VOL. 20 JULY 1959 NO. 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.

Volume 20 **Number 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. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (October 17, 1958).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1959

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TRACTOR-PLOW TACTICS

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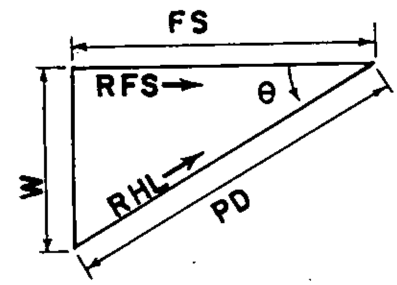
Tractor-plow fire suppression units have been in use in the South since about 1942. At present there may be as many as 2,000 units in use by Federal, State, and private forest fire control forces. Although these units are used to fight several thousand fires each year, relatively little has been written about the tactical use of tractor-plows in fire suppression. Hartman has described the development of the tractor-plow and early results from its use. He gave a typical crew organization used with a plow unit in 1947 and emphasized the desirability of attack by two plows rather than by one. In 1956 the writer mentioned the common practice of stopping the forward movement of the head of the fire by plowing a line in front of it, backfiring, and holding the plowed line.

Distinction has been made between ordinary fires and high-intensity fires and the characteristics of high-intensity fires are being studied. However, it appears that there has been no attempt to set forth any statement of the theory and practice of tractor-plow tactics in the suppression of ordinary fires. Yet, each year, there are enough fires which get away from tractor-plow crews to justify the belief that something could be gained in fire suppression technique by understanding the theoretical relationships that exist between the movement of the fire and the movement of the plow, and considering the practical applications which result.

One of the principal theoretical relationships is that of the rate of forward movement of the head of the fire to the rate at which fireline may be plowed, fired, and held. It is common practice to regard the fire as having three parts, the head, the right flank, and the left flank. Fires, like rivers, name their own flanks. Hartman observed that "on bad windy days heads run rapidly and produce a long cigar-shaped burn." Since the head moves more rapidly than the flanks, it is desirable to focus attention on the control of the head of the fire.

For this purpose, it is useful to consider the head of the fire as a straight line. In unpublished material used at Region 8 fire behavior training sessions the following appears, "Ordinary Fires —Behavior Factor: Advance of Head. More or less uniform line of fire or wall of flame, with wind or upslope." This line of fire may be regarded as the base of a right triangle and designated the Width (W). The Rate of Forward Spread (RFS) is the other leg of the triangle. The Rate of Held Line (RHL) is the hypotenuse. The relationship of rate of forward spread to rate of held line is that of the cosine of the angle they form (fig. 1).

The distance the head of the fire will run while a line is being plowed across the front of it, is called the Forward Spread (FS). It is the cotangent of the angle theta times the width. The distance the plow will have to travel to cross the head of a fire having a certain width and rate of forward spread is called the Plowing Distance (PD). It is the width divided by the sine of the angle theta. In table 1, which is for illustration only, the rate of held line is constant at 60 chains per hour.



$$\frac{RFS}{RHL} = \cos\theta$$

$$FS = \cot\theta\, W$$

$$PD = \frac{W}{\sin\theta}$$

FIGURE 1.—Relationship between movement of the head of the fire and movement of a tractor-plow unit.

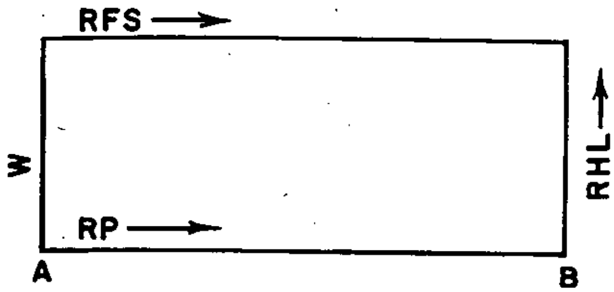
TABLE 1.—*Forward Spread (FS) and Plowing Distance (PD) for single plow, angle attack, at rate of held line of 60 chains per hour, by width of fire head and rate of forward spread*

Rate of forward spread per hour (chains)[1]	Width of fire head in chains is—							
	10		20		30		40	
	FS	PD	FS	PD	FS	PD	FS	PD
	Chains	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*
10	1.6	10.1	3.3	20.3	5.0	30.4	6.7	40.6
20	3.5	10.6	7.0	21.2	10.6	31.8	14.2	42.4
30	5.7	11.5	11.5	23.1	17.3	34.6	23.1	46.2
40	8.9	13.4	17.9	26.8	26.8	40.3	35.8	53.7
50	15.1	18.1	30.2	36.2	45.3	54.4	60.4	72.5
	50		60		70		80	
	FS	PD	FS	PD	FS	PD	FS	PD
10	8.4	50.7	10.0	60.8	11.8	71.0	13.5	81.1
20	17.7	53.0	21.2	63.7	24.8	74.3	28.3	84.9
30	28.8	57.7	34.6	69.3	40.4	80.8	46.2	92.4
40	44.8	67.1	53.7	80.5	62.1	94.0	71.6	107.4
50	75.5	90.6	90.6	108.7	105.8	126.8	120.9	145.0

[1] 1 Chain = 66 feet; 10 chains per hour is a speed of 11 feet per minute.

For example, with a rate of forward spread of 40 chains per hour, a width of 20 chains, and a rate of held line of 60 chains, a single plow attack will require 26.8 chains of held line (Plowing Distance). The farther side of the head will run 17.9 chains (Forward Spread) while the line is being plowed. The area burned during the attack will be 17.9 acres. With two plows, attacking simultaneously from opposite sides of the head, the forward spread (in the center of the head) is only 8.9 chains. Although the length of line plowed by both plows is still 26.8 chains, the area burned during the attack is only 8.9 acres.

If the rate of forward spread equals or exceeds the rate of held line, an "angle attack" cannot be made successfully. Advantage should be taken of the fact that tractor-plow units can plow about as fast as they can travel. The tractor-plow unit should move ahead, plowing but not firing and holding, to a Lead Distance far enough ahead of the fire to enable the crew to plow, fire, and hold a line across the head of the fire. The relationship and the calculation of the lead distance are shown in figure 2.



$$\text{Lead Distance (AB)} = \left(\frac{W}{RHL}\right)\left(\frac{RP \times RFS}{RP - RFS}\right)$$

FIGURE 2.—Relationship of a Lead Distance and a width of held line to the forward movement of the head of a fire.

Table 2 shows lead distances thus calculated for various widths of head and rates of forward spread.

TABLE 2.—*Lead Distances, where rate of held line is 60 chains and rate of plowing 240 chains per hour, by width of fire head and rate of forward spread*

Rate of forward spread per hour (chains)	Width of fire head in chains is—							
	10	20	30	40	50	60	70	80
	Chains	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*
30	5.7	11.4	17.1	22.8	28.5	34.2	39.9	45.6
40	8.0	16.0	24.0	32.0	40.0	48.0	56.0	64.0
50	10.5	21.1	31.6	42.1	52.6	63.2	73.7	84.2
60	13.3	26.6	39.9	53.2	66.5	79.8	93.1	106.4
80	20	40	60	80	100	120	140	160
120	40	80	120	160	200	240	280	320

Taking a lead distance involves trading space for time and sacrifices area. For example, if RFS=60 and W=20, the lead distance to be taken is 26.6 chains, the area burned during the attack would be 53.2 acres. However, it must be borne in mind that this fire cannot be cut off by angle attack by a tractor-plow unit making held line at 60 chains per hour; 53.2 acres is the least area that will be burned by any method of attack with a single tractor-plow unit. Obviously if the rate of forward spread exceeds the rate of plowing, even greater lead distances must be taken by falling back to roads, plow lines, or other barriers.

That these theoretical relationships have practical applications may be shown by the following illustration. It is not unusual for a fire to start along a road and burn away from it. The tractor-plow on a transport arrives along the same road and is unloaded at the fire. All too often the crew begins to plow, fire, and hold line on one of the flanks, moving toward the head of the fire, unaware of the relation between the rate of forward spread and their rate of held line. The effect of the head start of the fire is found simply by dividing the length of the flank from point of attack to the head by the difference between the rate of held line and the rate of forward spread.

In the illustration, it would take the crew one hour just to reach an anchor point at the head of the fire from which a line could be plowed across the head. In that time the fire head would have advanced an additional 40 chains. The preferred method of attack is to plow along the flank to the anchor point, where flank fire becomes head fire, there estimate the rate of forward spread and decide on an "angle attack" or a "lead distance" attack (fig. 3).

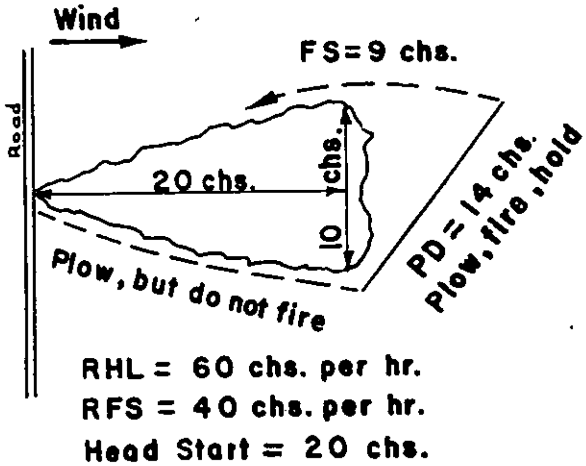


FIGURE 3.—Tractor-plow action to overcome a head start and make an angle attack.

In this case, with a width of 10 chains and a rate of forward spread of 40 chains, an angle attack can be made. The crew would plow and backfire a line 14 chains across the head. Meanwhile, the head of the fire would advance about 9 chains.

After the head is stopped either flank may be worked. In this case the line along the right flank may now be fired and held. If the line holding crew can be divided the tractor-plow and part of the crew could take the left flank at the same time. Since most wind shifts are clockwise, it might be a good rule (in the absence of actual forecast) to secure the south flank first.

The calculations made in the tables are, of course, theoretical. According to them the plow and the fire would reach the far side of the head at the same time. They do not allow for a Backfire Distance. To do so would complicate the presentation of the principle without adding anything of practical usefulness. It is, of course, necessary to allow a backfire distance.

As stated in a previous article, the meeting of head fire and backfire should take place at least ½ to 1-½ chains from the plow line, under ordinary conditions. The rate of movement of backfire is so low (about 1 chain per hour) that this cannot be accomplished by time alone. Parallel backfiring by a man and drip torch is the best means now available for increasing the width of the burned-out strip. Igniters have been tried but did not produce parallel backfire as satisfactorily as a man and a torch. Parallel backfiring requires two men. The man setting parallel backfire should be from ½ to 1 chain inside the plow line and about the same distance ahead of the line firer.

It appears from the information available that the rate of line holding is generally about one-fourth the rate of line plowing. Considering the relationship of rate of held line in the formulas, it is evident that the largest opportunity for improvement in tractor-plow suppression is by increasing the rate of held line. In addition to parallel backfiring, the most useful device for increasing rate of held line seems to be the tractor-tanker. The tractor-tanker is a light crawler type tractor carrying two 50-gallon tanks and a separate pump and engine capable of pressures of about 200 p.s.i. The tractor-tanker can follow a tractor-plow where a truck tanker cannot go. It can replace 5 to 10 men in line holding. Of course, it requires a suitable truck transport.

The tractor-tanker should be at or near the point where backfire meets head fire, since it is there that most simple breakovers occur. One, two, or more men should follow along the line helping with line holding. Where the woods are open enough, both tractor-tanker and line holders can work better back of the plow line, but if undergrowth is thick they have to move and work in the plow line.

In 1926, The Fire Code called for "Immediate attack—day or night—at the apparent point or points of greatest danger" "Scouting Fire: Going around it; checking probabilities; recalculating the job to be completed before the next 'burning hour,' determining its critical points."

With modifications to suit the conditions of rapidly moving fires in the Coastal Plain, these principles are still applicable. To accomplish a successful attack with a tractor-plow team the crew chief should know (1) the width of the head, (2) what's ahead of the fire, (3) what's ahead of the plow, (4) the rate of held line, and (5) the rate of forward spread. With fast moving surface fires, he needs to obtain this information en route to the fire or immediately after arrival at it.

The width of the head can best be determined by scouting aircraft, but, unfortunately, planes are usually not available with the initial attack force. However, a scout in a 4-wheel drive vehicle, on the far side of the fire, with radio communication, can often supply information as to width of head. Aerial photos can often help tell what is ahead of the fire and what is ahead of the plow. An unplowable swamp may lie ahead of the plow, making it impossible for one plow to complete a line across the head of the fire. However, aerial photos need to be supplemented by local knowledge and recent information. For example, the photos may show a swamp ahead of the fire but they will not show if the swamp is wet or dry. They will also not show a recent prescribed burn which may be of equal importance.

It is suggested that the rate of held line for various types and fuel conditions could be predetermined. It is also suggested here that rates of forward spread can be estimated satisfactorily by one-minute observations of the forward movement of the head, the distance being expressed in feet. In four training fires on the fire training strip on the Apalachicola National Forest, November 24 and 25, 1958, rates of forward spread of 30 chains per hour were measured. This rate occurred in mature longleaf pine timber, 3-year rough of wire grass and needles, under weather conditions as follows:

	Nov. 24	Nov. 25
Time 1:00 p.m.		
Fuel moisture ... percent	13.5	10.2
Wind (NNE) ... m.p.h.	4.5	4.5
Burning Index (8-100 meter)	4	5
Danger Class	2	2
Build-up Index	47	51
Relative humidity ... percent	68	50

Twenty fire control men of various degrees of experience found they could approximate the rate of forward spread to the degree of accuracy here required by estimating in feet the distance traveled by the head of the fire in one minute. Estimates were checked by marking the position of the head at one-minute intervals with steel can markers. The distances in feet per minute correspond approximately to chains per hour.

It was also found by timing and measuring that tractor-plow crews at the four training fires produced held line at about 60 chains per hour in the type and under the burning conditions given above.

The efficient execution of fast-moving tractor-plow attacks on fast-moving surface fires calls for a degree of skill and coordination that can be reached only by trained crews. Often fire occurrence is at a low level and it is not possible to give crews experience on a large number of actual fires. A good device for giving training in tractor-plow tactics appears to be the "fire training strip," first used, so far as the writer knows, on the Apalachicola National Forest, November 24, 1958:

I. Location and installation.
   1. A strip 10 chains wide by 1 mile long.
   2. Secure both sides and ends by a road, by plowing, or by prescribed burning.
   3. Orient length of strip to prevailing wind.
   4. Locate in mature timber to avoid excessive damage.
   5. More than 1-year rough; preferably an area to be prescribed burned.
   6. Stake both sides at 2-chain intervals.

This strip, fired on the windward end, represents the head of a fire 10 chains wide. The flanks are eliminated by the sides of the strip. Fires may be set and plowed out repeatedly in a number of demonstrations or tests.

II. Use of the fire training strip.

1. Set fire to the windward end and time it.
2. Estimate the rate of forward spread by one-minute sample.
3. Take a suitable backfire distance, or a lead distance.
4. Plow across strip, fire and hold line and time it. Use parallel backfiring.
5. Measure the forward spread to check the one-minute estimate.
6. Measure the plowing distance.
7. Obtain the average rate of held line.
8. Hold discussion of the execution of the operation and the results.

Four training fires were used on the fire training strip on November 24 and 25 with a group of 20 trainees. The one-minute estimate of rate of forward spread proved reliable and usable by the whole group. Rates of plowing checked between 240 and 300 chains per hour. Rates of held line were close to 60 chains per hour in each test. Parallel backfiring was successfully executed by man-and-torch but not by igniters. The effect of parallel firing—pulling the backfire away from the line and moving the meeting point of backfire with head fire away from the line—was adequately demonstrated. The tractor-tanker, which is not yet standard equipment in all fire control units, demonstrated its ability to hold line. In addition, the realism of the training fires may have had a beneficial effect on the less experienced trainees.

Both theoretical and practical considerations of what is to be accomplished in the suppression of fast-moving fires in the Coastal Plain lead to the concept of an Initial Attack Force of sufficient strength and proper composition for the task. The initial attack force should be instantly and constantly available. The following is suggested: one tractor-plow, on transport; one tractor-tanker, on transport; one truck, for line holding crew, with handtools; one scout car (4-wheel drive); one truck-tanker (4-wheel drive).

In addition to serving as "nurse tanker" for the tractor-tanker, the truck-tanker is useful for holding along roads, or for extinguishing spot fires it can reach, and for mopping-up.

Without attempting to be comprehensive, a number of points of theory and practice can be summarized as follows:

1. Fires should be thought of as having three sides: Head, right flank, left flank. Control of the head should be the first operation.

2. The principal method of control is the removal of fuel by burning, not by plowing. The principal function of the plow line is to make a fuel separation sufficient to hold the backfire.

3. The principal function of the line holding crew is to prevent the backfire from crossing the plow line.

4. The meeting of head fire and backfire should be far enough (½ to 1½ chains ordinarily) from the plow line so as to cause no breakovers and no great exposure of men to heat and flames. The distance can be increased by parallel backfiring, which should be standard practice.

5. The relation between rate of forward spread of the head and rate of held line by the tractor-plow crew in an angle attack is

the cosine of the angle they form. The distance to be plowed to cross the width of the head is the width divided by the sine of the angle. The distance the head will run while under attack is the width times the cotangent of the angle.

6. If the rate of forward spread is less than two-thirds the rate of held line an angle attack can be made from one anchor point to the other across the width of the head.

7. Two plows, attacking the head from both sides, can cut the time for control in half and reduce the area burned during the attack by half.

8. If rate of forward spread equals or exceeds two-thirds of the rate of held line, a lead distance should be taken sufficient to make and hold line across the width of the head before the fire reaches the line.

9. If fires must be approached from the rear, the time required to overcome the head start of the fire should be realized. Advantage should be taken of the present great difference between the rate of plowing and the rate of held line. Plow along the flank to the head of the fire, but do not fire and hold.

10. The tractor-tanker is the "sister" of the tractor-plow and affords the best opportunity now available for increasing rate of held line.

11. In the few minutes between arrival and attack, the fire boss needs to find the answers to the following: (a) What is the width of the head? (b) What is the rate of forward spread? (c) What is ahead of the fire? (d) What is ahead of the plow? He should know the capability of his crew in rate of held line.

12. Rate of forward spread can be obtained satisfactorily by estimating the forward movement in feet for one minute and converting feet per minute to chains per hour.

13. Doing the job of fire suppression quickly and reliably requires the existence and dispatch of an initial attack force of sufficient strength and proper composition. This force is suggested as consisting of (a) tractor-plow, with transport; (b) tractor-tanker, with transport; (c) truck-tanker (4-wheel drive); (d) truck, for line holding crew and handtools; and (e) scout car (4-wheel drive).

14. Tractor-plow tactics can be taught successfully on fire training strips, which give repeated head fires in little acreage and without time consuming flank control work.

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CHANGES IN THE HELITACK TRAINING PLAN

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In 1958 turbo-jet helicopters made their debut as a part of the fire control team. The small helicopter dropped paracargo from a remote-controlled release for the first time. For flexibility on larger forests, ground crews as well as especially trained Helitack crews were fitted into the Helitack fire plan. Fire fighters from Forest Service Regions 1, 2, 3, 4, and 5, the California Division of Forestry, the Los Angeles County Fire Department, and the U. S. Park Service, Yosemite National Park, were introduced to helitactics. The new techniques and the expansion of operations required changes in both the organization and the training for Helitack.[2]

New trends in Helitack organization.—The Helitack crew continued to be the backbone of the helicopter operation, but on the larger forests the Helitack foreman and his 3- to 4-man crew were not able to handle the whole job. Additional crews were necessary to maintain the flexibility of Helitack operations. Tanker crews, "hotshot" fire crews, brush crews, timber stand improvement crews, and smokejumpers were all trained as reinforcement crews to round out the Helitack organization.

How the Helitack organization operated.—When a fire was reported, the Helitack foreman and possibly one of his crewmen responded in the helicopter. The rest of the Helitack crew went to a previously located and improved reinforcement base heliport near the fire. The nearest reinforcement crew was also sent to the reinforcement base. When the helicopter had placed the Helitack crew on the fire, it flew immediately to the reinforcement base. The reinforcement crew was ferried to the fire. Helicopter accessories such as the helitank and hosetray were available there, too, and as a result, the fire often was manned by adequate manpower and equipment many hours before a ground crew could reach it. However, the most important part of this kind of operation had to come before the fire occurred. The new organization had to be trained.

Who was trained.—Helitack training of different intensity was given to most of the Forest organization, to fire-going personnel (Helitack crews and Helitack reinforcement crews: Tanker, hotshot fire, timber stand improvement, and brush crews and smokejumpers) and to non-fire-going crews (engineering and timber survey) who might use the helicopter for administrative projects.

Where they were trained.—A week-long training school was held in each Forest Service Region for all Helitack foremen. Each foreman returned to his home unit where he was responsible for or-

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[1]Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California. Much of the work included in this report was conducted under terms of a cooperative student-aid agreement between Utah State University and the Experiment Station.

[2]See *Training the Helitack Crew*, Fire Control Notes 19 (2): 91-93, illus.

ganizing and carrying out his own Helitack training program. Most units held a school during the early fire season for all forest personnel. Helitack training was included as a part of this fire school (fig. 1). An outline of the revised training plan follows:

Training for Helitack Crews

I. Crew organization.
II. Tour of duty.
III. Ground operations—preparation for flight. Establishing the base heliport, alternate base heliports, and reinforcement base heliports.
  A. Location principles.
  B. Heliport facilities.
  C. Safety regulations.
  D. Assembling Helitack equipment.
  E. Helicopter operations map.
  F. Flight and other records.
IV. Training the Helitack crew.
  A. Pilot training.
    1. Helicopter use policies and working instructions.
    2. Fundamentals of fire behavior.
  B. Crew training.
    1. Helitack safety.
    2. Job familiarization.
      a. How the helicopter works.
      b. Maintenance and use of Helitack equipment.
    3. Development of skills.
      a. Physical conditioning.
      b. Refresher course in fire behavior, use of tools, and line construction.
      c. Map reading and use of compass.
      d. Ground-to-air visual signal code.
      e. Use of radios.
      f. Helijump training with protective suit.
      g. Hover-landing techniques.
      h. Helispot location and construction.
      i. Fire suppression procedure.
        (1) Initial attack.
        (2) Large fires.
      j. Heliport management.
      k. Helicopter loading principles.
      l. Standby duties: Prevention patrols, helispot networks, insect and disease control, search and rescue, aerial seeding.

Training for Helitack Reinforcement Crews

I. The place of the Helitack reinforcement crew in the Helitack operation.
II. Designating an air officer in charge and heliport management.
III. Crew training.
  A. Helitack Safety.
  B. Job familiarization.
    1. How the helicopter works.
    2. Assembling, maintenance, and use of Helitack equipment.
  C. Development of skills.
    1. Ground-to-air visual signal code.
    2. Use of radios.
    3. Helijump training with protective suit.
    4. Hover-landing techniques.
    5. Helispot location and construction.
    6. Helicopter loading principles.
    7. Fire suppression procedures.

Training for Non-fire-going Crews

I. How the helicopter works.
II. Helitack safety.
III. Helicopter loading principles.

IV. Ground-to-air visual signal code.

V. Helispot location and contruction.

Helitack, during 1958, spread to many new areas throughout the West. New areas presented new problems; flexibility of helicopter attack was a major one. To supplement the regular Helitack crew, other ground units were used as Helitack reinforcement crews. Training the old crews in new methods and the new crews in all methods became the key to the successful Helitack operation.

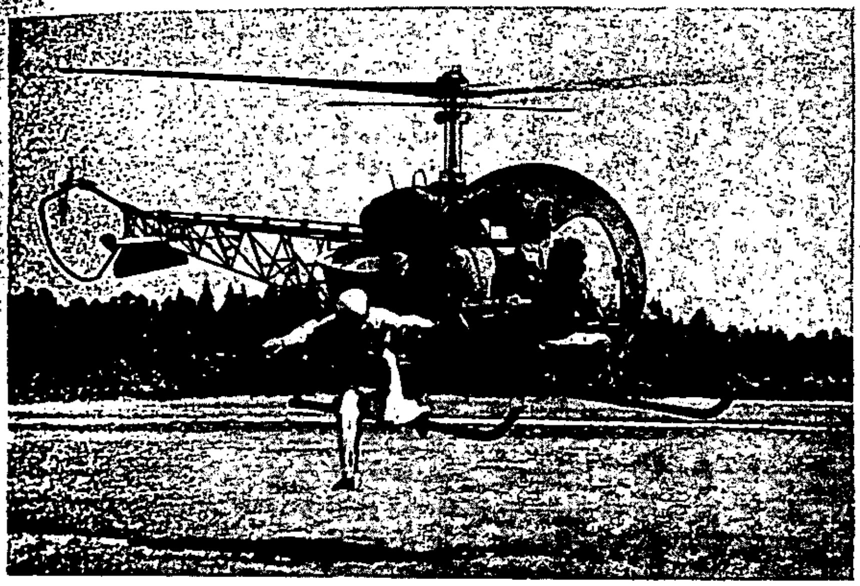

FIGURE 1.—Helitack crewmen are thoroughly trained in helijump techniques.

CARGO DROPPING FROM SEAPLANES ON THE SUPERIOR NATIONAL FOREST

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The fire which starts in an inaccessible area usually results in a difficult problem for Service of Supply. How to service crews in such areas, provide adequate supplies and equipment so that men can work with a reasonable degree of efficiency, has always vexed fire control officers.

The Boundary Waters Canoe Area, 1,800,000 acres in the Superior National Forest lying just south of the Canadian border in northeastern Minnesota, is just such an area. There are no roads and surface travel is slow and arduous by canoe and portage. The Superior, however, has had an "ace in the hole," its seaplane, because this part of the forest is studded with thousands of lakes and waterways. But even with the seaplane, which landed "hot-shot" crews at the nearest lake, pumpers, hose, handtools, gasoline, and supplies had to be packed, sometimes miles, to the fire. This slowed down the fire fighter and he, more times than not, arrived at the fire physically tired and too late.

The speed and effectiveness with which a fire is attacked usually determines the ultimate size of the burned area. Obviously then, any improvement that increases the speed of attack can be expected to reflect a corresponding degree of efficiency in fire suppression. This then was the problem on the Superior National Forest: (a) To get fire fighting personnel to fires in inaccessible areas as fast as possible; (b) to have them arrive in good physical condition; (c) to have fire fighting equipment and supplies ready for their use upon arrival at the fire.

Ely Service Center personnel decided that dropping equipment and supplies from the air offered the most practical solution to the third part of the problem. The dropping of cargo, one way or another, had been done almost from the time the airplane was invented. Reasons varied but usually dropping was the quickest way to get material and equipment into an area and to people in an emergency.

At that time, 1950, the Superior had three seaplanes, a Norduyn Norseman with a 27-inch belly hatch and two smaller Stinsons. Experimental work was started that year and material and supplies, packaged to fit the 27-inch hatch opening of the Norseman, were dropped both by parachute and free-fall. This proved successful even though only one drop could be made with each pass of the plane over a given area. It meant strong back and arm muscles for the droppers who had to hold the materials and containers in the hatch during the dropping run. But this was not nearly as arduous as if the supplies had to be packed to the fire and it allowed the fire fighters to arrive on the fireline comparatively fresh. Through the ensuing years considerable work has been done in determining proper type of container, contents and packaging, size of parachutes, and packaged weight of containers.

The acquisition of a DeHavilland Beaver seaplane for the 1957 fire season and the loss of the Norseman through trade-in presented a different problem. The DeHavilland Beaver had only a 17-inch hatch, which meant that many of the cargo containers would not pass through. It was not practicable to drop cargo through the door because of the danger of cargo or chute becoming snagged on the pontoons. It was then decided to experiment with cargo dropping of supplies and equipment from the pontoons themselves. If this proved feasible all three of the planes, the Beaver, a Stinson Station Wagon, and a Cessna 180, could be used. Forty-five drops, totaling 7,000 pounds, have proved the method not only safe and practicable but as far as is known unique in its field.

The Stinson seaplane was equipped first. A quickly attachable rack, to which the cargo drums are fastened, was designed to fit on top of a pontoon (figs. 1 and 2). Drums are held under tension by ½-inch elastic shock cord. When released by control cables extended into the cabin and conveniently located for the dropper to operate, they roll safely clear of the pontoons. Metal drums afford maximum protection to the equipment and are used mainly where equipment could be damaged. Pumpers, power saws, etc., are fastened inside drums with harness rings and steel runners. Plywood and fiber containers are being experimented with and can be used for hose, canvas goods, water buckets, and the like. Almost all fire fighting equipment except the heavy construction machinery can be dropped.

Numerous drops and observations, including motion pictures, were made to check for safety of operation. The original design proved so good and nearly foolproof that very little adjustment has been made, although packaging, chute sizes, and containers have been changed from time to time.

FIGURE 1.—Quickly attachable, light cargo rack constructed from conduit piping.

FIGURE 2.—Rack, containers, and fastenings.

Single, quickly attachable cargo racks are now available for each pontoon of the Stinson and Cessna 180 seaplanes and double cargo racks for each pontoon of the Beaver (fig. 3). By including a drop that can be made through the hatch of the Beaver, the three-

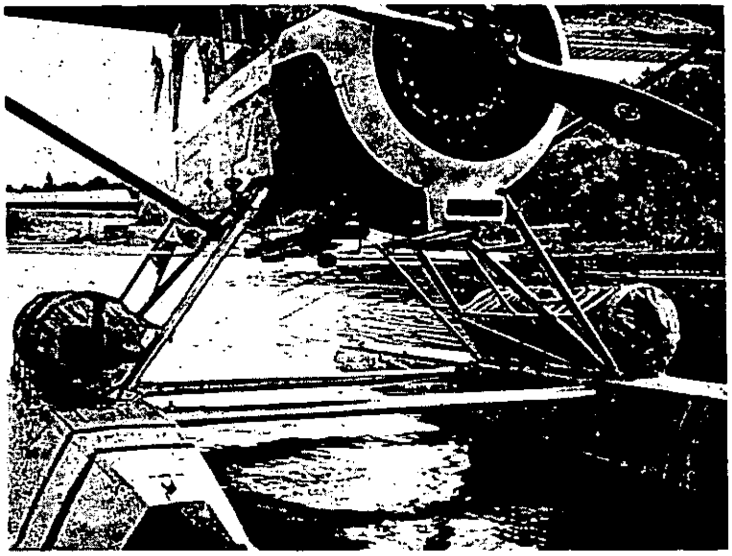

FIGURE 3.—Two containers mounted on each of the pontoons of DeHavilland Beaver seaplane.

plane fleet can deliver a total of nine drops of equipment and supplies individually or together. The many innovations available for packaging make it possible to drop almost all fire fighting equipment and supplies to suppression forces.

Weight of each container including parachute is held to a maximum of 160 pounds. Either the 24- or 28-foot military personnel chute is used (fig. 4). These parachutes are secured from military surplus and converted for cargo dropping. Lighter loads take a proportionately smaller parachute.

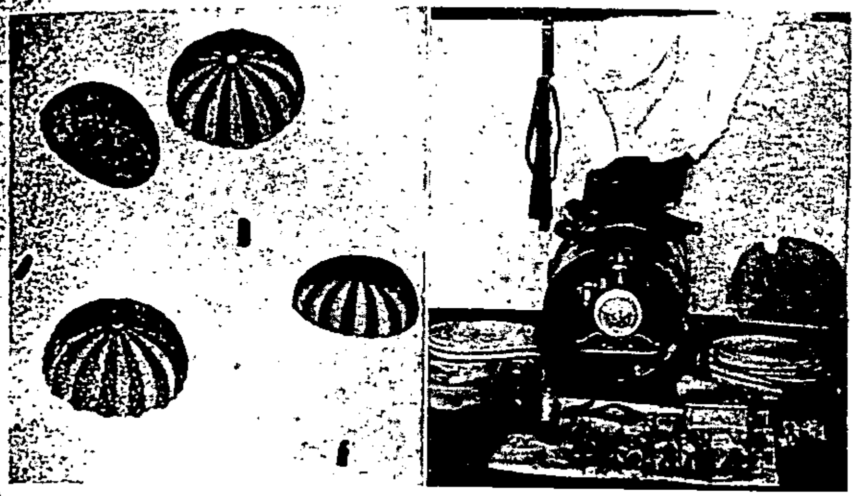

FIGURE 4.—*Left,* Simultaneous drop of four containers using converted 28-foot military surplus personnel chutes. *Right,* This container carries Pacific Marine Type A7 pumper, suction hose, 600 feet of 1½-inch linen hose, 1 gallon gas-oil mixture, nozzles, pumper tools, and spanner wrenches. Pumper is fastened securely to drum with bolts and wing nuts.

Depending upon terrain and wind conditions, drops are made from a height of 300 to 400 feet. Tests to date have shown very good accuracy. Pilots attempt to make drops as close to the fire as possible. Pumper and hose equipment is dropped to the nearest water supply. Up to now, where the container was properly packaged, no equipment has been damaged in the drop even though the container landed on ledge or rock.

Very important is the necessity of two-way radio communication, not only from a fire control standpoint but also for safety in clearing the area for dropping. Two-way radio, if not already available at the fire, is therefore the first piece of equipment dropped.

CARGO BAG HOLDER

KENNETH CALL
Dispatcher, Salmon National Forest

An easily constructed frame for holding a cargo bag while it is being filled was designed by the writer for the Salmon National Forest. The top of the cargo bag is spread and securely attached to the holder by four springs (fig. 1). The 6-inch platform (fig. 2) keeps the bag from moving away from the cargo packer and also provides a more convenient elevation for arranging packages.

Material list:

Plywood, 1 piece ¾″ x 24″ x 60″
2 pieces ¾″ x 24″ x 18″
Lumber, 4 pieces 2″ x 6″ x 24″
4 pieces 2″ x 6″ x 14″
4 pieces 2″ x 2″ x 44″
Screw eyes, 4 No. 4 or 6
Springs, automobile brake shoe, 4 about 6″ long
Light strap iron, 4 pieces 2″ x 8″
Carriage bolts, 8 ¾″ x 4½″
Wood screws, 1½″ (to fasten base and tops to boxes)
Nails or screws (to fasten 2″ x 6″ pieces to make boxes).

Construction details.—Nail or screw together two pieces of 2″ x 6″ x 24″ and two pieces of 2″ x 6″ x 14″ to make a box 24″ x 18″ x 6″. Repeat with the remaining four pieces. Fasten these boxes with 1½″ wood screws to the ends of the 24″ x 60″ plywood base leaving a 24″ x 24″ opening in the center. Set the four pieces of 2″ x 2″ x 44″ in the four inside corners of the boxes. These posts should be mortised in so that their tops will be about 22″ apart. Bolt each post to a box side and end with two ⅜″ x 4½″ carriage bolts (at right angles, nuts on inside). Put tops

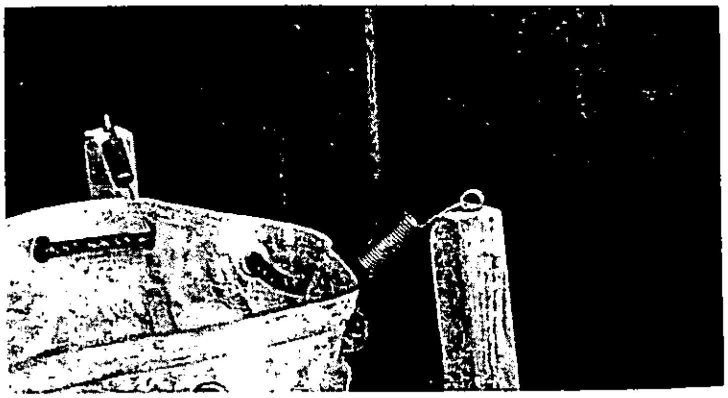

FIGURE 1.—Hooks on the ends of the springs are slipped into rope grommets to hold cargo bag open.

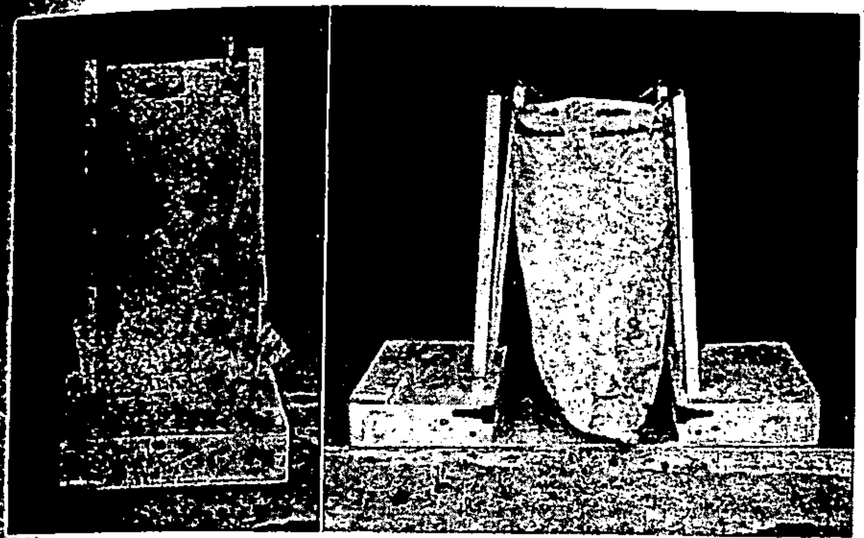

FIGURE 2.—Cargo bag holder. The plywood base acts as a spring and reduces shock on the four posts.

on boxes using ¾" plywood (or 1" material if more readily available). Fasten strap iron around each inside corner to reinforce posts. Make an eye in one end of each of the four springs and loop it through a No. 4 or 6 screw eye. Screw one of these into top of each post. Bend other end of each spring so it will hook into grommets of cargo bag.

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Aluminum Hard Hat Retainer

The use of chin straps to hold hard hats in place is objectionable to many people because the straps are uncomfortable and become loose easily.

A light, simple, and inexpensive retainer can be made from a piece of leather boot lace approximately 24 inches long. The ends of the lace are tied together, forming a loop approximately eight inches in diameter. This is attached to the hat by sliding the headband catches off and placing the lace behind them. The lace is fitted snugly to the brim around the front and sides of the hat, which allows a loop to drop down on the back of the head when the hat is worn. The loop can be adjusted to fit the head comfortably by pulling the lace under the slides toward the front of the hat.—*Albert H. Leuthauser, Forester, Williamette National Forest.*

UNIFYING FIRE DANGER RATING—A NATIONAL SYSTEM NEEDED

A. A. Brown

Director, Division of Forest Fire Research, U. S. Forest Service

Forest fire danger rating is now a little over 25 years old. Starting as an innovation devised by H. T. Gisborne and first applied in 1933 to guide the seasonal buildup of fire control forces in Montana and North Idaho, it has kept growing in importance and usefulness as a management tool for the administrator.

The concept of rating fire danger relates fire which is universal to environment which is local. It is only natural that this correlation, or combination should lead to some contradiction and to some confusion in thinking. Because the environment for the start and spread of fire in forest lands has infinite variation, efforts toward making danger ratings faithfully reflect its influence, have tended also toward detailed variation in the fire danger rating systems employed. These variations have become increasingly troublesome.

A regional system must necessarily reflect a variety of environments, yet it takes on a suggestion of highly localized adaptations and of fixed accuracy up to some jurisdictional boundary. Systems vary also in the purposes served, in their numerical expression, and in how they are to be interpreted. No one system is best. Each has its advantages and limitations. Each is serving a valuable function, and each has well repaid the time and effort devoted to them by fire research men and administrators. All require diligence in observation and reporting, and experience and skill in application for best results.

But further effort in this direction is not likely to be very productive. Individual refinement and administrative adaptation of the details of a variety of inexact danger rating systems is very time-consuming. It is not conducive to maximum contributions by research men and cannot contribute much to overall progress in fire control.

For maximum progress ahead, the time has come for fire danger rating to attain national status and for all danger rating to become part of a unified national system through a single project. This is a big task. It must take into account the universal response of fire to a few controlling factors, yet recognize just how these factors operate locally. The objective visualized is to develop a universal formula for rating fire danger and a more uniform method for giving it expression, but with full provision for substituting varying values in this formula to reflect local environment.

A 3-year project to produce a unified national system has been initiated. Mr. John Keetch was selected to head it up. In the following article he gives the history of the project and a brief progress report.

Further research in moisture and wind relationships under carefully controlled laboratory conditions will be necessary to establish points of reference for the national system. The help of a field committee which will soon be established will also be needed to resolve many other questions of systems and method.

UNIFYING FIRE DANGER RATING—PROGRESS TOWARD A NATIONAL SYSTEM

JOHN J. KEETCH
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Ever since the first probing estimate of the severity of burning conditions was made to guide fire preparedness planning, fire control men have earnestly searched for more reliable means to gage the current fire danger. Fire research technicians in all parts of the country have spent many years studying the problem, identifying the significant elements of fire danger, exploring methods of accurately measuring the key factors, and integrating the variables into useful ratings. In the past 20 years, fire danger measurement has progressed far beyond the trial stage, and is today universally accepted as an important tool in fire control management. The extent of use is emphasized by the fact that every day during the fire season nearly 3,000 trained fire danger observers, distributed throughout the forested areas of the United States, make careful measurements of fire danger elements according to accepted regional procedures.

Though there has been considerable progress in identifying and clarifying weather as a key variable, unfortunately the weather elements recognized, their method of measurement, and their integration in a scale of fire danger vary widely in different regions of the country. Since combustion and fire behavior follow the same natural laws everywhere, the multiple variation in existing fire danger systems serves to confuse rather than to clarify, particularly in interregional and national application.

In recent years there has been a growing determination to resolve this confusion. The possibility of standardizing fire danger rating methods was considered at the National Fire Research Conference held in Missoula, Mont., in 1955. The conferees agreed that standardization was technically feasible. The 1957 Report of the Fire Task Force, under the chairmanship of A. W. Greeley, stated the problem more urgently. The task force report strongly recommended that steps be taken as soon as possible to develop standard methods of rating fire danger. Although none of the fire disasters reviewed by the task force could be directly attributed to the confusion created by different danger rating systems, the report concluded that the situation was potentially dangerous because of the increasing interregional use of fire men, and the increasing use of fire danger data in all phases of fire control.

The need for better unification of fire danger ratings for use by Forest Service cooperators is also urgent. This need was emphasized by a request from the Bureau of Land Management for a single objective method of rating fire danger on their range areas. As a result of these and other recommendations, a joint committee of Fire Research and Fire Control men met in Washington January 1958, under the chairmanship of Dr. George M. Jemison. The group considered the needs for a unified rating system, the benefits to be gained, and agreed that a servicewide fire danger rating system was practical. The committee strongly recommended an aggressive development program which would result in the construction of a national fire danger rating system. Work on the project was started in the summer of 1958.

The first effort was directed at examining the problem region by region. As of May 1, 1959, a survey of the needs and uses of fire danger rating throughout the country, and a study of all the fire danger systems in current use, was completed. In all systems one of the major factors is the moisture content of the lightweight fuels forming the surface layer of the forest floor. In attempting to provide a more realistic measure of the complete litter drying rate, the majority of systems recognize two drying regimes, i.e., the surface drying and the buildup in the lower litter or larger fuel components. However, no two systems agree either on a standard for the surface litter, or the more complicated lower litter phase of the problem. In addition, drying in deep duff or organic soil to several feet below the surface is an important factor in many areas.

An objective of the national system will be to measure uniformly the effect of weather on standard fuels. To do this will require the development of several servicewide fuel standards as a first step. Work so far has been concerned specifically with the moisture content of surface fuels. A suggested standard for identifying surface fuels and an outline of the research needed to test the standard and to develop a method of measuring surface fuel moisture have been sent to all national-forest regions and experiment stations for review.

The moisture content of surface fuels was considered the first phase of the study, to be followed by development of separate standards and methods for measuring lower fuel moisture and deep duff conditions. The correlation and weighting of the standard fuels in a uniform fire danger system and their correlation with wind speed will be made.

One of the prime objectives of the national system will be to provide as accurate a measure as possible of the relative seriousness of burning conditions as an aid in fire control. To accomplish this objective, and to interpret the national system for local application in specific situations, a later phase of the study will be the development of separate fire indices that include fuel type and topography as variables.

USE OF THE 60-SECOND-PRINT CAMERA FOR STEREOPHOTOGRAPHY OF PROJECT FIRES AND RELATED ACTIVITIES

VINCENT J. SCHAEFER
Consultant, U. S. Forest Service

The polaroid system of photo reproduction is rapidly becoming a recognized and reliable tool in forest research and field activities. Perhaps the greatest advantage of the 60-second-print camera in Forest Service use is its rapid processing feature. In an activity so dependent on field evaluation, the value of an immediate visual record of a going fire, a lumbering operation, an insect kill, the progress on a new road, the site of a planned operation, etc., can hardly be overestimated. Since many pictures must be taken under poor atmospheric conditions, it is also of great value to be able to make an immediate check on the quality of the photo so that if necessary another exposure can be made.

STEREOPHOTOGRAPHY

The advantages and usefulness of stereophotography in forest and range practice are accepted facts. The 60-second-print camera has unique advantages for such use especially when combined with a small, reliable airplane. For fire suppression activities its value can hardly be overestimated. Although good stereo-pairs are simple to prepare, they result only if the camera is properly used.

In practice the most effective simple method for obtaining good stereo-pairs is for the observer to photograph the same object twice with a hand-held camera. The time between photographs is governed by the distance of the area of interest and the speed of the plane. As a general rule the photographic base line should not be greater than a quarter of the distance to the object. Thus if a fire is a mile away the base line should be in the range of 1,000-1,500 feet. In a plane traveling 100 miles per hour in calm air the time interval between photographs should thus range from 7 to 10 seconds.

The plane should be flown in a clockwise direction around the fire area or other object of interest. The distance is governed by the focal length of the camera. The photographer-observer is best equipped to decide this matter and should use the finder on his camera to advise the pilot. Photos are of best quality if taken through an open window. If this is not feasible the camera should be held with the lens nearly but not quite touching the window. During the photographing period the pilot should hold a straight course for the time interval between pictures and the photographer should pick out some feature of the subject in the center of the field and photograph it twice. The pilot should call the time although the photographer can also measure it in seconds by the familiar "one little second," "two little seconds" count down. Insofar as possible the photographs should always be taken with the sun to the rear or at right angles to the photographer.

With the quick-print camera the first photo is taken and immediately "pulled"; the second photo is then taken after the appropriate time interval. The second exposure is then "pulled" after the regular 60-second development interval.

If the photographs are of a fire and they are to be dropped to the fire boss it is recommended that the photos be coated while in the plane or slipped into suitable clear plastic envelopes. This latter procedure is recommended since it is possible for the observer to adapt the photos to stereographic mounting while the pilot is maneuvering for his drop run. The compass bearing of the photo direction, time, and date should be indicated on the mounted pair.

FILTERS

The filters that are available, including neutral, polarizing, and color filters, provide some of the most effective attachments to a camera. Experimentation will quickly establish their proper values for special purposes.

The "polascreen" is most useful in directions at right angles to the sun for cutting through haze, increasing contrast in critical directions, and controlling reflected light. The red filter provides high contrast for clouds and smoke against the sky or forest. A combination of red filter and properly oriented polascreen gives the maximum contrast possible. Proper orientation can be obtained by holding the polascreen over one eye and rotating it for a half turn. When the desired effect is attained the orientation with respect to the plane of the camera can be noted by the flats and numbers on the filter holder. If the polascreen is used with another filter it should be mounted on top so it is readily available for checking orientation.

With low light intensities a red filter may need to be replaced by a yellow filter. Rough rules based on Type 44 Polaroid can be given. A combination of red and polascreen filters gives an ASA rating of 10, the same as for 35-mm. Daylight Kodachrome. Good results are only achieved by practice and a few rolls of film used experimentally is a sound investment.

CONCLUSION

The 60-second-print camera can become a powerful tool in forest practice when properly exploited. With the present availability of 4" x 5" polaroid type sheet photos, all press type cameras become usable for this purpose. A special, relatively inexpensive attachment can be adapted to such cameras to greatly widen their usefulness. The 4" x 5" photos are large enough for use as illustrative material in reports. A little realized feature is that if protected from light, the negative which is normally discarded can be hardened in hypo and used as a first-class negative. For stereophotography the special quick-print camera turns out to be most practical and economical.

HEATER TO KEEP PORTABLE PUMP ENGINES DRY

EARL A. WEED
Fire Warden, Clatsop Tree Farm, Crown Zellerbach Corporation, Oregon

The problem of condensed moisture in the electrical components of small motors used to power portable pumps has been a constant source of trouble to all people connected with forest protection. This problem is especially acute in the Pacific Northwest coastal areas where cool nights with high relative humidity prevail. Several different storage methods have been tried at the Clatsop Tree Farm, but it was found that in a 2-week period enough moisture had formed in the electrical system to lower the output of the magneto 50 percent. This was sufficient to cause extremely hard starting, and in some cases rendered the pump unusable. The practice of starting each motor every 2 weeks and allowing it to run long enough to thoroughly warm the engine has been tried. This however is a costly, time-consuming job, as each motor must be taken from its stall and then returned. It was also found that if atmospheric conditions favored high humidity and low temperatures, excessive condensation was caused when the motor cooled. Therefore, there is a definite need for some device to prevent this condensation within the magneto. It is felt that the device described herein will economically and effectively fill this need.

The device consists of a sheet metal cone having a diameter of 10 inches and an altitude of 8 inches. At the apex of the cone a standard light socket, containing a 25-watt bulb is held in place by a radiator hose clamp (fig. 1).

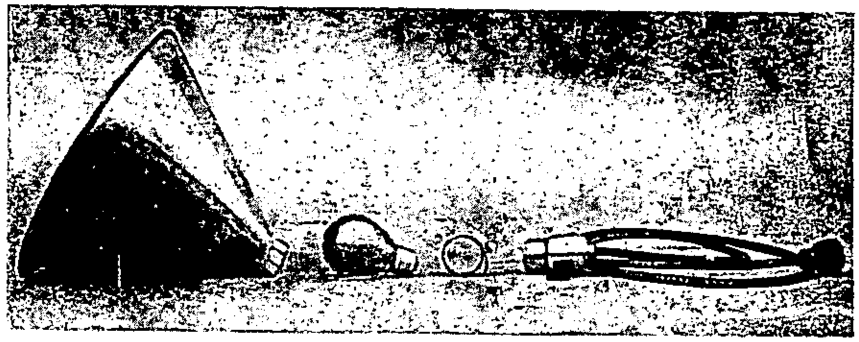

FIGURE 1.—Dismantled components of the engine heater.

The cone should be tailored to fit over the flywheel cover. The 10-inch diameter will fit most medium size motors. The cone is held in place over the flywheel ventilating screen by 2 sheet metal screws (fig. 2). To facilitate quick removal, the holes in the cones are elongated and the sheet metal screws are attached permanently to the motor.

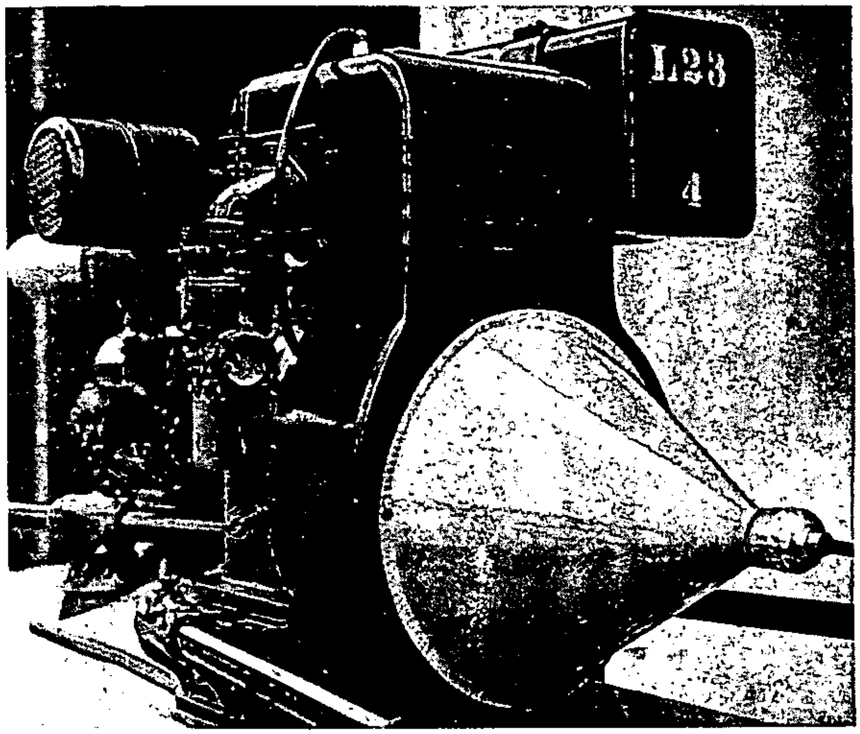

FIGURE 2.—Engine Heater fastened to the motor.

It has been found through tests that a 25-watt light bulb burned continuously is sufficient to provide heat enough to keep the magneto and breaker points dry enough to insure full output at all times. It is now only necessary to start the motors for periodic tests, thereby saving a considerable number of man-hours in periodic starting and in some cases, complete disassembly in order to dry out the magneto.

HOW FOREST FIRES WERE STARTED— CUMBERLAND AND MORGAN COUNTIES, TENN., 1953[1]

TENNESSEE DEPARTMENT OF CONSERVATION DIVISION OF FORESTRY AND TENNESSEE VALLEY AUTHORITY DIVISION OF FORESTRY RELATIONS

The Cumberland-Morgan County area is one of several high forest fire occurrence areas in the Tennessee Valley. Situated on the Cumberland Plateau in East Tennessee, it is fairly typical of the whole Cumberland Mountain area—not only in forest conditions but also in land ownership, agriculture, and industry. Eighty percent of the two-county area is drained by the Emory River, a troublesome tributary of the Tennessee.

The area is characterized by the rugged topography of the Cumberland Mountain Range and the rolling uplands of the Cumberland Plateau. There are few good access roads on the plateau and fewer still in the mountains. This makes rapid transport of fire fighting personnel and equipment impossible and increases the fire hazard.

Between 1945 and 1950 10 percent of the total forest area in Cumberland and Morgan Counties burned over each year. The average annual burn was about 67,000 acres. Under such conditions, watershed protection benefits are limited and long-term timber management is discouraged.

Although the Tennessee Division of Forestry had established organized fire protection in both counties in July 1949, too frequent fire occurrence continued to be the number one problem. Collaborating with TVA's Division of Forestry Relations, the State forester instituted an intensive prevention program in 1951. The objective was to reduce the number of fires through a concentrated attack on major fire causes. The project forester, employed by the State, tackled the well-planned project with energy and skill. However, experience in 1952, a "bad" fire year, was discouraging.

When representatives of the two agencies reviewed the project, they concluded that more precise and detailed information was needed on fire causes; recorded data appeared to be inaccurate. For example, past fire records indicated that 59 percent of all fires were caused by incendiarists. But careful observations during 1951 and 1952 led to quite different conclusions.

The project was accordingly revised. The direct prevention program was dropped, and the project forester concentrated on a detailed study and report of each fire. First he had to test and perfect a system for determining precise fire causes; then he had to establish the specific cause of each fire in the two-county area and the motivation behind the cause.

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[1]Condensed from *How Forest Fires Get Started in Cumberland and Morgan Counties, Tennessee,* [34] pp., illus. March 1954. [Processed.]

FIRE CAUSE ANALYSIS

The method developed for determining fire cause proved successful. Of the 238 fires that occurred during the dry year of 1953, specific causes were reliably determined for all but 9.

When the project was set up, determination of fire cause was listed as the project forester's primary job. This took precedence over everything else. He worked under the direct supervision of the State forester and had full freedom of action in conducting his investigations. Technical and advisory assistance was provided by TVA foresters as requested.

Although nothing was allowed to interfere with his fire investigations, the project forester did assist the district forester and TVA personnel with related forestry activities in the two-county area. As time permitted, he established two fire danger stations and one fire damage demonstration plot, organized 29 volunteer fire crews, conducted approximately 30 community meetings, and assisted with reforestation and timber harvesting demonstrations.

He was stationed in the local district office (Harriman) where he could get immediate notification of fires as they occurred. When in the field he maintained contact with either the district office or a "key" tower—one in each county was equipped to communicate with all other towers. He was thus able to begin his investigation of many fires soon after they started. This was important, because the quicker an investigation is started, the more likely it is to succeed. Actually he determined the precise cause of approximately 15 percent of all fires while they were still burning.

On each fire he first got all available information from towermen and fire crew leaders before making any inquiries in the field. This included date, time of day, location where first seen, how reported, etc. A towerman could often supply information on land ownership and the presence of hunters, fishermen, campers, loggers, or other persons in the area. In the case of debris burning or incendiary fires, he frequently could point out the exact spot where a fire had been set. Crew members could often provide information on point of fire origin and attitude of landowner (some people wanted their land burned over).

Next came a thorough search of the burned area for any evidence that might help establish cause—shell cases left by hunters, den trees that had been fired, remains of brush piles, burned stills, etc.

People living in the immediate area were then interviewed. Many times such questioning produced immediate positive information. In other cases, people were reluctant to express an opinion for fear of being "burned out" or otherwise harmed by the one who had set the fire. Discussions around general stores frequently revealed the name of the responsible party. As a general rule, at least five neighboring landowners were questioned about each fire. The primary purpose of these interviews was to get information, but they also served notice to a lot of people that the State was interested in eliminating forest fires.

When investigation pointed to a suspect, the project leader called on him and diplomatically informed him of the purpose of the investigation. Reactions varied. Brush burners usually admitted responsibility. While incendiarists and still operators resented being approached, they would often confess if tactfully handled. (Fixing *legal* responsibility was not a part of this project.)

The time required to thoroughly investigate a fire varies considerably. About 65 percent of the cases successfully concluded in this study were solved the first day; another 25 percent within a week. For the remaining 10 percent, some required intermittent investigation for as long as 2 months before the true cause could be established.

RESULTS

While the information assembled is for the two-county area only, it may be representative of a much wider area of the Cumberland Plateau.

Specific causes were determined for 96 percent of the 238 forest fires that burned in Cumberland and Morgan Counties during 1953. As data on fire causes, landowner attitude, and fire occurrence are quite similar, the two counties are treated as a single unit in this report.

The distribution of fire causes in 1953 was found to differ considerably from that previously reported. Debris burners, rather than incendiarists, were the chief cause. Sportsmen (hunters, fishermen, and campers) were also responsible for a large number of fires.

Precise causes were many and varied. The wide range, plus contributing reasons, argues strongly for some refinement in the standard classification customarily used.

Debris burners caused 35 percent of all fires. In this category are fires resulting from range burning, land clearing, burning tobacco beds, and cleaning fields, yards, and gardens. Only 7 debris burners out of 84 had taken any precaution to keep fires from spreading or becoming wildfires.

Sportsmen were responsible for 29 percent of all fires. Of the 68 in this category, 42 were started by hunters trying to smoke game out of den trees. The other 26 fires were traced to warming fires left by hunters, fishermen, and campers, their carelessness with smoking material, and an attempt to burn out bees.

Twenty-two fires (9 percent of the total) were found to be incendiary. Only those fires set with the intent to do harm (those stemming from meanness, spite, grudge, or revenge) were included in this category. For example, one involved an attempt to burn a church; another was a "cover up" for a still; another was set in an effort to obtain timber cutting rights. Those set with the idea of improving (?) woodland pasture or range were classified as debris burning fires.

Lumbering fires include those traced to burning sawdust or slab piles, loggers' warming fires, or their carelessness with smoking material in the woods. Fifteen fires (6 percent of the total) were thus traceable to lumbering.

Of the 11 railroad fires (5 percent of total), 5 were caused by fusees, the other 6 by sparks from engines. Diesels operating in the area were responsible for some fires. They, too, on hard pulls, throw off sparks capable of starting fires.

Twenty-one fires (9 percent of the total) were attributed to smokers. Where a smoker fire was traceable to one of the other causes, it was charged to that cause. That is, if a hunter caused a fire through carelessness with smoking material, the fire was classified as a sportsman fire. Only those that could not be traced to some other cause were called smoker fires.

Seventeen fires (7 percent) were classed as miscellaneous. Four of these resulted from children playing with matches, two from warming fires, and two from washpot fires. One was set for the avowed purpose of killing snakes.

The most surprising outcome of the study was that 54 percent of the owners of burned woodland were not concerned. They either wanted their woodland burned or didn't care one way or the other; and they didn't hesitate to admit their indifference. One landowner whose property burned summed it up this way: "Just don't see what it will hurt." Some landowners, however, do burn as a protective measure. They burn their woodland during February in an effort to prevent late spring and summer fires.

Responsibility for 32 percent of all fires was directly traceable to landowners. This does not include fires charged to sportsmen, lumbering, or smokers even though some of them were undoubtedly landowner caused.

Three-fourths of all fires originated from debris burning, smoking out game, land clearing, range burning, or maliciousness. Accidental fires—those caused by railroads, lumbering operations, careless smokers, and miscellaneous causes—accounted for only one-fourth of the total.

CONCLUSIONS

This project proved first of all that fire causes can be pinpointed with a high degree of accuracy and that facts essential to a sound fire prevention campaign can be assembled.

The records show no concentrations of fires by causes, except in the case of railroad fires. It appears that forest fires can be expected anywhere in the two-county area from any cause.

Posting land against hunters appeared to be a basic cause for several of the "spite" fires set by incendiarists. One landowner who posted his land prior to the hunting season, found practically all of it burned that fall. He removed the signs the following year and had no fires.

Landowners are predominantly indifferent toward fire regardless of how much land they own. Owners of small tracts seem to be a little better informed about fire damage, but more than 40 percent of them favor burning or just don't care. Only 46 percent of those whose land had burned had definite convictions against forest fires.

Woodland in absentee ownership was the target of many fires. There seems to be little local respect for any land lacking constant custodial supervision. Wildfires controlled by local residents on their own land are often allowed to burn freely on land having no local custodian. Unauthorized backfires are also more common on these woodlands than elsewhere.

Apparently the distribution of fire causes is affected by changes in land ownership pattern, local employment conditions, and the industrial picture generally. For this reason fire causes should be checked periodically to keep prevention programs on the right track.

There seems to be a strong correlation between number of fires and class of fire day. Ability to forecast fire danger accurately should be helpful in planning prevention activities.

Day of the week is apparently unimportant in fire occurrence—one day is as bad as another. As could be expected, more fires started during the day than at night; 85 percent originated between 8 a.m. and 5 p.m.; more started between 1 and 3 p.m. than in any other 2-hour period.

A man assigned to this type of project should be adept at meeting people. He should be capable of mature judgment, based on a careful sifting of facts. He should be thoroughly familiar with the policies and procedures of the fire control agency and have some understanding of the customs and habits of the local residents.

HOW FOREST FIRES WERE STARTED—NORTHERN GEORGIA AND SOUTHEASTERN TENNESSEE, 1957[1]

GEORGIA FORESTRY COMMISSION, TENNESSEE DEPARTMENT OF CONSERVATION, AND TENNESSEE VALLEY AUTHORITY DIVISION OF FORESTRY RELATIONS

For years the Georgia and Tennessee counties surrounding Chattanooga have been plagued by an extremely high number of forest fires. As far back as the early 1940's, foresters and landowners have sought answers to this perplexing situation.

In 1956, Dade and Walker Counties, Ga., and Hamilton and Marion Counties, Tenn., had next to the highest incidence rate in the Tennessee Valley. They had 724 fires in 1953, 826 in 1954, 519 in 1955, and 626 in 1956, an annual average of 91 for each 100,000 acres of forest land. The 20-year average (1934-53) for the 125 Valley counties was 41 fires per 100,000 acres.

State organized protection was established in Hamilton and Marion Counties in 1949. Dade County was organized in 1944, Walker County in 1950. As suppression forces became better trained and equipped, the area burned dropped sharply. However, there was little appreciable drop in number of fires.

In 1957, the Georgia Forestry Commission, Tennessee Division of Forestry, and Tennessee Valley Authority joined in a survey to determine the precise causes of fires, who is responsible, why people permit forests to burn, and what they think about forest fires in general.

DESCRIPTION OF AREA

Total area of the four counties is 1,069,000 acres, 71 percent is forested. Much of the forested area lies in the Cumberland and Lookout Mountain extensions of the Appalachians.

The rural population—177 persons per square mile—is more than two and one-half times as dense as that in the surrounding counties. Some of the rural wage earners are coal miners and woods workers, but most of them are part-time subsistence farmers with regular employment in Chattanooga, Rossville, or Lafayette.

Many business, professional, and political leaders had expressed interest in better fire protection and development of timber resources. Some landowners had been practicing forestry for more than 15 years. Radio and TV stations and the press were interested and cooperated in conservation projects. Several wood-using industries supported and participated in forest protection and development programs. Spotting past fires on maps revealed 11 definite concentrations in the four counties. These included only 22 percent of the forest area but accounted for 53 percent of the fires.

[1]Condensed from *How Forest Fires Were Started in 1957 in Northern Georgia and Southeastern Tennessee*, [13] pp., illus. May 1958. [Processed.]

FINDINGS

Every one of the 112 fires that occurred in the 11 designated areas during calendar year 1957 was investigated. Cause was determined with a high degree of confidence for 100 of them. The causes varied widely, as did the conditions under which fires occurred.

The pattern of debris burning (household, agricultural, garden, and dump burning) was pronounced in four areas. In two areas, fires originated from burning household refuse—paper and other trash. Burning is done at edge of yard, usually at the back of the lot. The fire is left unattended and escapes either directly into woods or through adjoining grassy area into woods. Adults, mostly housewives, were usually responsible. In another area, most fires start when new ground is being cleared for strawberries. Brush and small trees are cut and piled or bulldozed into windrows and then burned. Because material is green, burning is usually done on dry, windy days. In still another area, fires can be expected at spring gardening time. Early gardening and windy weather coincide. In some cases the clean-up is done simply by setting fire to the dead grass, weeds, and briars and letting it spread over the garden.

Who started the fires? Housewives and farmers led the list with 19 and 18 percent, respectively. Children were responsible for 14 percent, woods workers 11 percent, general laborers and factory workers 9 percent each. Six percent were caused by coal miners, 6 percent by unemployed persons, 3 percent by garbage collectors, 3 percent by moonshiners, and 2 percent by store clerks.

Why do so many people let the woods burn? As revealed by this analysis, they don't do it deliberately. Of the 112 landowners involved, 102 were opposed to woods burning, 5 indifferent, and 5 noncommittal. And yet, 26 percent of the fires were started by landowners. In 81 percent of the cases no precautions were taken to keep the fire from spreading.

Fires occurred most frequently between 1 and 4 p.m. Saturday was the worst day of the week. Incidence build-up began on Friday, reached a peak on Saturday, and tapered off to a low on Wednesday and Thursday. Fires caused by men were most frequent in the early evening. Fires caused by women followed no set pattern. Two-thirds of the fires occurred during the spring fire season, one-third during the fall season. March was the "hottest" month with one-third of the total.

FOLLOWUP

The survey and analysis revealed nothing of an unusual nature that would require major revision of present prevention programs in either State. It does indicate the desirability for some "tailoring" of present methods to fit each area. The occupational and habit patterns of local residents differ by areas even though fire causes are similar.

A fire prevention program, based on survey findings, was developed by a committee representing field forces of the three cooperating agencies and put into effect by the two States. These are some of the activities undertaken:

1. Personal contacts were made in the neighborhood of each fire. There were many indications from this survey and analysis that inquiries about fires have a deterrent effect.

2. Eighteen industrial establishments (over 250 employees) were supplied with enough fire prevention posters to service their safety bulletin boards for a year. Purpose was to reach the group of debris burners who work at plants but live in the country.

3. Three television stations were supplied with 23 appropriate film shorts; seven radio stations with 45 platters. Five newspapers were given weekly forestry material for publication.

4. Foresters discussed fire prevention at meetings of the local strawberry growers association and District 50, United Mine Workers.

5. Some 400 landowners received five pine seedlings each. They were given to all persons who had started fires, and also to some of their neighbors. Purpose was to create interest and ease followup contacts.

Other plans included:

1. Development and selective distribution of a poster on how to burn household refuse safely.

2. Encouragement of more citizens to report fires. To accomplish this, the States would provide better information on how and where to report fires. Telephone companies would be asked to list "How to report a forest fire" under emergency calls in telephone directories. Persons who reported fires would be telephoned later as to what action was taken and size of the fire.

3. Continuation of semi-annual meetings of the interagency committee on forest fire prevention to evaluate past prevention techniques and to develop new ideas.

4. Use of tree planting as a fire prevention tool: (a) Continue the practice of distributing a bundle of five pine seedlings to persons who started fires and to their neighbors; (b) canvass residents in a very limited area of high fire occurrence to determine interest in planting 100 tree seedlings each supplied without cost. This would be done as a club project aimed at creating interest in forest fire prevention.

5. Demonstrations to be held in cooperation with Home Demonstration Clubs on how to burn trash safely in the vicinity of woodlands.

The general public is becoming more and more aware of the effect of forest fires on timber resources and watershed values. However, there are local areas where the damage is not fully understood or appreciated, where further educational work is needed. While the effectiveness of steps now being taken cannot be evaluated for several years, some comparisons should be possible by 1960. By then, there should be a reduction of 300 fires. The rate should be down to about 40 fires per 100,000 acres of forest land. That is the immediate goal.

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.

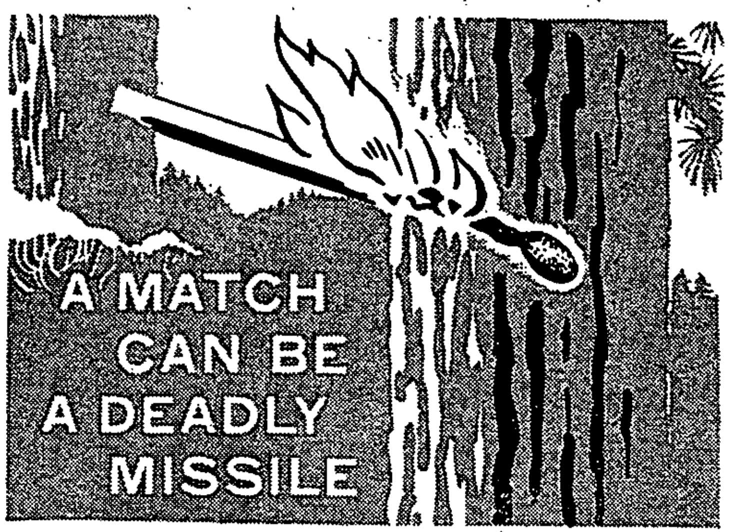
The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

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 in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. 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 illustrations. 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.

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



Prevent Forest Fires!