by 8-inch skids, leaving ample room beyond the rear of the tank for a platform to hold the pump unit. A Pacific portable pump was used for the power unit, and to prevent the necessity of stopping the pump every time the nozzle was shut off, a bypass was built into the pump unit. Because of the shape of the tank, some unknown person tacked the name Coffin Tank to this unit and since that time the name has stuck. Units developed by Rangers Barnum and Barron were so successful that the Shasta Forest purchased two additional tanks during the 1938 fire season and six more in 1939. The power units for these tanks were either the Bingham portable pump or the Pacific type portable pump, both mountable on the pump platform at very short notice.

A better power unit for these tanks was provided when the California Region came out with the Berkeley two-stage centrifugal pump powered by a one-cylinder Wisconsin air-cooled engine, a semiportable type. Firemen were able to instruct an experienced truck driver on the operation of the Berkeley pump in a very short time.

Seven coffin tanks are stored at the Mount Shasta supervisor's headquarters as part of the forest fire warehouse stock. To expedite loading, all the tanks are stored on a special platform with pipe rollers. Whenever a call for a tank is received, a 1½-ton truck is dispatched to the rack where two men roll a tank onto the truck. The truck then returns to the fire warehouse where a pump is mounted, suction lines connected, and the required amount of hose and pumper box is placed on the unit. A chain binder ties the tank to the truck.

If the fire is close to water supply points, the truck is dispatched with an empty tank to be filled near the fire. Should the fire be remote from



Tank storage and loading rack.

water, the unit is filled at the supervisor's headquarters with 500 gallons of fresh water and dispatched to the fire.

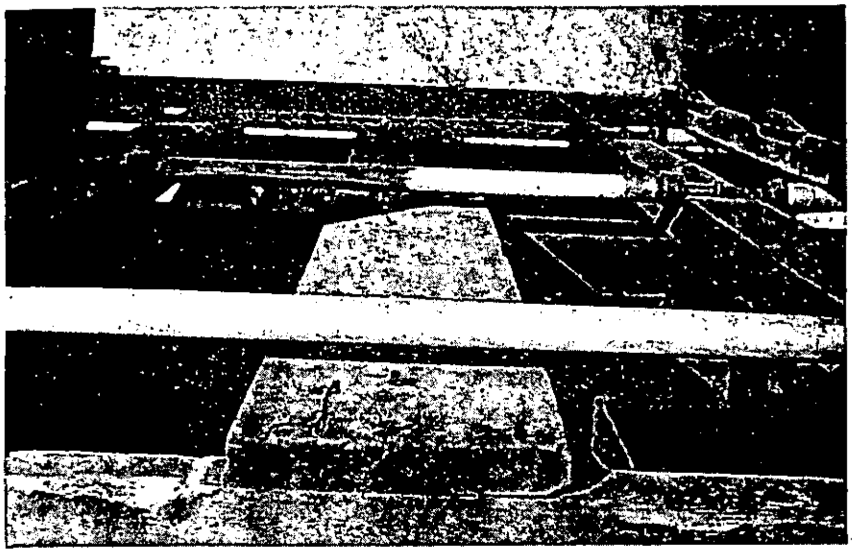
To expedite the mopping up of larger fires during the 1938 and 1939 fire season it was necessary to tow regular tankers and coffin tank units up steep portions of fire lines that had been constructed by bulldozers. In some cases towing damaged trucks and tankers.

George K. Fox, former fire control officer of the Shasta Forest, conceived a unit that could be pulled by either a truck or bulldozer. Incorporating all the features of the coffin tank, it would be a trailer unit which could be pulled to any location on a fire where a bulldozer had constructed a fire line and could be used for the tow unit. In more favorable terrain the tow unit could be a stakeside.

In the winter of 1939 the equipment shop at Redding constructed the Fox trailer unit, using a standard 1½-ton truck rear axle with dual wheels at a cost of $150. Scrap truck-chassis iron was used for the framework and the tongue was constructed of very heavy steel. This tongue was fixed to the trailer chassis by means of a hinged connection.

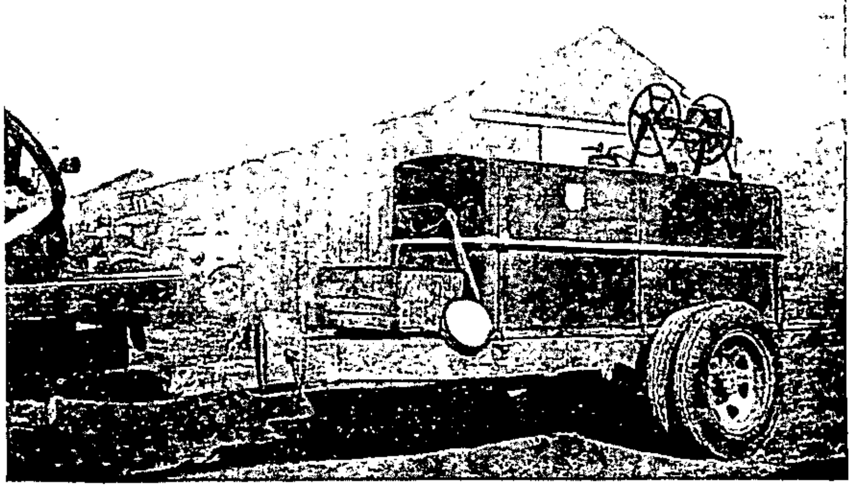
The tongue rode in an enclosed slot making it possible to lower or raise the tongue for attaching to either a bulldozer or a truck.

The trailer bed was built of 13-ply plywood to which the tank was bolted. Ample room was left on the trailer bed for mounting a Berke-



Tank rack showing pipe rollers.

ley centrifugal pump. Brackets for holding suction hoses were placed on the top edges of the tank, and at the rear and top of the tank a live hose reel was installed. By placing the live hose reel on the top of the tank, the nozzleman was able to unreel the hose on either side of the trailer unit without any trouble. Mounted forward of the pump unit, the tank acted as a protective shield for the pump. Just forward of



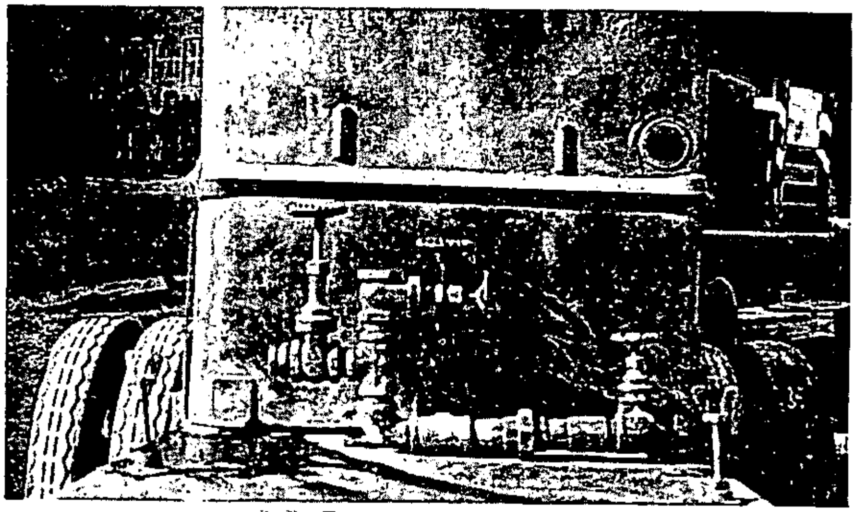
Shasta Coffin Trailer.

the tank is a tool box to hold the necessary connections, spanner wrenches, lubrication oils, strainers, etc.

On the under side of the tongue, forward of the tongue slot, a special jack slot was constructed so that a hydraulic jack could be inserted to lower or raise the tongue when connecting the trailer to a bulldozer or a truck. This jack could also hold the trailer unit in a loading position when the unit was not in use.

The coffin trailer unit has been used since the 1940 season and as soon as a fire boss sees that he can use a coffin tank or trailer he asks the dispatcher for the proper units. Both the coffin tank and the trailer have become an integral part of the fire-control equipment on the Shasta Forest.

Other forests in northern California have seen the coffin tanks in operation and often request the Shasta Forest to send the desired



Coffin Trailer valve arrangement.

number of units on stakesides to their fires. The Mendocino, Modoc, and Plumas Forests all used those units in the 1946 season.

By using these units, forests are able to release their initial attack crews much earlies, and to reduce the time required to mop-up a major fire.

The standard squad tanker now costs 23 cents per mile for every mile traveled; when pumping, the squad tanker costs $6.50 per hour of pump operation. But the coffin tanker costs 12½ cents per mile for the stakeside and $1 per hour for the pump unit.

During the winter months, one of the coffin trailer units is used to haul water to the Forest Service horse pasture.

These units are also used on hazard-reduction work and highway safety strip burning. During highway safety strip burning, four of the tanks are placed on a semi, providing a 2,000-gallon water supply unit. By this means we keep all our units at the burning job rather than having to pull some out to return to water supply points.

In 1942 all of the coffin tanks were treated with a rust preventive so that any of the units could be used for camp water and for furnishing drinking water to any fire, besides serving as tankers on suppression and mop-up.

U. S. GOVERNMENT PRINTING OFFICE: 1947

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustration. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.

The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually following the first reference to the illustration.