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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.

Volume 18 Number 4

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.

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RELATIONSHIP OF WEATHER FACTORS TO RATE OF SPREAD OF THE ROBIE CREEK FIRE[1]

R. T. SMALL[2]

Weather Bureau, U. S. Department of Commerce

The Robie Creek Fire in Boise National Forest, Idaho, September 5-9, 1955, is described, and concurrent weather conditions are analyzed. The fire exhibits four different types of behavior during the 5 days. On four of the days, the behavior follows patterns previously recognized as being usually associated with the prevailing weather conditions. The exceptions occur on the third day, which is meteorologically similar to the second day but exhibits a different fire behavior. Some implications that this study has for forecasting and research are pointed out.

Many observations have been made regarding the cause of forest and range fire spread and a number of well-qualified men have made investigations and contributed valuable reports and technical papers on this complex subject. There is general agreement that weather is the most important variable in fire spread, and that the conditions which lead to "blowups" are very complex and difficult to predict.

This paper consists of a report of the weather conditions which existed during the Robie Creek Fire in the Boise National Forest, Idaho, September 5-9, 1955, and an analysis of the relationship of those conditions to the fire behavior.

There are several reasons why this fire adapts itself to an analysis of this type: (1) The fire occurred only 10 to 15 airline miles northeast of the Boise Weather Bureau Airport Station where regular surface and upper air observations are made. (2) The fire area was bracketed by two fire-weather stations, Shafer Butte Lookout, six miles north of Robie Creek at an elevation of 7,590 feet, and Idaho City Ranger Station some 12 miles northeast of the fire, at an elevation of 3,950 feet, in the main Mores Creek drainage. (3) The fire went through four different types of behavior-day: a blowup, a long run, a potentially critical but quiet day, and a quiet day.

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[1] An article of this title appeared in its entirety in the January 1957 Monthly Weather Review. A somewhat shortened version is published here through the courtesy of the author and the Weather Bureau.

[2] Our thanks to George M. Byram and Charles C. Buck of the U. S. Forest Service and to DeVer Colson of the U. S. Weather Bureau for their reviews and comments on the first draft of this paper. Our thanks also to the staff of the Boise National Forest for their patience in answering questions and supplying data.

DESCRIPTION OF THE FIRE

The Robie Creek Fire in the Boise National Forest started in the early afternoon of Labor Day, September 5, 1955. It was a hot, dry day; the 45th day since there was measurable precipitation in that area and the 21st consecutive day with the maximum temperature above normal. The maximum temperature at nearby Idaho City Ranger Station that day was 101° F. and the relative humidity was 6 percent resulting in a very high fire danger (Burning Index of 72 on the Forest Service Model 8 Meter).

The fire apparently started on the east side of the Boise Ridge and at a point on a minor slope exposed to the southeast. The point of ignition was in well-cured grass in a light stand of chokeberry brush. Fuel in the general area consisted mostly of dry grass, several kinds of brush, and second growth ponderosa pine. The fire started at an elevation of about 5,000 feet, but eventually spread over an elevation range from 4,000 to 5,500 feet. Although winds were light and variable, the other factors were very conducive to fire spread. Within 2 hours of the time that fire began there were 15 to 20 people from the nearby Karney Lakes Resort, four smokejumpers, and a crew of 20 trained fire fighters at the scene, but the rate of spread was so great that the fire fighters had to retreat from the fire area.

The fire started on Monday, September 5, and was brought under control on Friday, September 9. Of the 5 days, major runs or "blowups" occurred on 3 days: Monday, Tuesday, and Thursday. On Wednesday there were minor flareups, but no sustained run occurred. There was very little spread on Friday as established lines were widened and mopup commenced (fig. 1).

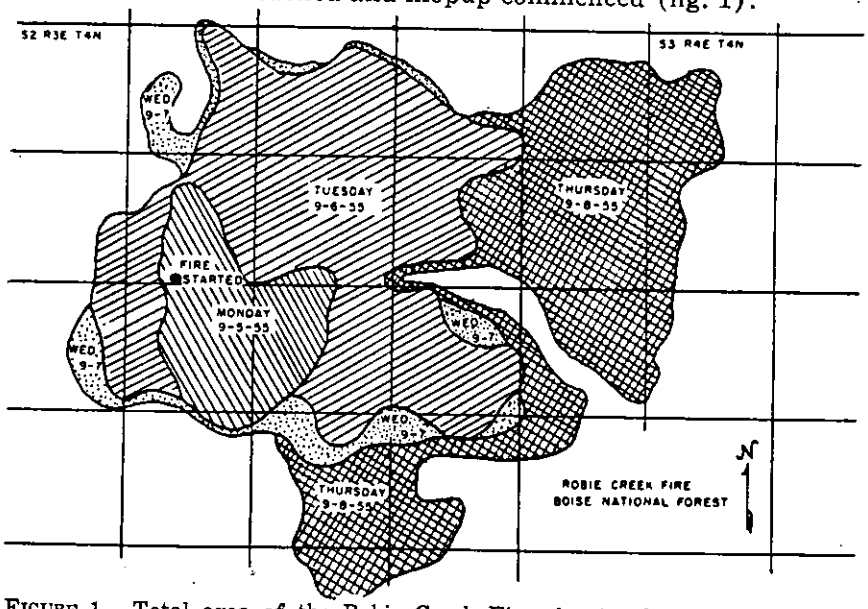

FIGURE 1.—Total area of the Robie Creek Fire showing location where fire started on Monday, September 5, 1955, and its spread on succeeding days. Grid interval equals 1 mile.

During the 5 days the fire spread over 8,310 acres of private and national-forest land. At the peak of the attack over 700 men were employed and total suppression costs were in excess of $100,000.

WEATHER CONDITIONS

In the attempt to determine which weather parameters had the most influence on the fire behavior during the 5-day period, comparisons were made of the various weather data.

The upper air measurements give the values of temperature and humidity at different heights. The decrease in temperature with altitude is called the lapse rate. When this value becomes 5½° F. per 1,000 feet the lapse rate is known as the dry adiabatic lapse rate. With lapse rates considerably less than dry adiabatic, the atmosphere is more stable. Where the lapse rate approaches or is greater than the dry adiabatic rate the air becomes unstable and upward motion is greatly increased.

On the assumption that stability would be an important factor, a comparison was made of the twice-daily Boise radiosonde observations (fig. 2). The lapse rate was very nearly dry adiabatic on Monday, Tuesday, and Wednesday and only more stable on Thursday and Friday.

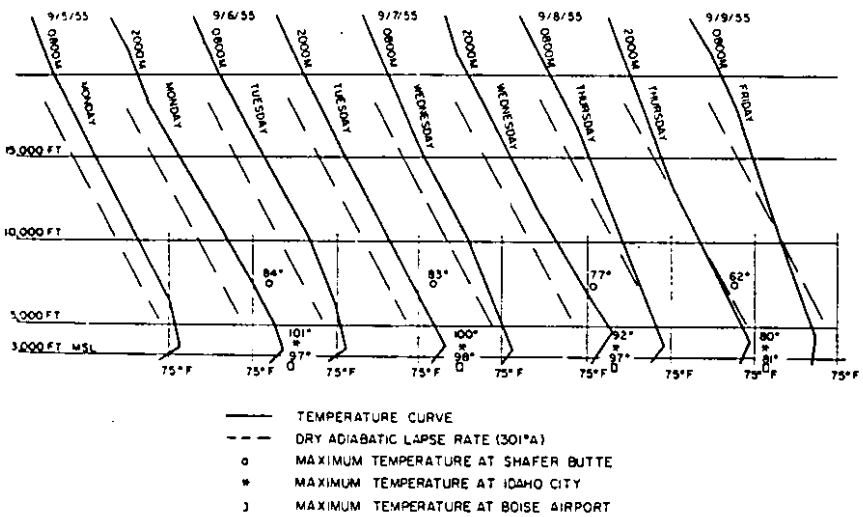

FIGURE 2.—Radiosonde temperature observations at Weather Bureau Airport Station, Boise, Idaho, during period of Robie Creek Fire. Daily maximum temperatures for Shafer Butte Lookout, Idaho City Ranger Station, and Boise Airport are plotted at their relative elevations.

Plotting the maximum surface temperatures at Shafer Butte, Idaho City, and Boise WBAS on the soundings show that superadiabatic lapse rates existed on Monday and Tuesday near the surface, but the layer near the surface was more stable on Wednesday and Thursday.

The surface conditions as shown in table 1 reveal that the weather was hot and dry all 5 days, but that there was a definite cooling on Thursday and Friday.

The wind speed profiles for the 0800 MST and 1400 MST Boise winds aloft observations are shown in figure 3. The wind speeds above 7,000 ft. m. s. l. increased gradually during the first 4 days of the fire and then slacked off again at the end of the week.

TABLE 1.—*The maximum temperature and 1600 MST[1] relative humidity for the 5 days of the Robie Creek Fire, Boise National Forest, Idaho, September 5-9, 1955*

Day	Boise Weather Bureau Airport Station		Idaho City Ranger Station		Shafer Butte	
	Maximum temperature	Relative humidity	Maximum temperature	Relative humidity	Maximum temperature	Relative humidity
	°F.	*Percent*	*°F.*	*Percent*	*°F.*	*Percent*
Monday	97	24	101	6	84	12
Tuesday	98	23	100	12	83	14
Wednesday	97	17	92	12	77	14
Thursday	81	27	80	19	62	34
Friday	80	30	81	25	62	40

[1] MST is mountain standard time.

FIRE BEHAVIOR

The fire behavior on Monday was very similar to that of Tuesday and most of the weather data were strikingly similar on those 2 days, except for minor changes in the winds aloft patterns.

Monday and Tuesday both had some of the characteristics associated with a blowup pattern; i. e., steep lapse rates, high temperatures, low humidity, dry fuel, and relatively light winds aloft. On both Monday and Tuesday the major spread occurred in the middle and late afternoon and was accompanied by a nearly vertical smoke column which was topped by a well-developed cumulus cloud. Both Monday night and Tuesday night the smoke filled the surrounding valleys and remained low until upslope motion commenced at 1000 MST on Tuesday and 1100 MST Wednesday.

On Wednesday the fire spread over only about 500 additional acres compared to over 3,000 acres on Tuesday. However, the temperature lapse rate was almost as steep as on the previous 2 days and the minimum relative humidity at Idaho City and Shafer Butte was the same as on Tuesday. There were minor changes in maximum temperature with a drop of 6° at Shafer Butte and 8° at Idaho City. Winds aloft were weaker at low elevations and stronger at high elevations as shown by the wind speed profiles. On Wednesday there was no towering cloud-capped smoke column, only small areas of billowing smoke during the afternoon. In contrast to the previous nights the fire continued to spread during the night, especially near the ridgetops, and there was very little smoke hanging in the valleys Thursday morning.

On Thursday cooler air was obviously moving into the fire area with moderate westerly winds across the Boise Ridge and down onto the fire. In the early morning the fire was moving rapidly up the slopes exposed to the west, and throughout the morning and afternoon the fire continued to spread in an easterly direction. Maximum temperatures were down about 20° from Tuesday and minimum relative humidity was up 10 to 20 percent. Although the fire covered nearly as great an area on this day as on Tuesday the behavior was different. The wind was relatively consistent in both speed and direction and the fire moved from west to east, up slope and down. The forest officials described it as more of a steady "push" than a blowup. The smoke column leaned to the east and although small cumulus tops appeared frequently they disappeared almost as quickly as they formed.

On Friday winds were light and variable, temperatures were about the same as on Thursday, and the relative humidity was higher by 5 to 10 percent. In the afternoon a few minor dust whirls were visible in the ashes and smoke stumps, but at no time was there a serious flareup or threat to the firelines. By this time the suppression attack was organized and lines were well established and manned.

DISCUSSION

Arnold and Buck[3] have listed five atmospheric situations under which fire blowups may occur:

1. Fire burning under a weak inversion.
2. Fire burning in hot air beneath a cool air mass.
3. Combustible gases from a fire accumulating near the ground.
4. Fire exposed to a steady-flow convection wind.
5. Fire burning near a cell of vertical air circulation.

The rapid spread on Monday and Tuesday corresponded to situation 5, and the conditions on Thursday seemed to fit situation 4. On Monday and Tuesday there appeared to be a "chimney effect" reaching to an estimated 25,000 to 30,000 feet which induced a strong draft at the base of the column.

Byram[4] states that for the greatest blowup potential the wind should reach a maximum within the first 1,000 feet above the fire and then decrease in speed with elevation for the next several thousand feet. He refers to this point of maximum wind speed immediately above the fire as the "jet point" and states that the wind speed near the jet point for most dangerous fires will be 18 to 24 m. p. h. for light to medium fuels. Byram has classified the wind speed profiles into four main types, each with two or more subtypes (fig. 3).

In comparing the wind speed profiles of the 1400 MST Boise winds aloft reports for the 5 days of this discussion we find that the profile for Monday resembles Byram's Type 1-a except for wind speed. The wind blowing upslope tended to offset this low velocity.

[3] Arnold, R. Keith, and Buck, Charles C. *Blow-Up Fires—Silviculture or a Weather Problem?* Jour. Forestry 52: 408-411. 1954.

[4] Byram, George M. *Atmospheric Conditions Related to Blow-Up Fires.* U. S. Forest Serv. Southeast. Forest Expt. Sta., Sta. Paper 35. 1954.

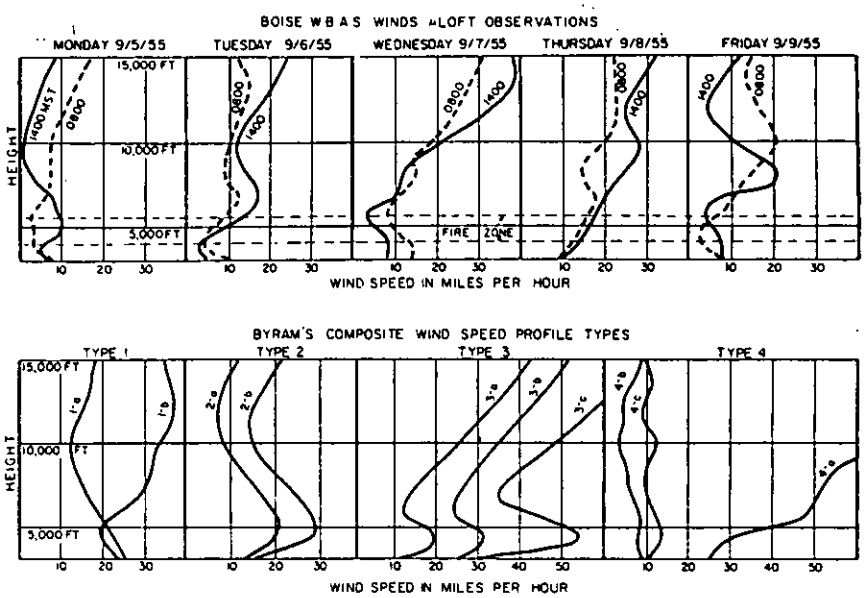

FIGURE 3.—Daily winds aloft observations taken at Weather Bureau Airport Station, Boise, during period of Robie Creek Fire (upper graphs) compared with Byram's wind speed profile types.

The wind speed profile at 1400 MST on Tuesday for Boise closely resembles Byram's Type 3-a with the jet point just above the fire zone. This type has strong winds at high levels, but with a layer of decreasing speed just above the jet point. Byram says of this particular profile ". . . for a fire near 7,000 feet it resembles the dangerous Type 1-a and it is doubtful if the wind speeds at high levels are strong enough to shear off the convection column." Type 3-a and 3-b may be accompanied by strong whirlwinds and rapid fire spread when jet point winds are 20 m. p. h. or more. The winds at the jet point level at Boise Weather Bureau Airport Station were below Byram's minima, but speeds must have been higher just above the fire. Fire crews reported spotting as much as a quarter of a mile ahead of the fire Tuesday afternoon which would indicate some of the whirlwind activity mentioned by Byram.

On Wednesday the wind speed profile resembles Byram's Type 1-b, except that wind speeds in the fire zone were much below the limits shown. The strong winds above 10,000 feet would tend to prevent formation of a convection column which might induce strong winds at the surface. Colson[5] states ". . . the convection column will not attain great heights if the wind speed increases too rapidly with height. Too strong a wind speed may cause the column to be broken away from its energy source."

[5] Colson, DeVer. *Meteorological Problems Associated with Mass Fires.* Fire Control Notes 17: 9-11. 1956.

Byram's Type 4-a resembles the wind speed profile and also the fire behavior on Thursday. Regarding Type 4-a Byram states "... fires were intense and fast-spreading, but they could not be considered dangerous to experienced crews, nor were there any erratic and unusual aspects to their behavior."

The speed profile at 1400 MST on Friday closely resembles Byram's Type 2-a, but other conditions reduced the fire danger.

The fire behavior on Monday, Tuesday, Thursday, and Friday followed previously recognized patterns usually associated with the prevailing weather variables. However, the meteorological similarity between Tuesday and Wednesday was remarkable while the fire behavior was very different. Following is a comparison of the 2 days:

1. Fuel conditions on Wednesday were essentially the same as on Tuesday with fuel remaining on all sides of the fire. Lines had been established on some of the fire boundary, but the long run the following day indicates that the spread potential was present.

2. Figure 2 indicates that stability was not the prime differentiating factor.

3. When the maximum surface temperatures at Idaho City, Shafer Butte, and Boise were plotted on the tephigram with the Boise radiosonde observations (fig. 2) it appeared that there must have been a superadiabatic lapse rate near the surface at Idaho City and Shafer Butte on Monday and Tuesday which was not nearly so pronounced on Wednesday. This superheating effect was at a maximum on Monday and Tuesday, was at a minimum on Wednesday, and gradually increased again on Thursday and Friday.

4. Minimum relative humidity was the same both days.

5. Maximum temperatures were the same at Boise and 5° to 8° lower at Idaho City and Shafer Butte on Wednesday, but that change in itself hardly seems great enough to be critical.

6. The winds aloft at Boise Weather Bureau Airport Station show minor differences in direction on the 2 days, but wind speed profiles (fig. 3) varied considerably. Byram's wind speed profile types are different for the 2 days and they offer a possible explanation for the variation in fire behavior between the 2 days.

CONCLUSIONS

The principal objective in an analysis of this type is to develop means of improving forecast and warning techniques. Byram's wind speed profiles have considerable merit, as the evidence has shown, but, from a forecaster's standpoint, it would be difficult to separate the blowup days from the quiet days on the basis of projected 0800 MST wind speed profiles. This is a field in which further study seems warranted.

This study indicates that the forecasters on large fires should consider carefully the wind speed profiles and surface temperature distribution as well as temperature lapse rates, surface weather charts, and other observational material. If it were possible to

dispatch a mobile radiosonde observational unit to large fires the information gained would be very valuable to the forecaster in predicting fire behavior. The cost of constructing and operating a mobile radiosonde unit would be considerable, but in view of the terrific property losses and suppression costs on large fires, such a unit would be justified. Pilot balloon observations would be impractical because of visibility restrictions, and only very rarely does a large fire occur close enough to an upper air observational station to make the data representative of conditions over the fire.

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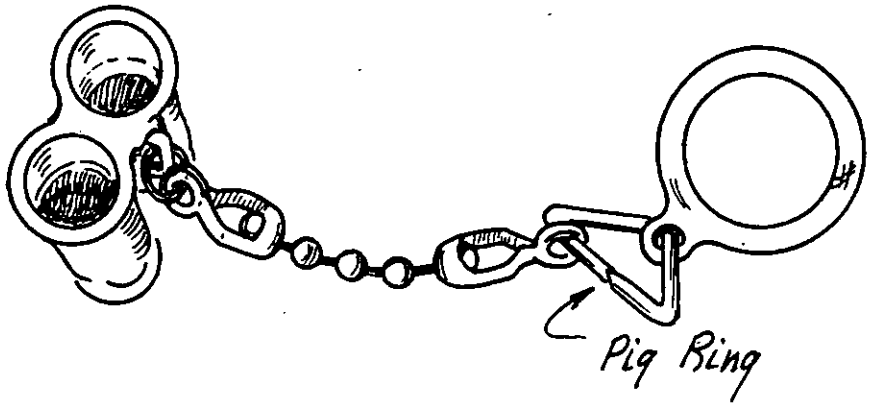
Pig Rings For Fastening Nozzles To Backpack Cans

Indian backpack can replacement nozzles (part number 235) come equipped with a swivel chain ending in a metal loop. The pump (part number F-9) to which it is to be attached has a washer at the end. This washer extends on one side where it is pierced with a hole where the nozzle swivel chain is to be fastened. Twine, string, or wire are all unsatisfactory for joining the loop at the end of the swivel chain through the hole in the washer on the pump.



A #1 pig ring makes a very secure, stout fastening which can be easily installed with widemouthed pliers. The beveled edges of the ring come together for a very tight fit. The joint may be heated and sealed with solder for a stronger, smooth joint.

The cost is very low and the rings are readily available. One hundred rings sell for twenty cents.—ELDON CAMPEN, *Farm Forester, Division of Forestry, Illinois Department of Conservation.*

STANDARD FIRE FIGHTING ORDERS

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

Every Forest Service employee who will have fire fighting duties will learn these orders and follow each order when it applies to his assignment.

(s) R. E. McArdle
Chief, Forest Service

June 28, 1957

HELICOPTER MESSAGE OR CARGO DROP-AND-PICKUP KIT

JAMES MURPHY[1]

A helicopter drop-and-pickup unit has solved many of the communication problems arising on fires and other projects, particularly where the use of radio is limited.

THE MESSAGE UNIT

Any type of conventional message tube may be used (fig. 1). Surplus Army plastic message cylinders were used for the origi-

[1] Cooperator, California Forest and Range Experiment Station, working under cooperative agreement with Utah State University. This report is based upon work which was conducted by the writer while employed as Air Officer, Angeles National Forest, Region 5, U. S. Forest Service.

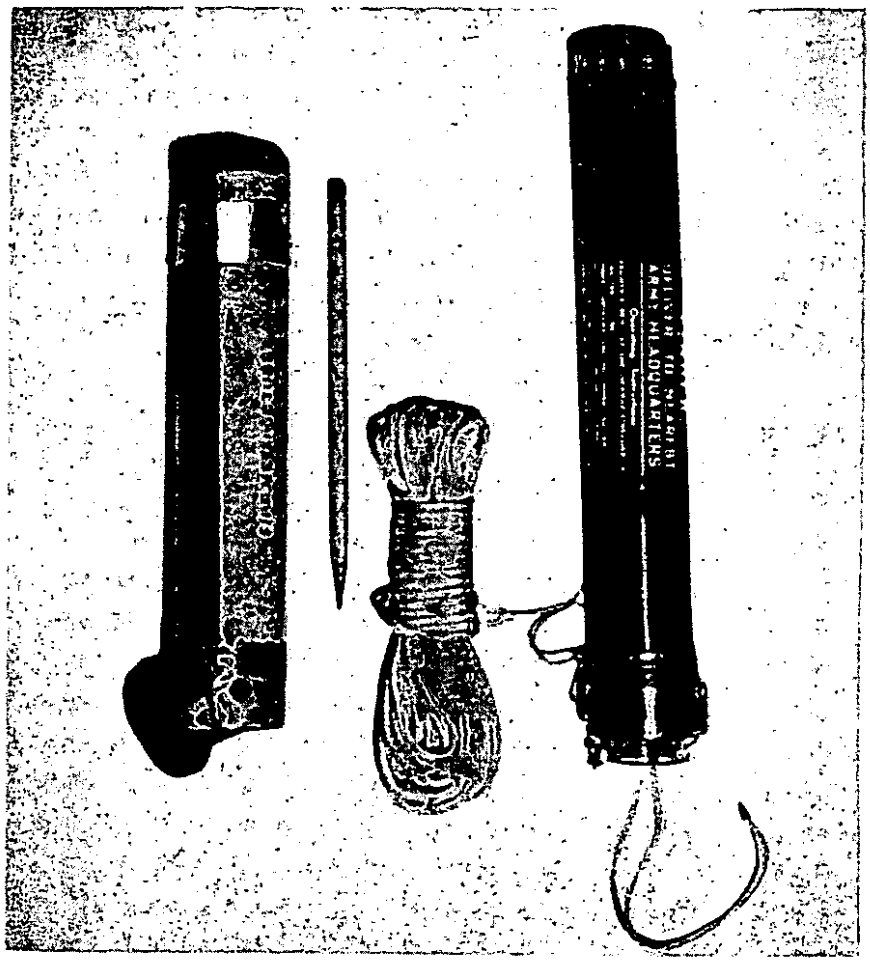


FIGURE 1.—Two types of message units. *Left:* U. S. Army message cylinder with holes drilled in cap for pickup cord. *Right:* Homemade cardboard tube with elastic band to hold caps in place. Nylon cord, pencil, and instruction sheet are enclosed in message tube.

nal tests. Holes were drilled in the plastic caps through which a nylon cord could be passed when preparing for the pickup. A less expensive and simpler message tube was developed later in the season from a 1½-inch diameter cardboard tube cut in 9-inch lengths. One-half inch elastic garter bands were looped lengthwise around the entire tube, attached to cardboard caps, and immobilized with acetate tape at each end of the tube. The elastic allows the caps to be stretched from the tube far enough to insert or remove the message. A long yellow streamer makes the unit visible during the air drop. Enclosed in the message tube are a pencil, sheet of instructions, and 35-foot length of nylon cord.

THE PICKUP UNIT

The pickup unit remains with the ship at all times. It consists of a hand reel, much the same as a fishing dropline hand reel, and a heavy nylon cord (parachute shroud cord) with a weight attached. The weight is cast from any light metal alloy and should weigh a minimum of 8 ounces for maximum control. It it 3½-inches long and tapers from the rounded base, 1½-inches in diameter, to ¾-inch at the top. Three triangular projections extend the top surface of the weight ⅜-inch, forming three grooves between them. A ¼-inch hole extends lengthwise through the weight for cord attachment. For safety reasons, the weight should be painted high-visibility yellow (fig. 2).

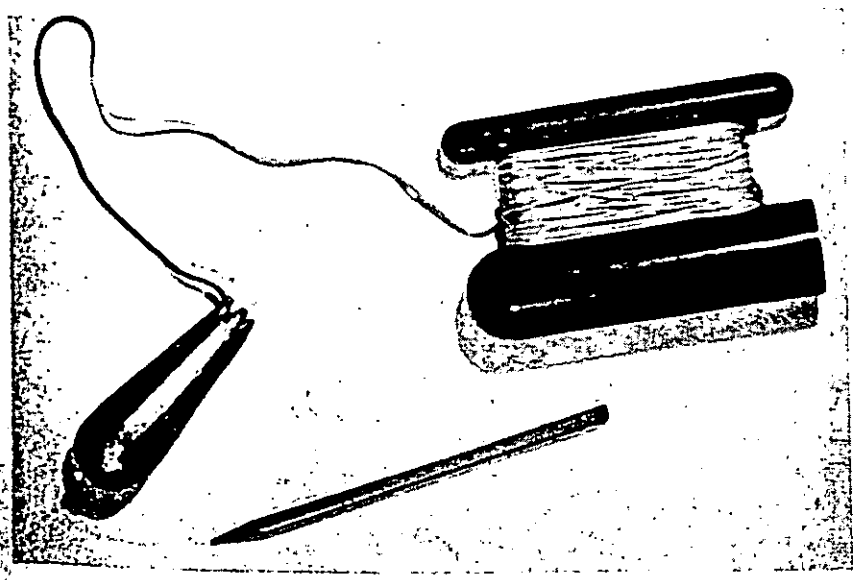


FIGURE 2.—Pickup unit consists of hand reel, cord, and weight. Note projections and grooves on top of weight to catch cord to which message tube is attached.

HOW IT IS USED[2]

1. The message tube is dropped to the ground party with message and pickup instruction sheet enclosed. Care must be taken in dropping tube so that men on the ground are not endangered. If a return message pickup is desired, the yellow streamer is waved by the man on the ground.

2. The nylon cord is removed from the message tube and unwrapped. It is threaded through the holes in the message tube, and the ends are tied together. The result will be a continuous loop of cord with the tube attached.

3. The cord is suspended loosely 6 feet above the ground by two men standing 15 feet apart. The remainder of the cord loop and the message tube are allowed to trail on the ground. Sticks may be substituted to support the cord if assistance is not available (fig. 3).

4. The helicopter reduces speed to about 20 miles per hour and flies as low over the area as is safe. The weight and cord are paid

[2]The techniques described here should not be tried unless the crew has been properly instructed in the safety practices required. If, for example, the pickup cord is held too tightly, the message unit may be flipped into the 'copter's control cables or its tail rotor.

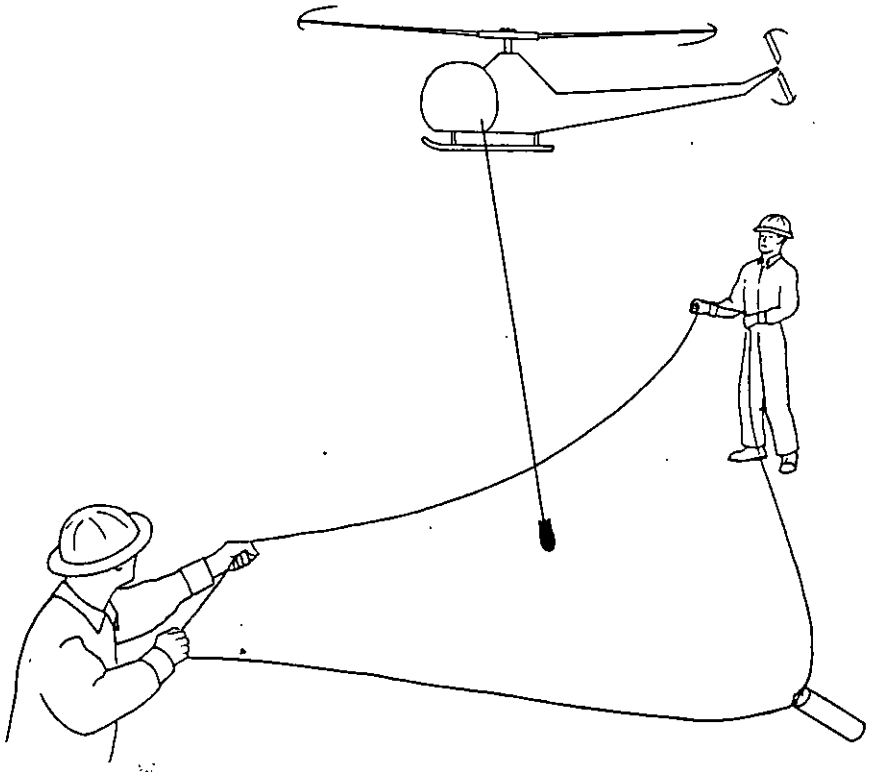


FIGURE 3.—Helicopter, moving at slow forward speed, flies over pickup area. Grooved weight, suspended from the ship, contacts the cord with attached message tube, and the air snatch is completed.

out over the front horizontal tube of the skid assembly until the weight is near the ground. The horizontal tube, present on the Hiller and the Bell 47-G, acts as a guide and furnishes better control over the weight. The weight is lowered until it hooks the suspended cord. The cord is reeled into the helicopter, and the message pickup is complete.

The same procedure is used when a cargo pickup is necessary. The cargo is packed in a knapsack or tied securely in a bundle and substituted for the message tube during the pickup procedure. All tests were made with weights less than 60 pounds, and further experimentation is necessary before cargo pickup in excess of 60 pounds can be attempted.

The drop-and-pickup device and procedure have been tested on many occasions. It takes little time and is simply executed. The reduced speed of the helicopter and the ability of the man in the ship to guide the weight reduce the chance of the weight striking the men on the ground. There are no hooks involved, and therefore no danger of "hanging-up" the weight on brush and other ground objects while performing the pickup.

COMBINATION PUMP TRUCK AND TRACTOR TRANSPORT

LOREN A. TUCKER

Supervisor, Division of Fire Control, Washington Department of Natural Resources

To bring more flexibility and utility into tractor transport for fire fighting, the Fire Control Division of the Department of Natural Resources in Washington has designed a rig for transporting small D-4 class tractors equipped with dozers. An especially designed dump truck provides pulling power. It has a two-speed rear axle with an 18,000-pound carrying capacity, heavy duty front springs with a 5,500-pound carrying capacity, and a 360-cubic inch displacement engine ordered special to haul the extra load. A 980-gallon flat tank slipon unit is designed as a pumping unit. This unit is divided into two compartments so that the truck can carry 200 gallons of water at all times, even while it is pulling the tractor transport. The truck is equipped with a heavy duty hitch to haul a lowboy trailer, which is used as the tractor transport (fig. 1). The first lowboy was built in the Department shops, but it was later found that they could be purchased direct from a trailer construction company as cheaply as our shop could build them. The trailer has a 24,000-pound gross vehicular weight.

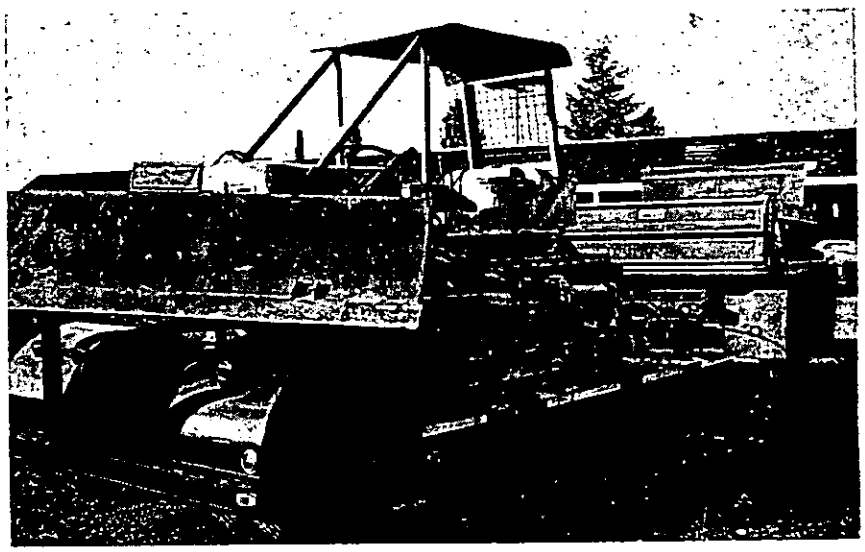


FIGURE 1.—Combination pump truck and tractor transport.

Contrary to the old conventional flat-bed transport, which was of very little value once the tractor reached the fire, this unit transports the tractor to the fire and the truck is disconnected and used as a pump truck for initial attack and mopup purposes until time to transport the tractor back home again.

For road maintenance projects, this has proved to be an ideal unit also, as the dump truck takes the tractor right along with it. The two can work together on fills and culverts and it is not necessary to have a driver for the tractor transport in addition to the regular dump truck driver.

Detailed specifications can be furnished by the Department to those who are interested.

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Smokey At Lake Ouachita

Smokies, by the thousands, ride the waves of Arkansas' Lake Ouachita in the continuing effort to keep the fire prevention message before the two million visitors seeking recreation on and around this new 40,100-acre lake administered by the U. S. Engineers in the heart of the Ouachita National Forest. The concessionnaires at the fishing villages and boat rental landings were requested to let us put Smokey bumper strips—Prevent Woods Fires—in the bow of all their boats. All of the operators enthusiastically offered their boats to transport Smokey as a constant reminder against forest fires. With Smokey in the boats, signing the islands came next. The islands are signed, along with their identification number, with the standard 44x16 fire prevention poster mounted in a new frame. The Corps of Engineers has fifteen recreation areas on Lake Ouachita, and in these we are using a small standard Smokey poster, mounted in a neat wooden frame with a small hangover to keep his nose in the shade. Fifty of the islands are posted with the big 44x16 signs, and 100 of the smaller Smokey frames adorn the recreation areas. The lodges and concessions are displaying the easel type Smokey.

This fire prevention project, aimed at the multitude of fishermen at Lake Ouachita, was a cooperative arrangement between the concessionnaires, Corps of Engineers, and the Jessieville and Womble Ranger Districts of the Ouachita National Forest. All made some contribution in making frames, mounting posters, and placing them in boats, on islands and peninsulas, and among the recreation areas and lodges of the fishing villages.—W. L. LANE, *District Ranger, Ouachita National Forest.*

HONEYCOMB PAPER FOR PROTECTION OF AIR CARGO

W. C. Wood
Equipment Specialist, Region 1, U. S. Forest Service

The Missoula Aerial Equipment Development Center has recently begun a preliminary study of the value of honeycomb paper for absorbing impact shock on air cargo. While considerably more investigative work remains to be done, it was felt that the information brought out to date should be passed on for the benefit of those involved in aerial delivery programs. Undoubtedly, field use of this new material will result in the development of new methods and techniques.

Briefly, honeycomb paper is a direct imitation of the honeybee's architectural ingenuity. Strips of ordinary kraft paper are formed into cellular sections similar to those found in beehives. These cellular sections are sandwiched (glued on edge) between flat sheets of kraft paper. When subjected to impact loads, the paper cells crush and absorb the energy of the impact. The honeycomb paper is available in several thicknesses with a variety of cell sizes and kraft paper weights. The smaller cells and heavier paper, of course, yield at higher impact forces and thus provide more energy absorption. For some cargo the use of honeycomb pallets will provide as much as 400 percent increased protection against damage.

In drop tower tests, it was shown that lightweight 5-gallon tins of water would burst upon impact when dropped unprotected on soft ground from a height of 9 feet. With 3-inch honeycomb pallets, these cans could be dropped from 18 feet without bursting. The increase in velocity as a result of falling this greater distance resulted in approximately four times more impact force.

Honeycomb is adaptable to Forest Service cargoing techniques. It is particularly well suited for use in palleting of air cargo. Water cans may be banded singly or doubled and protected by honeycomb (figs. 1 and 2). For most purposes, it is better to ex-

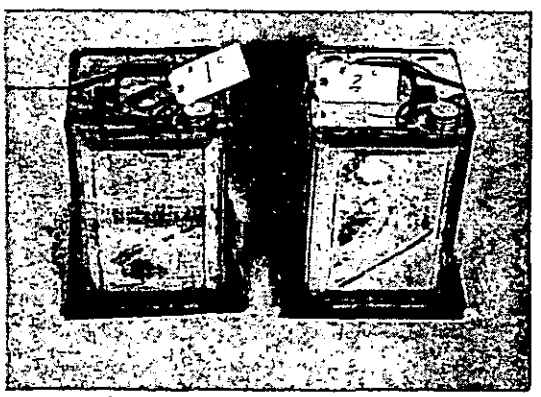

Figure 1.—Single 5-gallon disposable water cans with metal-strap cargo method and with honeycomb pallets, ½ inch and 1 inch thick.

FIGURE 2.—Double can cargo method. Note that board is used to prevent metal band from crushing cans. Small wooden blocks hold cargo handle in place. Honeycomb is 1½ and 2 inches.

tend the pallet edges approximately an inch beyond the corners of containers. An equipment development proposal to investigate the application of honeycomb to other standard cargo items (tools, etc.) has been approved for fiscal year 1958. One optimistic viewpoint is that with proper use of honeycomb padding, certain durable cargo items might be delivered free fall without damage.

Honeycomb pallets are superior to plywood or other wooden pallets. Honeycomb may be easily cut with a handsaw and is extremely lightweight. It is sold in board-foot quantities and is less expensive than plywood. Recent price lists show honeycomb to cost about 6 cents per board-foot.

Air drop tests using 12-foot diameter parachutes showed that more than twice as much water can be dropped without damage when honeycomb pallets are used (fig. 3). In some cases water cans burst upon impact when the honeycomb pallet failed to crush and absorb the energy of the impact. Pallets made from lighter

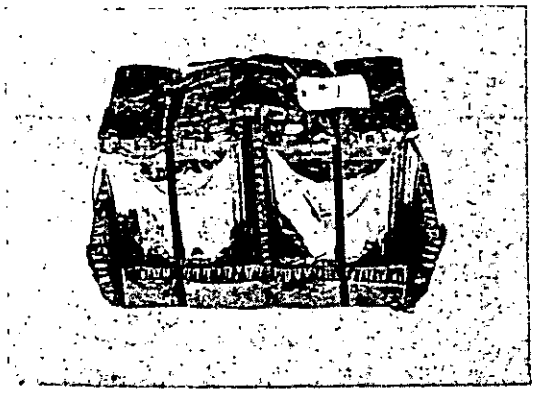

FIGURE 3.—Ninety pounds of water dropped on a 12-foot parachute. Note deformation of cans without leakage. Honeycomb at top and sides is unnecessary.

paper and with larger cells would, in this case, provide more protection. A good deal of experimenting will be necessary in determining the correct weights, sizes, and thicknesses needed to provide maximum and economical protection for the various air cargo items used in fire control work.

As with any kraft paper the honeycomb is weakened by moisture. Reasonable precaution against wetting should be taken. Resin-impregnated honeycomb (water resistant) is available, but at higher cost. Honeycomb sheets should be ordered expanded and faced on two sides. For most water cargo in standard 5-gallon cans, we suggest the 1-inch thickness until additional information is obtained. This is described as 99(0) ¾ EDF Caliper 1 inch. For added protection, additional sheets may be used. Honeycomb paper may be ordered from leading paper fabricators.

AIRBORNE BUCKET BRIGADE[1]

Bush fire fighting planes in Ontario may be soon equipped with water tanks that can be filled while the aircraft skims over a lake. One Department of Lands & Forests plane, an Otter stationed at Sault Ste. Marie has been fitted with a tank on each float (fig. 1). It can take on 180 gallons of water in 18 seconds—without stopping. This is accomplished as the aircraft skims along the surface of a lake dragging a refill pipe on the step of the seaplane float.

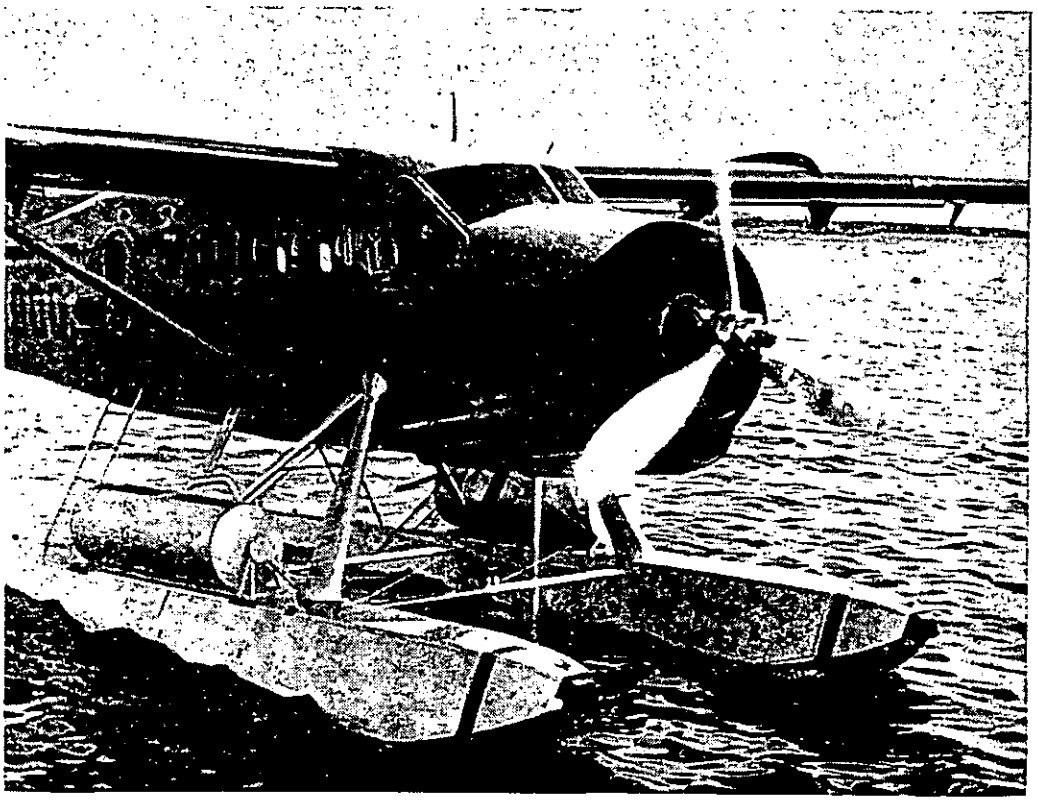

FIGURE 1.—A float-tank-equipped Otter.

While the float tank designed by Lands & Forests engineers is still in the development stage, the Department considers it highly promising (fig. 2). Said District Forester William Cleaverley, "a plane flying in the neighborhood of 100 feet can concentrate a 180-gallon drenching and really saturate the area. Pumps and water-bombs are ineffectual when compared to the new tanks."

[1]Illustrations for this article were furnished by the De Havilland Aircraft of Canada, Ltd., Downsview, Ontario.

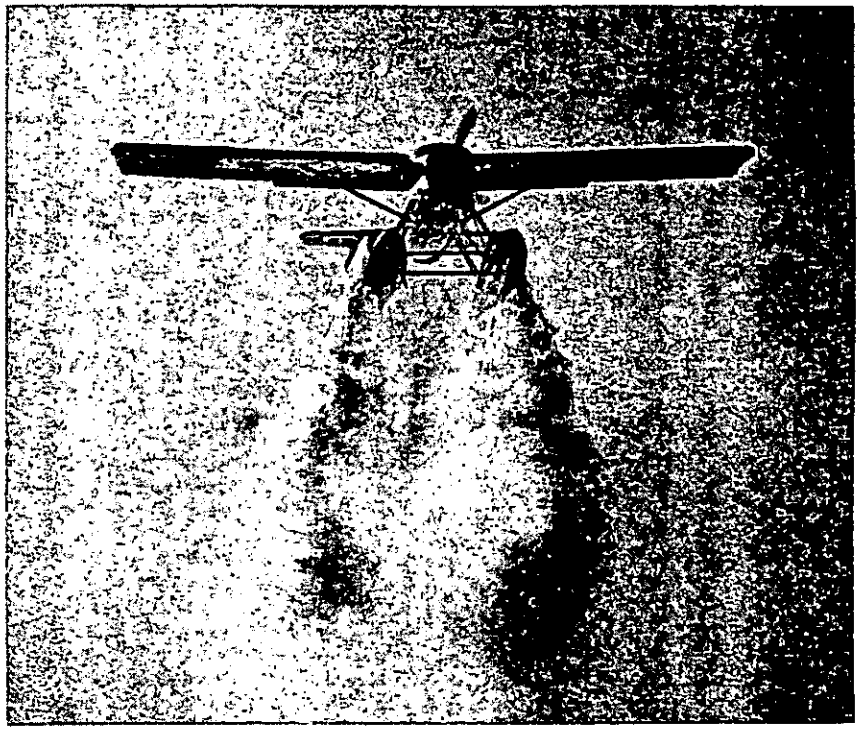

FIGURE 2.—Flying low and slow over the fire, the pilot flips the switch, the tanks revolve and open to release their cargo. Baffle plates prevent the water from sloshing.

In earlier experiments the tanks were fitted to the fuselage of the plane, but with tanks thus positioned the plane had to stop to reload. The "on the run" reloading feature of the float-positioned tanks cuts the turn-around time to a fraction. Given a situation where a fire is burning within 2 miles of a lake, a float-tank-equipped Otter could deliver an approximate 1,800-gallon drenching over the fire area within an hour. This would thoroughly drench an area of 2,000 square feet.

Since 1948, Ontario Provincial Air Service Beavers (and later Otters) have been fighting fires in Ontario's woodlands (figs. 3 and 4). OPAS is the Department's air arm and has some 40 Beavers and 5 Otters. The Otter's float tank will be redesigned to fit the smaller Beavers.

A useful piece of fire fighting equipment transported by the Beaver to otherwise inaccessible forest fire locales is the pack tractor which can be taken apart, put in the cabin and quickly reassembled when the destination is reached. Developed jointly by the Research, Air Service, and Forest Protection Division, this small, but highly efficient wheel-track vehicle will carry a 700-pound load up a steep hill at walking speed.

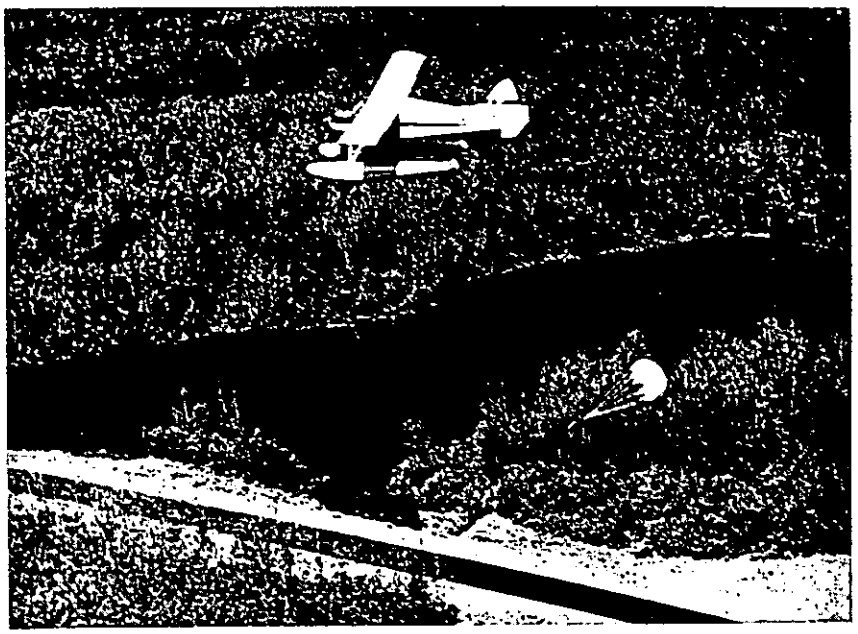

FIGURE 3.—A Beaver drops a portable gas-engined fire pump in a cushioned cannister to a waiting fire crew.

FIGURE 4.—Equipment unloaded from Beaver to dock after successful fire fighting operation.

PRIMACORD TESTED FOR BLASTING FIRELINE

W. G. BANKS and R. H. FENTON
Foresters, Northeastern Forest Experiment Station

Labor for fighting forest fires is not always readily available in the Northeast; so any tool that offers even a remote possibility of reducing fire-control manpower requirements seems worth investigating. Primacord, a type of detonating fuse used in blasting, fell in this category. Primacord was considered as a means of making or helping to make firelines.

Some testing of Primacord as an aid in making firelines was previously conducted by Thomas W. Church, Jr., of Whitney Industries, Inc., in northern New York; and his findings were similar to ours.

Primacord consists of an explosive core of Pentaerythritetetranitrate contained within a waterproof textile or plastic cover. The cord comes in rolls of 500 and 1,000 feet, of various strengths from 40 grains per foot upward. The cost is approximately 3½ cents a foot for 50-grain cord with plain textile cover, and double that for 100-grain cord.

It was recognized that there might be a number of drawbacks to the use of this product. For example: (a) the danger of working with explosives in close proximity to going fires and under the pressures frequently accompanying fire suppression; and (b) the possibility of setting additional fires. However, we decided to carry out some exploratory testing of Primacord to observe in a general way its capabilities and limitations for making or helping to make satisfactory firelines.

Primacord is relatively safe to use and store. According to the manufacturers it cannot be set off by friction, sparks, or any ordinary shock, but must be detonated with a blasting cap attached to it. To check the sensitivity we laid two short pieces within 2 inches of a stretch of cord being detonated. These sections were blown several feet away and the covering was torn, but they were not exploded. One short section was burned without indication of explosion.

Tests were conducted April 15, 1957, at the Virginia Pine-Hardwood Research Center at Beltsville, Md. The two major objectives were:

1. To test the potential of Primacord for making an adequate fireline under various conditions of litter and underbrush.
2. To test the fire-setting hazards of Primacord.

Our tests were made in (1) mature Virginia pine-hardwoods with heavy hardwood litter and patches of low brush; (2) pure Virginia pine 40-50 years old, open, and with considerable underbrush; (3) mature hardwoods, lightly logged, open; and (4) pure Virginia pine about 30 years old, fairly dense and with little underbrush. During the period of testing, the burning index ranged from 35 to 60 on the Southeastern Forest Experiment Station meter type 8.

Only the 50-grain Primacord was available for our tests. For a heavier blast we twisted two 50-grain strands together and assumed that this would give approximately the same results as the 100-grain cord. Both single and double strand were used in all types except the 40-50-year-old pure Virginia pine.

The principal results of our tests were as follows:

1. The firelines were judged to be inadequate to stop a surface fire, or to backfire from without additional widening and deepening. It was estimated that the time required to make a satisfactory line would be reduced no more than 30 percent by using Primacord. The best line made was in a pure Virginia pine stand about 30 years old. This resulted from a double strand of Primacord and probably reduced by 50 percent the time required to make a satisfactory line for backfiring.

2. Double lines, as well as splices and loops of 50-grain Primacord, were exceedingly liable to start fires in hardwood litter (fig. 1). In the course of testing, many fires were set. On one 30-

FIGURE 1.—Primacord at moment of detonation. A noticeable flash of fire occurred, especially when a double strand was used.

foot stretch of double strand, seven fires were started (figs. 2 and 3). On another short stretch of about 8 feet of double-strand Primacord, the whole line seemed to burst into flame.

FIGURE 2.—A double strand of Primacord laid and ready to detonate in a mature Virginia pine-hardwood stand. The litter here is mostly hardwood leaves.

3. No fires were started in pine litter. However, in spite of the burning index, the pine litter would hardly support a fire. If conditions were such that surface fires would spread readily in the pine, then the Primacord might set fires there too. We were unable to determine this possibility while these tests were being made.

4. When suspended on brush only a foot above ground the Primacord was of little value in making a fireline.

On the basis of these limited tests, the authors feel that Primacord has no practical application for fire-control work in the pine and hardwood stands of the coastal plains in the Middle Atlantic States. Nor were we encouraged by the results to continue the tests elsewhere in the Northeast. Of course there may be certain conditions under which this material would be helpful in fireline construction, for example, in the pine flatlands of the deep South, where rather light litter is found on top of sand.

FIGURE 3.—The line made by detonating the Primacord shown in figure 2. Seven fires in 30 feet of line were started by the detonation.

HIT 'EM HARD WHILE THEY'RE SMALL

TOM SMITH and MARK BOESCH
Bitterroot National Forest

This story was written for use in training initial attack forces and inexperienced dispatchers. It is applicable mostly to mountainous timber areas of the West but should be of interest to all forest fire control men.—Ed.

KEEPING AN EYE ON THE WEATHER

It was 0730 on the morning of August 10. The Darby District of the Bitterroot National Forest was ready to begin another busy summer day. Dispatcher Boesch turned to the brush crew foreman, about to leave for the Lick Creek timber sale area with his four-man crew.

"Clarence, we better have hourly checks beginning at 0930. I'll have the weather forecast from the Supervisor's office by then, and we'll have an idea of what's in store for us. If I don't miss my guess, you fellows will be on fires before the day is over."

"Okay," Clarence Lindquist replied. A few minutes later he and his crew pulled away from the ranger station in the carryall after making sure it was fully gassed and ready for a lot more miles than the ten or so that would take them to their brush piling job.

District Ranger Foskette came into the office about that time.

"What's the picture for today, Mark?" he asked his dispatcher.

"The brush crew's on the way to Lick Creek, Red. The East Side trail crew will be working Trail 159 on the way to Coyote Meadows. They should be checking in soon. We should be hearing from the Tin Cup Trail crew any minute, too. I have a hunch we're going to be busy today. Here's the weather picture, based on yesterday's readings."

The dispatcher handed the ranger the sheet that had on it not only the weather readings he had taken at the weather station the evening before, but also the estimated readings for this day. Ranger Foskette studied them carefully.

The dispatcher had predicted for this day of August 10 that the ½-inch fuel sticks would weigh 5; there would be a severity index of 8; humidity of 15 percent; a wind average of 10 m. p. h. during the afternoon, making a burning index of 65. He also predicted lightning for this day.

"Wow!", Foskette exclaimed. "We better pray for rain with that storm."

"Trouble is, these August storms don't give us much rain," Boesch said. "When they do, it's generally spotty. Right now we have dry areas on the district. Rock Creek is one. Hasn't rained up there since July 20, and only a trace then."

"Lucky thing we haven't had any hot storms the past 2 weeks the way this weather's building up," Foskette said. "But we're bound to catch it sooner or later. Well, I've got to check some of the range today. This dry weather isn't doing the grass any good either. I'll take the mobile unit. Call you first from Smitty's, up Rye Creek."

Bad as this weather was, Red Foskette couldn't just let everything else drop and sit tight there at headquarters, waiting for something to happen. That's what he had his dispatcher on the job for. Boesch had been dispatching for 10 years. If he wasn't capable of taking action on a fire bust now, he never would be. And he had good men to aid him. There was the headquarters guard, a man with wide experience who could fill in behind the dispatcher at headquarters, or who could go out and take over a fire. There was also a station fireman, a skilled smokechaser who had seen a lot of fire action. And there was the packer-truckdriver, who could either take a string of mules up the trail to a fire, or could drive a truck load of fire fighters and/or equipment to the end of a road.

The Darby District Ranger was a resource manager of 391,000 acres of forest land. He was as concerned with fire as anyone else, but he had other things to look after too, such as grazing, timber sales, road, trail, and other improvement work. He had skilled, key men to help him with these various duties. The assistant ranger did a lot of the timber work, helping to supervise the cutting by private operators of some ten million board-feet each year. Today the assistant and his helper would be working at headquarters on scale books. But the alternate ranger was up Tin Cup Creek, inspecting the trail reconstruction job that was going on there.

When the two-man East Side trail crew checked into headquarters by radio relay via the Deer Mountain lookout, Boesch gave them the same orders he had given the brush crew foreman. The same was true when the Tin Cup crew checked in.

EQUIPMENT CHECKED AND COOPERATORS ALERTED

Following the radio business Boesch gave orders to his headquarters men to make sure all the station vehicles had been gassed up the night before and now were ready to go. He told them to check all the equipment. Then he mentally checked what they had available. This included two pickup trucks, a Dodge power wagon, and a one-ton stockrack truck. There were 25 smokechaser packs made up, 2 10-man loose tool outfits, 1 Pacific pump with 1,200 feet of hose, 4 handi-talkie radios, 1 jeep pumper unit, and 2 25-man standard fire fighting outfits, the latter sufficient to fully equip 50 men on a fire. Finally, there were 2 chain saws. Soon the dispatcher heard the men warming up both chain saws out in the shop, making sure they were ready to use on a fire. Then they were testing the handi-talkies, calling the lookouts to make sure these vital radios were functioning properly.

It was now 0815. Boesch opened the front door of the office. Beginning to get a little warm.

"Going to be a hot day," he said to his clerk, who was busy typing a timber sale contract.

Boesch went back to the fire desk and opened his dispatcher binder. He turned to the section where the cooperators were listed. These people—farmers, ranchers, dude packers, townsmen, and logging and mill crews—had all been contacted early in June. All were listed there in the binder, along with their experience, capabilities, and the kind of equipment they had to offer. The latter included trucks, jeeps, mules and horses, school busses, chain saws, and even bulldozers. Boesch was personally acquainted with most of these cooperators and could talk to them on a first name basis. Now, he began calling them, seeing who would be available for fire duty that day.

Some of the ranchers in the valley had hay down. Even so, most of them agreed to come to his aid if Boesch needed them badly enough. Most of them were grazing permittees. They had a big stake in this business of stopping fires.

Jack Lykins, a commercial packer on the district, had a full string available, shod and ready to go, with his own truck to haul them wherever they might be needed.

The sawmills had their crews working, and they would spare what men they could in an emergency. They, too, had a stake in this business, since they could not long remain in business without Bitterroot Forest timber.

The two restaurants in the town of Darby were alerted to be prepared to make double lunches for fire fighters. They knew what to put in these lunches—four big sandwiches, fruit, several candy bars, cookies or pastry—enough to do a man all day if necessary.

As Boesch called the various cooperators, individuals, and crews, he made notes on his ready pad on who and what was available and even how to contact them. That was not only for his own use, but for someone who might have to fill in for him here at the desk when the going got heavy.

By the time Boesch was through working on the list of fire cooperators, it was 0900 and the forest dispatcher, Tom Smith, was calling all five of the Bitterroot districts on the radio.

"Here's the weather forecast," Smith said. "And it's a bad one. Increasing cumulus clouds today, followed by moderate, scattered lightning storms with little or no rain over the Nezperce, Bitterroot, Beaverhead, and Deerlodge forests. Humidity will range from 15 to 25 percent over southern areas. Maximum temperature at 3,000 feet, 90 to 95 degrees. Winds will be light to gentle, but moderate and gusty in vicinity of lightning storms." Smith then suggested that each district review its manpower situation and arrange to have necessary men available for immediate action.

Boesch gave his 10-4 that he had received the forecast okay, then after the other districts had done the same, he got back on the radio again with Smith.

"Tom, in view of that forecast, maybe you'd better alert that boomer crew of yours and have them available. Looks like we'll be needing them."

"Will do," Smith replied. He was proud of this crew of young cooperators he had organized to chase smoke and fight fire. Their ages ran from eighteen to the early twenties—about a dozen young huskies who had been trained through previous smokechasing and fire fighting jobs to do a good job of hitting the trails with fire packs, all of them being in fine physical condition.

"I'll alert Fred Fite, the regional dispatcher," Smith told Boesch. "We'll probably be needing smokejumpers too."

After this radio business with Smith, Boesch called the two Darby lookouts to give them the weather forecast—Deer Mountain, in the Sapphire Range on the east side of the Bitterroot Valley, and Ward Mountain over on the west side in the high, rugged Bitterroot Range. The two lookouts wrote the forecast in their logs. Then Boesch got a weather check with them.

"Scattered cumulus in the southwest," Deer Mountain said.

"Yeah, looks like we're going to get that storm all right," Ward Mountain agreed.

FURTHER PREPARATION FOR THE BUST

The forest dispatcher called Darby. "The patrol plane will take off from the Hamilton airport at 1000," Smith said. "They'll be flying Flight B, down Darby's west side, through the West Fork District, over into Idaho for a look at the Magruder and Salmon River country, back over into the Sula District, over Darby's east side, then both sides of the Stevensville District. Pass the word to the other districts."

As Boesch gave this information to the districts that lay south of him, he also checked with them on the manpower they had available that day. They were accustomed to swapping forces back and forth in the kind of bust that was now shaping up.

It was now 0930.

The crews began checking in via radio. Boesch gave each one the weather forecast and told them to be sure and check in again at 1030.

At 1000 Deer Mountain called. "Those clouds are really building up," he said. "That storm is on the way."

Calling Ward Mountain, Boesch got much the same report. Then he called Smith. "Tom, how are you doing with recruiting your boomer crew?"

"Have six of them standing by here. Can probably get four or five more within an hour or so."

"Better send what you have here for standby," Boesch told Smith.

"Will do," Smith agreed, "one of them has a car. They'll ride up in that. And, Mark, I checked with Fite. He has plenty of jumpers available. In addition there are 100 Blister Rust men available on the St. Joe Forest. Don't hesitate to call on them. I've notified Vern Hamre, who is at Stevensville, of what's shaping up."

"10-4," Boesch said. Hamre was the fire control staff officer.

It is 17 miles from Hamilton to Darby. Those six men would be at the district headquarters within 30 minutes.

Boesch was looking out the front door toward the southwest, seeing the angry-looking cumulo-nimbus himself now, when the boomer crew pulled into the station. About the same time the brush crew was calling from Lick Creek. Boesch stepped over to the radio.

"Bring your crew in, Clarence," Boesch told foreman Lindquist. "We'll be getting lightning soon."

He got the verification of that when he heard one of the West Fork District lookouts calling his headquarters, reporting lightning on the southern edge of that district.

"Not much rain with it, either," he heard the lookout say grimly. "But, it looks like Darby will get the worst of this one."

From then on the radio stayed busy, with Boesch glued to the fire desk. Ranger Foskette called from the Smith ranch, was apprised of the situation, and said he would start back for headquarters at once. The East Side trail crew checked in, and Boesch told them to stay in contact with Deer Mountain for possible fire duty. The Tin Cup crew called and was told to check in again at 1100, and every half hour after that. The patrol plane checked in from over on the west side, one of their routine 15-minute checks, this being a safety factor. The observer gave Boesch their location, then called Smith. Boesch heard the observer tell the forest dispatcher that they would not be able to make their scheduled patrol because of the menacing storm. Smith ordered the observer to keep a watch on the route of the storm and to continue checking in regularly with the district dispatchers.

It was 1100. Deer Mountain called to report that the storm had entered into Darby District and was putting down lightning at the head of Trapper Creek on the west side of the valley.

Boesch now had available at his headquarters station the six-man boomer crew of Smith's, the five-man brush crew, the assistant ranger and his helper, the headquarters guard, the station fireman, and the packer-truckdriver. The storm was now moving along the west side of the district, lightning plastering the head of Trapper Creek, then moving north to hit sections of Chaffin, Tin Cup, and Rock Creek. But, as it neared the deep drainage of Lost Horse Creek, it veered eastward, crossing the wide Bitterroot Valley where it started a barn on fire, killed two cows in a field, then started plastering the forest again in Sleeping Child Creek, from where it moved northeast across the Skalkaho drainage and finally passed out of the district over the head of Gird Creek. All the while the forest patrol plane flew near the storm, watching the areas of hot lightning concentration.

Even before the storm passed out of the district, about half an hour after it first arrived, Deer Mountain was calling in the first fire location.

MEN AND PLANES DISPATCHED

The fire was at the head of Tin Cup Creek, one of the worst areas on the district. Dispatcher Boesch was glad now of having

that crew in Tin Cup. Almost immediately he was able to contact them by radio. He gave Alternate Henderson the fire location, and they agreed that four of the seven trail men had better get started for it. They were all set to go, having fire packs in their camp. With a 3-mile hike ahead of them, they should be able to hit the fire within 2 hours.

Boesch contacted the patrol plane and asked him to swing over the Tin Cup fire. He would be there in about 5 minutes, and after a good look at it would be able to give the dispatcher a better idea of its potentialities. Boesch might have all of that Tin Cup crew on this fire before it was over with. But he couldn't sacrifice too much of his manpower on the first fire.

It was 1130. Ward Mountain now called in. He had a fire over near Bald Top Mountain on the east side of the valley in the Sleeping Child drainage. "Looks bad," he said. "Spreading fast."

He reported the smoke as being white, with a heavy volume. Having the location of it plotted on his board, Boesch saw that it was burning in an open area near Bald Top. Lots of grass in there and down lodgepole. Likely that was the cause of its fast spread.

"This is one for you, Clarence," Boesch said to the brush crew foreman. He didn't send all of Lindquist's crew with him. Those brush men were all skilled fire fighters and could act as straw-bosses on project fires. He let Lindquist take one of those with him, then gave him three of Smith's boomer crew—good men, but a little less experienced than the regular crew men.

"I'm going to put in an order for smokejumpers on that one, too," Boesch told Lindquist. "Be sure and take a radio with you."

The headquarters guard would get them outfitted with what they needed. Boesch stayed at the fire desk. He now called the forest dispatcher. He had quickly made out a smokejumper request form, and he gave Smith the necessary information for relay on to the regional office. That fire was already close to a half acre, so he ordered eight jumpers, a Ford Tri-Motor load.

"Wind's kicking up," Smith told him. "They might not be able to jump."

"I know," Boesch said, "But, I've got a five-man ground crew on the way."

Smith agreed that was a good idea—the old insurance business. Then he told Boesch he had four more of his boomer crew who would soon be ready to start for Darby. He would keep recruiting. West Fork now had two fires going, even though they'd had less lightning than Darby.

INTERDISTRICT TEAMWORK

Then the Sula District dispatcher was calling. He'd pulled his brush crew in—wanted to know if Darby wanted the five men.

"Send them right away," Boesch said, "and thanks, Terry."

The patrol plane was calling Darby now. He hadn't made it to that Tin Cup fire yet. Instead, the observer had spotted another

fire just above Lake Como in the Rock Creek drainage. This one, too, looked bad. Boesch knew that country well. He knew it was steep as a cow's face there. The fire was burning about half way up the slope. If it reached the top it would have bad fuels and would spread all over the country. Wasn't doing much yet, for the fuels were light where it had started. Just one snag burning. But the wind was throwing sparks from that snag. And when it fell, the burning tree would likely roll down to the creek bottom where there were more bad fuels.

Boesch called Smith. He asked if the rest of that boomer crew had got started for Darby.

"No," Smith said, "but they're ready to leave now. Got five of them with their own transportation."

This was good news. Boesch asked Smith to tell the men not to come to Darby, but instead to wait at the Lake Como road for the crew he was sending from Darby. They would go to the fire up Rock Creek.

Ward Mountain called then. He could see the Rock Creek fire throwing up smoke now—couldn't see it before because of a high ridge that shut him off. That one was beginning to spot, Boesch knew. Then he had Ward Mountain give him a report on the Bald Top fire.

"Doesn't seem to be spreading so fast now," was the word.

Boesch told him to watch for that jumper plane. Probably, he thought, the fire had made its initial run through the grass. But there was a lot of down lodgepole in the area. It would need a chain saw. He made a note of that.

Rock Creek was one for the assistant ranger, Bernie Swift. Boesch gave him two of Smith's boomer crew, one of whom was of strawboss caliber. Then Swift left, taking a handi-talkie, extra loose tools—enough to give each man a pulaski and shovel—and smokechaser rations.

"I'll get the rest of the stuff you'll need in to you, Bernie," Boesch said as the assistant went out the door, "one way or another."

A HELICOPTER JOINS THE FIGHT

The forest dispatcher was calling on the radio.

"Mark, what about the helicopter at Missoula? Possibly you can use it to stop the head of that Rock Creek fire."

"Fine, Tom," Boesch said happily. "We can sure use it. Have the pilot set down here at Darby."

"Will do," Smith said.

The headquarters guard went out to the wide area back of the ranger station to mark a set-down spot for the 'copter. This was not the first time the 'copter had been called for this kind of duty.

Now, the patrol plane was calling. There were two fires up Tin Cup. One of them, the one Deer Mountain had seen, was on a ridge top. It wasn't as much of a threat as one lower down, about a mile away. This one was beginning to spread in bad fuels.

"Swing down the canyon over the trail camp," Boesch ordered the observer. "Henderson will get on the radio. Give him that dope, and ask him to take the rest of his crew up there."

"10-4," came the acknowledgment. Then the observer added, "I tossed out some of Tom's pink toilet paper to mark those fires."

"Good dope," Boesch said, and smiled. But humorous or not, he knew the value of this. This scheme worked wonderfully in helping ground men find a fire. The pink color of the toilet paper could be seen a long distance as it unraveled itself earthward. And it marked an area well as it spread out over the trees and rocks.

Having a minute, Boesch called both restaurants in town and asked them to start making double lunches.

Now, Medicine Point, one of the Sula District lookouts, was calling Darby. He had just picked up a fire in Chaffin Creek. Just one snag burning. Boesch plotted its location quickly on his board—about a mile from the end of the road. Two good smokechasers could get there within an hour. He sent one man from Smith's boomer crew, plus one of the brush crew men. He decided not to send a radio with them. They could use the streamers in their smokechaser packs for signaling the plane if they needed anything. Ordinarily they would take a radio, but this one looked fairly easy, and Boesch wanted to hold a radio or two in reserve for higher priority.

Ranger Foskette came in just as Deer Mountain was reporting another fire. This one was in the head of Sleeping Child, near Coyote Meadows. This was high lodgepole country. The fire wasn't doing much, but it could. Plotting its location, Boesch saw it was not more than a mile from the East Side trail crew's location. He gave them orders through Deer Mountain to proceed to the fire. They had smokechaser packs with them, plus their radio. In about half-an-hour he would know the story on that one.

Ranger Foskette was busy reading the log the office clerk had been keeping as Boesch was busy working the fires. Darby now had six fires going, but also had men on the way to all of them.

"That Rock Creek fire worries me," the ranger said. "Maybe I'd better head up there."

"The 'copter will be here shortly, Red," Boesch told his ranger. "Why don't you use it to scout?"

"Good idea," Foskette said. "I'll go over, grab a quick lunch, then be all set."

The headquarters guard was busy. He had detailed several of the men standing by for fire duty to begin making up more smokechaser packs. Boesch could now hear the patrol plane talking to Alternate Henderson, giving him the word about the two Tin Cup fires. He heard Henderson 10-4 on taking the rest of the men up there, then get promptly off the air. Boesch got on the radio and asked the plane to swing over for another look at Rock Creek.

Now, Ward Mountain was on the air, calling in another fire, this one up Skalkaho. It was close to the Tenderfoot logging road. A bad area—logging slash in there, and open yellow pine country,

the fire burning on a south slope. It was beginning to spread. This was one for Bill Helm, the headquarters guard, a man with lots of fire experience. Before dispatching him, Boesch checked with Smith to see if he'd been able to recruit any more men.

"I've got two here," Smith said. "But, I've also got Stevensville's five-man brush crew coming. Figured you would need them. They should be here at Hamilton in about 10 minutes."

"That's fine, Tom. Send those seven men out to the Skalkaho road turnoff. Bill Helm will meet them there with the necessary tools."

Stevensville was the district north of Hamilton. Smith, as forest dispatcher, was doing his job of coordinating the Bitterroot Forest forces, helping to cope with this threat on the Darby District.

Boesch sent two of the experienced Sula men with Helm, along with a ten-man loose tool outfit, and had them stop at one of the restaurants to pick up ten double lunches. They could eat part of those lunches on the way to the fire. Helm also grabbed a chain saw, one of his favorite weapons.

It was 1230. Darby now had seven fires going.

Ward Mountain called. The jumper plane was over the Bald Top fire. Rock Creek was kicking up more smoke. Boesch called one of the sawmills. He spoke to the foreman who promised to have a ten-man crew ready for instant use when needed. Another sawmill promised the same. Both crews would have their own overhead.

Now, the patrol plane called. He couldn't get on the air earlier because of the traffic. He had scouted that Rock Creek fire carefully. The snag had fallen and rolled nearly a quarter of a mile downhill, setting spot fires along the way.

"You've got about six different fires burning there now," the observer reported. "Some are still spots. But two of them are spreading out. That country's mighty steep. No chance for jumpers." The observer should know. He was an exsmokejumper.

Now, Smith was calling from Hamilton. He'd talked to the Ford Tri-Motor that was circling Bald Top. Too much wind up there at the present time. They couldn't risk letting the men drop to that one.

There were eight good fire fighters in that plane. Boesch wanted to get them into action. "Ask them to swing over Tin Cup," he said to Smith. "Maybe they can jump on the lower fire. We'll have trouble there if it starts to crown."

"Will do," Smith said.

Then Boesch called the patrol plane. "Go over and have a look at Bald Top. Find where that ground crew is, and see if they'll be able to handle it."

"10-4."

COOPERATORS CALLED IN

It was 1245.

Would there be any more fires showing up? Boesch thought so. That's why he had held smokechasers in reserve. And he still had

cooperators to call on—individuals he had alerted earlier. Ranger Foskette was back from lunch. He got a refresher from the log, then went out to where the helicopter was setting down, taking a radio with him.

Boesch was on the phone again, calling one of the dude packers, Jack Lykins, and asking him to load his mules and take them to Lake Como to where the trail took off for Rock Creek. He made several other calls. These to other cooperators—men who owned boats with outboard motors. He asked them to get their boats and motors to Lake Como right away. In 15 minutes they could make a trip from one end of the lake to the other, saving Lykins 5 miles of packing. Then he had the packer-truckdriver take several men to help him load one of the 25-man outfits onto the truck. He would haul it to Lake Como and the stuff would be loaded onto the boats, then taken up to where Lykins could start packing. Bernie Swift and his men had been able to take a short cut around the rugged side of the lake. But there was no short cut for the mule string. They would have to use the good trail around the far side of the lake. But once at the head of the lake they would only have to pack that 25-man outfit a mile or so to where it was needed.

The patrol plane called then to say that the ground crew was about 15 minutes away from the Bald Top fire, and it looked like they could handle it. It was just about one-half acre in size.

Boesch told the plane to go look at the fire near Coyote Meadows, then swing over for a look at Skalkaho. But just then the trail crew called from Coyote Meadows, saying they had just got there and could handle the fire.

That was one of them, anyway, Boesch thought. He called Medicine Point to see how Chaffin Creek was doing. Still that one snag smoking. Those two smokechasers should just about be there, Boesch thought. When there was time, he would have the patrol plane swing over for a look at it.

The patrol plane was calling again. Another fire, this one in Little Sleeping Child Creek. It wasn't more than a mile from the Patterson Ranch. Al Patterson was a per diem guard and had a tool cache. Quickly Boesch called him and gave him the necessary information on the fire.

"You can grab your tools and get started for that one, Pat," Boesch told the per diem guard. "I'll call the Lovely boys and have them come up to give you a hand."

The Lovely brothers had a ranch about a mile below Patterson's. They'd been alerted earlier that morning and were standing by. Now they loaded two saddle horses onto their stock truck and in a few minutes were on the way. That fire would be manned by three capable cooperators in less than an hour. They were trained men who could put the fire out and return home without further instructions.

Ranger Foskette was now calling on the radio. It was only 20 minutes since he had walked out of the office, but already the helicopter had set him down on a large flat rock above those Rock Creek fires.

"Going to need about ten men up here, Mark," Foskette told his dispatcher. "I've sent the 'copter back to start ferrying them in. With luck we can handle this situation. I've just talked with Bernie below me. He's been trying to get out to you, but he must be boxed in. He's putting his men on the fires below. This is goat country. Worst fuel is up here on top. But I think we can keep those fires from getting up this high."

"Will it be safe working up there, Red?" Boesch asked.

"Yeah, it's okay," Foskette said. "Fuels are scattered there below us. Worst danger is for Bernie and his boys, from rolling rocks. I've warned him about them."

Now, Smith was calling from Hamilton. He'd just heard from the jumper plane over Tin Cup. Wind was a lot better there. They could put all eight of those jumpers on the lower fire.

"The spotter says it looks like they can use them down there, too," Smith told Boesch. "That lower fire is a couple acres and wanting to go. The upper fire is maybe a quarter of an acre, and is burning down slope. About four men can hold it."

That tricky wind, Boesch thought. It was true of a lot of those rugged west side canyons. Normally, fires burned a lot faster upslope this time of day, but in places like Tin Cup, the wind could really fool you. He gave Smith a quick go-ahead on putting the jumpers in. Good to get those huskies into action.

Now, the patrol plane was calling from Skalkaho.

"This fire is spreading pretty fast," Boesch was told. "It's in that yellow pine now. Must be 3 acres anyway. Looks like you'll need some followup."

"Can you see anything of Helm and his crew?" Boesch asked.

"Yeah, they're on the road. They've got about a mile to go yet. Should be on the fire in 20 minutes.

Boesch cleared, then got busy. He called one of the sawmills and got their ten-man crew headed for the ranger station. They would be there in 10 minutes. Then he called another mill and got their ten-man crew headed for the station. They'd be there shortly, too. One of these he would put on Rock Creek via helicopter. The other would go as reinforcements to Skalkaho.

Skalkaho was a dozer chance, too. He got one from a logger, working about 5 miles away. He could walk his dozer up the Tenderfoot road. He got another dozer from another logger, then called the County road department for their transport to haul it. Both dozers would be on the fire in 2 to 3 hours.

The packer-truckdriver was back from Lake Como now. The other 25-man outfit was loaded onto his truck, and he was soon off for Skalkaho.

"MOVE UP" OF FORCES PAYS OFF

Boesch still had seven good smokechasers and fire fighters left at his headquarters. Past experience had taught him that this was necessary. The day wasn't over yet. There would likely be

more fires showing up. And there was lots of work for those men right here at headquarters, keeping stuff moving, and running the numerous errands.

And so it went, with two more fires picked up later that afternoon, one by the patrol plane, the other by one of the lookouts. One of these fires was in remote back country. Boesch used two jumpers on that one, getting them on the fire within an hour and a half of the call, whereas it would have taken ground men 6 to 8 hours to get there. The other fire was closer in and Boesch put four of the seven reserves on it.

By nightfall every fire on the Darby District was manned. Several were under control. Skalkaho was 5 acres, but Helm was sure he would have it under control by the 10 o'clock deadline the next morning. Those two dozers had saved his men a lot of tough line building. Boesch had ordered a drop of tools, grub, and beds for the Tin Cup men. Henderson had the drop site marked. Among other things, he'd had them drop a pump with 4,000 feet of hose. The pump with 500 feet of hose could be used on the lower fire which was near the creek. The rest of the hose was used on the upper fire. Avery Hughes, one of the trail crew men, had worked out an ingenious system of gravity feed from a water source high up in the goat rocks. No pump was needed. All they had to do was start that water from the pot hole into the hose which ran down the steep hill. That gave them plenty of pressure. It was a system the Darby District had been using with great success for several years now. Henderson expected to have his Tin Cup fires controlled by the 10 o'clock deadline, too.

Rock Creek was six small fires spread out over a steep slope, the largest just under an acre in size. The 'copter had put all ten of the mill crew up there to help Ranger Foskette. He and his assistant working below had the situation under control. Lindquist and his crew held the Bald Top fire to an acre. The threat of project fires was over. Ten fires from one storm were held down to six Class A and four Class B.

Darby District, thanks to good beforehand thinking and preparedness, with the dispatcher using his meter to estimate rate of spread for slope exposure and fuels, which gave him a good idea of manpower and equipment needs, plus willing and able cooperators, and good teamwork on the part of forest and district headquarters, had again come through a tough situation, keeping the small ones from becoming big ones.

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SMOKEY
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with Matches
with Smokes
with Campfires
with Every Fire!
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PREVENT FOREST FIRES!