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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 16 Number 1

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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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CONTENTS

PRIMARY BASES AND IDEAS FOR FIRE CONTROL PLANNING ON CALIFORNIA NATIONAL FORESTS

S. B. SHOW[1]

Fire control planning is taken to mean the rational determination by professionals of that balanced and integrated assembly of forces, means, and methods calculated to hold fire losses to predetermined maxima, regularly and in each resource management unit such as watersheds, working circles, and range allotments.

In the area discussed, identification and measurement of the many independent variables involved and synthesis of findings of fact and informed estimates into fire control systems were brilliantly begun by Du Bois in 1913 and have been continued by others, at variable intensity and pace and with variable ingenuity, imagination, boldness, and method. Concurrently, allowable burn goals have been set and reset at irregular intervals, most recently for northern California in 1930 and for southern California in 1939.

The philosophical ceiling of planning, except on a few small timber sale and watershed areas, has been to hold losses to goals under the *average* worst conditions expected from the recorded and short period (now circa 45 years) experienced in organized fire control. Acceptance of this limited ceiling in and of itself insures that losses must exceed the tolerable limits under worse than average worst conditions, and thus that losses as averaged for almost any term of years will exceed the allowable.

The actual fire record is dominated by the fact that no design system has ever been fully applied. Closest approach to full application was of the order of 80 percent, during early C.C.C. and early World War II years. Currently the rate is of the order of 60 percent. The compound effect of inadequate design incompletely applied goes far to explain in general terms the continued frustration in attaining the goals set by the Forest Service for itself. The annual Regional Board of Fire Review, begun in 1924, regularly identified major fires which became large because of such deficiency factors as indirect visibility and consequent delayed discovery; unavoidable longer than standard travel time by first attack forces; unavoidable lower than standard first attack strength of both men and machines. Such built-in quantity defects inevitably lead to larger than necessary fires, except under conditions of less than average difficulty.

A further general fact, contributing to the record, is that more than a few small fires are lost and move on from A and B to C, D, E small, and E large because of less than superior quality of initial attack, a condition resulting primarily from employment, training and equipping policies and practices imposed by budgetary authorities, and by the commonly exceedingly tight fits in quality of first attack as imposed by nature. The Board of Review also identi-

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fied many first attack failures resulting in large fires which were chargeable to mediocre or insufficiently trained leaders who, faced by the instant moment of decision on a brisk small fire, selected the wrong course. Such quality defects, too, are good enough only under conditions of less than average difficulty.

Concurrently, too, the physical difficulties and magnitude of the problem have continued to grow. Very rapid initial spread has become more general. Volume of fuels and resistance to control have increased greatly. Industrial and recreational use, and thus exposure to risk, affects a larger area each year. Utilization of timber, overutilization of range, type changes caused by fire have greatly increased the fast-spread, high-hazard area. The frequency of critical or difficult seasons, judged by their own context rather than by absolute standards, averaging 3 out of 10, shows no tendency to decrease. The most recent major lightning storm caused more fires than any predecessor.

In total, we deal with persistent, frequently recurring and increasingly difficult control problems on a larger and larger area. These form the general terms of the problem.

A broad perspective of the total effect of the several inadequacies and unbeneficial changes is given by the facts that during the period 1921-50 the annual burned area on the 13 or 14 northern California national forests *as a group* has been held to allowable only 6 times; on the 4 southern California national forests only once; for the Region as a whole only 4 times. Using individual national forest and year record as the unit and for the same period, the allowable has been exceeded in northern California in 172 out of 390 cases and, omitting the Eldorado and Inyo, in 166 out of 330 cases—just about half; in southern California, in 76 out of 120 cases; for the Region in 248 out of 510 cases. Of 18 national forests, 16 repeatedly fail to hold losses to allowable.

The indubitably intolerable forest and year records (arbitrarily those with 10 times annual allowable) number for the 30-year period 43 in northern California, 20 in southern California.

In northern California the trend has been toward reduction in the frequency by both measures; in southern California the lowest frequency was in the decade 1931-40. But in the north, 42 out of 130 cases in the decade 1941-50 exceeded allowable and 9 out of 130 cases exceeded 10 times allowable. In the south during the period 1921-50 there have been 10 seasons, or one-third of total, rated as critical or more difficult, as judged by frequency of bad forest and year records—further indication of the persistence of the imbalance between end and means.

Perspective then would say that the concurrent significant and continuing advances in means and skill have slowly gained on the goal in northern California, but have by no means attained it; in southern California have lost ground from a high point still very far from the goal.

Similar criteria applied to resource management units would surely yield depressing conclusions. It is axiomatic that a satisfyingly low burned area figure for a national forest, subregion or region, type or group of types, conceals severe damage to or wreckage of individual resource management units. To hold losses in such units to tolerable size involves holding individual fires to not over say 1,500-2,000 acres.

One general conclusion from all of this would seem to be that the case for "adequate protection" has never been made so convincingly that budgetary authorities feel compelled to act on it. The thing proves itself.

This note tries to suggest some of the kinds of information and some of the kinds of consideration which, viewed in perspective, would support powerfully a really full-scale program, such as is required to break out of the past and present losing stalemate. The methods, techniques and content of planning, and plan are not dealt with. It considers the basis for planning rather than planning itself.

The first item might be a re-examination of goals, which in northern California stand at 0.2 and 0.5 percent average annual for timber and brush types. Both were set by informed judgment (1930) when: (1) Complete destruction of timber stands by fire was far less prevalent than today. (2) Great areas were appraised at zero or negative value stumpage, as were the true firs generally, and there was much informed pessimism as to whether such areas would ever be used. (3) The potential of fires in low-value temporary fire-caused types to smash into and destroy adjacent high values was clearly given less than full weight in the brushfield objective. (4) Very much more area was untouched by logging or other fire-causing uses.

Today the once negative value areas and species are salable at rates several times as high as the 1930 rates for then accessible pine. It would seem then that what was good enough for negative value or $2 stumpage is not good enough for $10-$20 stumpage.

The allowable rate for brush areas is particularly weak. As to watershed values, the figure 0.15 percent, set for southern California in 1939, is fairly solid. Like stumpage, water values and thus watershed values have zoomed from speculative to actual in many places.

The effect of greatly intensified demand for resources, created by explosively growing population and expanding economy, is to reduce tolerable loss rates; this relation can be grasped by intelligent laymen.

Point two might be the accumulated effect of fire losses on the total pool of timber, most simply expressed as the area of nonrestocking brushfields. The present total of 2.1 million acres found by disciplined survey methods is almost 20 percent greater than that found 35 years earlier by ground examination, using far less exact methods. The most elementary totaling of known major fires only would confirm that loss of productive timber area has not been halted. That, to repeat, is simply not good enough for the kind of economy and society now existing.

A nagging question which has to be faced as point three is an estimation of the worst possible that might occur—that is, a finding broadly comparable to the "design storm" of the engineers.

It seems to be generally agreed by experts that post- or interglacial periods are characterized by irregular and pulsating desiccation. Such things as the drying up of evaporation pans in the Great Basin, the retreat of the big trees to most favorable islands in the Sierra, the isolated relict stands of conifers on southern California mountaintops, all tend to confirm the conclusion that the current period is indeed one of desiccation.

Climatic pulsations of the geologically recent past have been demonstrated and dated by tree ring analysis. Within the short period of formal weather records, drought-sensitive trees reflect in ring growth the fluctuating ups and downs of current or immediately preceding seasonal precipitation, and it is thus a fair assumption that growth reflects seasonal precipitation for earlier periods.

Using drought-sensitive big cone spruce in southern California Schulman found that, for example, the 27-year period 1571-97 had twice as great an accumulated deficit as that of any period during the century of weather record; that ring growth in individual years during that period was as little as 5 percent of average, whereas from 1896-1944 growth has never been less than 25 percent of average. During the latest dry period measured by tree rings, 1924-34, average minus departure from average was 15 percent; during the 1571-97 period it was 24 percent.

Huntington's earlier work on bigtrees showed irregular pulsations in ring growth of varying duration and degree of departure from average, back more than 3,000 years. Within the short period of weather records he, too, related growth to seasonal precipitation.

Fire control people would at once insist that short-period conditions within a season commonly are more controlling on fire behavior than the general character of the season. Generally dry seasons such as 1913 (73 percent) and 1925 (67 percent) may be easy fire seasons because of favorable distribution of precipitation; or like 1924 (57 percent), 1928 (72 percent), and 1929 (73 percent) they may go down in fire control history. Or generally wet seasons such as 1922 (155 percent) or 1944 (125 percent) may have great fires due to short unfavorable periods; or like 1935 (127 percent) and 1937 (178 percent) they may be pointed to with pride.

The point is that the ring-measured dry period 1924-34 produced 6 critical years ('24, '26, '28, '29, '31, '34) whereas the 1935-44 wet period produced but 3 ('36, '39, '44).

It would seem prudent to assume that the worst possible, as measured by length and depth of rainfall deficit periods and excessive departure from average of individual years, has not been experienced during the brief half-century span of organized fire control.

One measure of worst possible for short periods as experienced to date is the fire spreading with great rapidity from the start, making a great and continuous first run of say 10,000 to 20,000 acres, and on which the verdict is that standard first attack by conventional means is ineffectual. Such fires always occur where annual grass is the fire carrier. There have been but few, but they still happen. Whether the worst possible, as thus measured, has happened would seem uncertain.

Another measure of short-term worst possible is the "dry" lightning storm causing so many starts that large areas are saturated and standard control forces are overwhelmed. The latest experience (1951) being worse than previous recorded worst, suggests that worst possible has not been experienced.

In total it seems strongly probable that worst possible, by whatever single measure and particularly as a theoretical combined total (e.g., excessively dry season in prolonged and deep dry period; critical period within season; numerous simultaneous starts in fast-spread types and/or poorly accessible areas), has not been experienced.

A fundamental preparation to planning and to forceful and convincing presentation of the case is thus estimation of the worst possible—the design fire situation. A study of the design fire situation which created a fire storm and overwhelmed the then control forces in Victoria, Australia, in 1939 might afford a sobering background for appraising the potential locally.

Budgetary people have been trained, albeit reluctantly, to accept professional planners' design for such costly public necessities as flood control dams, battle fleets, air forces, highway systems, school systems. Fire control planning, as a profession, has by no means established the basis for and the validity and inexorable inescapability of its findings to the same degree.

Fire control planners can learn from other professional planners such as those noted, and particularly in the arts and skills of presenting the case in unified and understandable simplicity. The air force talks of the wing, which by design and definition carries supporting and ancillary services. The unit for the navy is the battle fleet—and design supports. Highway planners deal with peak capacity. And so on. The essential components of fire control design, once the goal is set, are understandable by the intelligent layman, if they are put that way.

On experience and aiming to prepare for estimated worst possible, planning to design situations deals with two general cases. These are:

1. The more widespread areas for which first attack plus followup, standardized as to speed, strength, and quality are calculated to do the job. Here nature, expressed in rapid initial spread, leaves no room for fumbling, and imposes the need for an elite corps of first attack leadership. Planners will have to devise arithmetical measurements of the vast difference in results (in a word, failure or success) between mediocrity and superiority in first attack. From such a documented finding will follow recognition of the measures required to attract and hold elite quality men.

Both quantity and quality questions are involved.

For a good many years it was possible to concentrate first attack coverage on the well marked zones in which fires had started, and to go light on the considerable areas free from starts and those, such as true fir types, where slow attack was sufficient.

Expansion of use, particularly logging, has increased area subject to risk, and has changed large areas from old growth to cutover. Probably prudence now dictates full coverage of all areas.

2. The more specialized areas where runaway starts cannot be caught by standard attack. Perhaps no more than 1 to 3 percent of starts on the annual grass areas are involved, but areas burned, costs, and losses from this minority of fires are excessive and will continue to frustrate the whole project on many national forests.

Special measures in addition to standard attack are dictated by nature. Rigid exclusion of risk, moving use from fire to nonfire seasons, fireproofing of risk areas, block control, insulation from adjacent risk areas, change of cover and fuel type from more to less hazardous, intensification of control organization, particularly in quality: all have been tested on a limited scale but not persistently for a long period, and all, when and while fully applied, have proved effective.

Here planners must establish and sell a new and unavoidably costly idea. Integral to a really competent design and to operation of a resulting organization is a group of supporting technical services, lacking which operations will falter. Included are definition of hazard conditions and sure forecasting of them; research in fire behavior, fire equipment, and prevention and control methods; continuing analysis of operations and of changes of the localized terms of the problem; improvements in teaching material and texts and in training programs; intensification of recruiting and selection programs; devising and improving methods for making desirable type changes and large scale programs to apply them. For each of these, work has been done and is under way, but to a scale and at a pace far below evident and imminent needs.

Competent planning deals with things—numbers of lookouts, first attack crews, tankers, line-building machines; miles of telephone lines, roads, trails; back-of-the-line specialists—all the complex array, each element of which has a significant place in the whole, and which can be packaged in terms of major fire control units, thus attaining simplicity and avoiding confusing complexity.

All of these have price tags which, compared to the vanished unit costs of not many years ago, are shocking. But they must be faced and made as palatable and inescapable as may be to reluctant budget authorities.

Much of the noncontrollable increase in unit costs comes, of course, from reductions in buying power of money, both for things and people; from softer terms of employment—8-hour day, 40-hour week, overtime; from a sharpened social conscience—camp sanitation, safety measures; from the monstrous ballooning of formal requirements for paper work. None of these is controllable by the Forest Service.

But the most binding change in price tag is in the annual cost of the superior guard or crew leader. For many years the Forest Service got and retained many good men on the basis of employment during fire season only. Interest in the job was one element. A liking for or acceptance of an economically unstable streak of lean and a streak of fat life was another. But the absence or scarcity of superior competitive employment—in the sense of long-term or yearlong employment, wage rates, chance to advance and/or reasonable assurance of a career job was the dominant element. In taking advantage of its superior power as an employer, the Forest Service long held down costs—and failed to establish the guard position as a desirable career job.

Planners have to accept that to get and hold men of the superior quality dictated by the basic terms of the problem, the erstwhile short-term guard job has to be recalculated and built up to meet competition in a world where good men can demand and get job security and continuity at competitively set levels of wages and supplemental benefits. The inescapable fact is that a fire control system, however well designed, is no stronger than the men operating it. Mediocre quality of the human material causes structural failures as great as do substandard steel and concrete in an otherwise well-designed flood control dam. Design includes strength of material as well as kinds and quantities.

If the inevitable and noncontrollable terms of the design problem are accepted, the resultant design will have a very large number of man-days per year available for other useful work outside the fire season and during low-hazard periods within the fire season. Vast quantities of such work lie undone outdoors in each protection unit. The totality can readily be broken down into smallish projects, each of which can be defined by specifications removing the magic and mystery from technical works, and thereby come within the competence of first attack crews and leadership. Any officer can draw up a long list of projects which, as accomplished, better the chances for success of the fire control project as a whole.

Fire control planning thus has boundaries broader than those commonly accepted in the legalistic formalization of budgets. It is, for example, vital to displace cheatgrass with crested wheatgrass on areas where such a type change will most benefit the fire control project rather than on areas most favored by cowmen, cows, or grazing experts. So for establishing, tending, and fireproofing timber stands to replace brush on areas most beneficial to fire control rather than on areas most favored by timber experts. So for tending and fireproofing already established stands, etc.

An idea to be worked out and sold is that fully feasible and planned out-season use of a full design fire control system will both, over a term of years, decrease the fire control job and increase the usable pool of resources. This is basically a bargain—a two for the price of one deal—and has a greater allure than the essentially negative idea of avoiding or preventing losses. It is well to appraise the political potency of "reforestation," "range reseeding," and "upstream flood control," which are positive and satisfy the deep inner urge of nontechnical people of good will for constructive ideas and programs to support.

It is worth speculating, too, whether a more specific identification of resource development programs as a handmaid of fire control—a two for one deal—might not greatly increase the political potency of such propaganda. A successful marriage of the "adequate fire control" and "resource development" ideas, plans, and programs would, it is submitted, strengthen both.

Any study of, and pondering over, the fire control experience to date in this persistently difficult area must accept that the problem is not solved and will not be solved by a deficient and partially applied design. No matter how skillfully and luckily the available means are spread; no matter what the devotion to duty of the people concerned; the past and current imbalance between means and end must continue to produce insufficient results.

The central idea of this note is that the prime need is to restate and redefine the problem and needs in their true nature and stature as proved the hard and costly way. This imposes acceptance, measurement, and pricing of new ideas and concepts, some of which are suggested, and are widely accepted in dealing with other sorts of public programs for no more convincing reasons than apply to the fire control project. The real public cost of inching along toward the unattained and perhaps receding goal can be and needs to be restated emphatically and convincingly.

Imaginative, bold, and unifying ideas are prerequisite to a level of fire control planning which may hope to break out of the straightjacket of chronic undernourishment.

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FIRE EXTINGUISHERS, THEIR TYPES AND USE. II. THE DRY CHEMICAL EXTINGUISHER

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Everyone should have a basic knowledge of fire extinguishers and the type or class of fires on which these extinguishers are effective. No one type of fire extinguisher is effective on all classes of fires. These classes are as follows:

Class A fire.—A fire in paper, wood, cloth, excelsior, rubbish, etc.—or what we call forest fuels. For Class A fires the *quenching and cooling* effect of water is required.

Class B fire.—A fire in burning liquids (gasoline, oil, paint, cooking fats, etc.) in which a *smothering* action is required.

Class C fire.—A fire in *live* electrical equipment (motors, switches, fuse boxes, transformers, appliances, etc.). A *nonconducting* extinguishing agent is required.

To be sure, a fire may start as one class and then quickly develop into a second class—or even a third. In this case, it is necessary to use one or more types of extinguishers or methods to control the fire.

Let's remember, too, that fire extinguishers are first-aid treatment only. It's the old rule of "get 'em while they're small." There are three basic rules in extinguishing a fire with an extinguisher: (1) Locate the fire, (2) confine it so that it will not spread, and (3) extinguish it.

Now that we have the classes of fires in mind, let's go on to the basic types of fire extinguishers and the classes of fires for which they were designed. There are five basic types. Each major manufacturer has his own design. There are also variations within the type. The basic types are: (1) Carbon dioxide (CO_2); (2) dry chemical (dry powder); (3) water; (4) foam; (5) vaporizing liquid. In this article we will discuss the dry chemical extinguisher; the discussion of the others is planned for publication in other issues of Fire Control Notes.[1]

Dry chemical is a Class B and Class C extinguishing agent. It extinguishes a fire by cooling and smothering. The chemical is primarily sodium bicarbonate (baking soda) with a moisture inhibitor added to prevent caking and to permit free flow.

[1] *Fire Extinguishers, Their Types and Use. I. Carbon Dioxide Extinguishers*, by A. B. Everts. Fire Control Notes 15(4): 1-5. 1954.

Actually, the dry chemical extinguisher is not new. It is only during the last few years, however, that it has gained the favorable acceptance it rightly deserves.

Many of us remember the old tube extinguishers, the kind you'd jerk off the wall (to remove the lid) and scatter the contents over a fire with a sweeping motion. The chemical in the tube was sodium bicarbonate. The inefficiency of these tube extinguishers was due to three reasons: (a) Usually there was no moisture inhibitor in the soda with the result that the chemical caked; (b) a sweeping motion of application would not produce a "cloud" as is possible with pressurized extinguishers: and (c) all too frequently the extinguishing agent was used on a Class A fire, for which it is not intended.

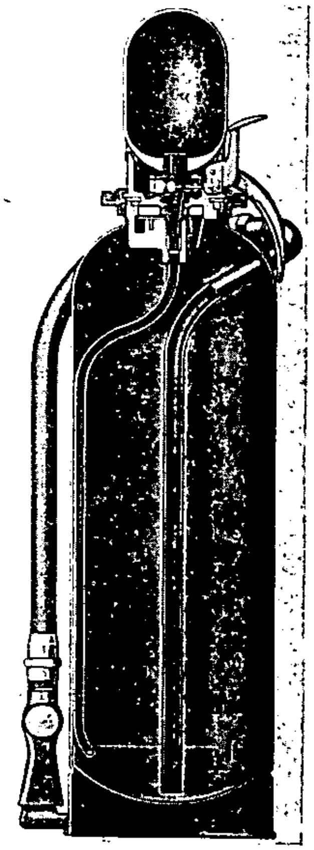

FIGURE 1.—Cutaway photograph of a modern dry chemical pressurized extinguisher. The CO_2 expelling cartridge is in the top. Other types carry the cartridge on the side, or inside the extinguisher shell.

The first CO_2 pressurized dry chemical extinguisher in the United States came on the market in 1928. It was the product of one company and certain patent rights prevented general manufacture until the patent expired. All the major extinguisher manufacturers now have their own designs and sizes.

How the extinguisher works.—Figure 1 is typical of the working parts of a modern dry chemical fire extinguisher. When the CO_2 gas in the oval cartridge is released, the gas is conveyed to the bottom of the cylinder through the tube shown on the left. This action tends to "fluff up" the chemical in the bottom of the cylinder and force it to the hose line through the center tube. Most nozzles have a squeeze operating lever which permits the application of the chemical intermittently or all at one time.

The great majority of the hand extinguishers are pressurized with CO_2 cartridges. A few of the smaller units are pressurized direct (without cartridges) with air or nitrogen. This type is provided with a pressure gage so that the pressure can be easily checked. Large 150- to 350-pound wheeled sizes usually use nitrogen for pressure (drier than CO_2). These types have hose lines and the nozzle is usually a horn similar to the kind used on CO_2 extinguishers.

Since only a small amount of CO_2 gas is used in expelling the chemical, it isn't necessary that the extinguisher shell withstand excessive pressures as is the case with the CO_2 extinguisher. For this reason the dry chemical extinguisher is relatively light in weight per unit size. The large wheeled types, using cylinder nitrogen, are provided with pressure regulating valves.

How the chemical works on a fire.—The fine chemical is emitted in a cloud. Reach, or projection, is 8 to 12 feet in the hand sizes as compared to 6 to 8 feet for CO_2 extinguishers. The large wheeled types have a projection of from 20 to 25 feet.

The spectacular performance of dry chemical on a fire is due to three reactions:

SMOTHERING: The fine cloud of dust displaces the oxygen.

COOLING: The fine particles of chemical have the physical properties to rapidly absorb heat. The intensity of the fire is very rapidly decreased.

CHEMICAL: When exposed to sufficient heat, sodium bicarbonate will break down and release carbon dioxide and water vapor. This reaction takes place in the flame area. An exceedingly hot fire will bring about this chemical change simultaneously and much quicker than a fire of less intensity.

As mentioned earlier, dry chemical is essentially a Class B and Class C extinguisher. Its most spectacular performance will usually be on a Class B fire. The chemical is a nonconductor and is safe to use on Class C fires. However, certain types of Class C fires, such as a fire in an electric motor, may be more difficult to extinguish with dry chemical than with a vaporizing liquid extinguisher. The reason for this is the difficulty of getting the powder into the openings in the motor housing.

On Class A fires dry chemical is about as effective as CO_2. Deep seated fires can be knocked down and retarded but reignition can be expected. However, on certain types of Class A fires, such as lint fires in a textile mill, dry chemical has been found to be quite effective. The chemical settles over the lint and prevents flame spread.

It is on flammable liquid fires, however, that dry chemical "steals the show" per unit size. A series of approved tests, based on the number of square feet of fire area extinguished, proved that a 4-pound dry chemical extinguisher was more effective than a 2½-gallon foam extinguisher, a 20-pound dry chemical extinguisher outperformed a 100-pound wheeled carbon dioxide extinguisher, and a 30-pound dry chemical extinguisher was almost as effective as a 38-gallon wheeled foam unit.

Dry chemical is not as clean as CO_2. It leaves a residue of chemical in the fire area. Except for fires in vats of essential oils or in foodstuffs, this disadvantage is minor. It is not likely to be important in the class B fires with which we will be concerned.

Maintenance.—Maintenance of dry chemical extinguishers is no problem. If the expelling cartridge is intact, and the cylinder is full of chemical, the extinguisher is ready. In some models the cartridge is checked by weighing. Since CO_2 is the pressurizing medium, no freezing problems are encountered. The extinguisher is effective from —40° to 120° F. the same as CO_2.

If extra chemical and cartridges are on hand, the extinguisher can be recharged at field stations. On some fires only a blast or two of chemical may be used. To save the rest of the chemical, turn the extinguisher upside down and release the gas. More chemical can then be added and a new cartridge inserted. Used cartridges can be turned in for charged ones on an exchange basis.

Extinguisher sizes.—Like CO_2, the size of the dry chemical extinguisher indicates the weight of the chemical. Generally the total charged weight is about double the size classification in pounds, for the hand extinguishers. Prices vary somewhat between manufacturers, both for the extinguisher and for the chemical and cartridge replacements. The following list prices, therefore, are approximate only:

Size	List price	Chemical Charge	Cartridge list price	Cartridge exchange
5	$32.00	$ 2.00	....	....
10	55.00	2.50	$6.00	$2.50
20	67.50	4.75	6.00	2.50
30	82.00	11.50	6.50	2.50

How to use the extinguisher.—Carry the extinguisher to the fire area and set down (hose types). Aim the nozzle at the hottest part of the fire and release the gas. Usually a quick shot or two of the chemical will decrease the intensity of the fire, after which you can advance sweeping the nozzle back and forth across the face of the fire for greatest coverage.

Cautions.—There are no particular cautions in using a dry chemical extinguisher. It probably wouldn't be a good idea to discharge the chemical in a person's face.

Summary.—(a) Use on Class B and C fires, effective on some Class A surface fires; (b) light in weight in relation to its effectiveness; (c) can be serviced in the field; (d) will not freeze; (e) range 8 to 12 feet; (f) effective from —40° to 120° F.; (g) safe to use; (h) minor maintenance, trouble-free.

Dry chemical is sometimes referred to as dry powder or dry compound. Fire engineers, however, are attempting to standardize the term "dry chemical" as applying to an extinguishing agent for use on flammable liquid and electrical fires. The term "dry powder" on the other hand is meant to mean the powder type of agents used for specific hazards, such as certain metals.

AERIAL CARGO DROPPING STREAMERS

HOMER W. PARKS

District Ranger, Payette National Forest

The need for marking special fire cargo dropped from planes so it is easily and quickly recognized was clearly evident to the fire overhead who participated in the suppression of the Studebaker Saddle fire.

This fire was discovered August 11, 1952, at 2:25 p. m. in the steep walls of the rough, rugged "River-of-No-Return" just 4 miles west of the 7,000-acre Huntz Gulch blaze of 1949. It was started by a dry lightning storm at the base of Fall Creek Canyon in a blind area from all lookouts. Fire danger was extreme and this fire had spread to 10 acres in flash fuels before it was discovered. Plans were put into effect immediately to use a fast hard-hitting force to control this fire in the first burning period. This plan required special fire-fighting equipment to be delivered by air.

Eight trained and seasoned smokejumpers were equipped and loaded into a suitable plane piloted by experts at rough country flying and trained specifically for this type of work. At the same time the fire dispatcher in McCall requested from Missoula, Mont., 34 additional smokejumpers to be sent with experienced fire overhead to the fire. Experienced, trained fire fighters in trail crews, mining camps, and logging camps were started immediately to the fire from the Warren Ranger Station. The McCall jumpers bailed out on the top of the ridge above the fire and then their cargo was dropped to them. As the McCall plane was leaving for another load of cargo two C-47 planes roared over the high peaks from Missoula with the 34 fully equipped smokejumpers aboard.

By 6 p. m. 42 smokejumpers and 8 loggers and miners were on the fire and more than 100 individual cargoes had been dropped. These cargoes consisted of VHF radios, first-aid equipment, jumpers' gear, power chain saws, fire pumps, 4,000 feet of fire hose, gas and oil, camp equipment, beds, rations, and other supplies. Despite skilled dropping, more than half of the chutes hung up in dead snags and green timber on the steep slopes. There was a desperate need to get the cargo out of the snags and trees before the fire crowned over the drop spot area. The cargo was scattered over a quarter-mile radius because of the high up-slope winds at the time of the dropping. The problem which confronted us was locating the cargo bags that contained such items as one-man power saws, VHF radios, and first-aid equipment. Such items are always needed during the early stages of any project fire, while food and camp equipment may be retrieved after the suppression job is under way.

Valuable time was lost in locating the VHF radios because it was not possible to differentiate cargoes containing them from others. One badly needed power saw that could not be immediately replaced on the fire was burned as a result of delayed discovery. An extended search was necessary to find gas and oil needed for power saws being operated on the fire.

First-aid equipment, including snake bite kits, was needed because of the many hazards that confronted us in night work on this type of fire. The hazards included a rattlesnake infested area, falling snags and trees, rolling rocks (the slope exceeded 70 percent), working at night with headlights and sharp handtools, a crowning fire caused by high winds, and difficult smokejumping conditions.

This 160-acre fire was controlled the first burning period by an 85-man crew and fortunately no lost time accidents occurred. However, the difficulty in quickly identifying special cargo led to the development of what we call the "streamer method." This streamer method was used on the Warren District during the 1953 season on two project fires—the Vaux fire, a Class E, and the Mosquito Creek fire, a Class C—with very good results. By using colored streamers, there were no delays in retrieving urgently needed cargoes.

It was found that streamers of different colors to identify certain cargo were confusing both in the warehouse and in the field. Warehousemen preferred using only red streamers. From tests made, the best type of streamer for this purpose was red cloth, 4 inches by 4 feet, with the cloth streamer tied directly to the top of the cargo. This red cloth is standard equipment in the warehouse and costs only a few cents per streamer. The streamers may later be used as line markers on the fireline.

Streamers were attached to the following types of cargo: (a) first-aid equipment (including snake bite kits, sedatives, and stretchers); (b) communication equipment (including VHF and SPF radios); (c) gas and oil for power saws and fire pumps; and (d) linesman's climbers, safety belts, rope, and camp commissary. Power saws and fire pumps that are dropped in red plywood containers with the name of the contents lettered on the sides of the package did not require streamers.

The maximum number of packages requiring red streamers was 5 on any one plane load containing 15 cargoes. The contents of these loads were 6 VHF radios, a 1-man chain saw, 10 gallons of gas, 6 quarts of oil, linesman's climbers, safety belt, 40 feet of ½-inch rope, two 25-man first-aid kits, 24 small first-aid kits, a dozen notebooks for fire overhead, camp commissary, and hard hats. When VHF radios were dropped, no more than two radios were placed in one package in case of chute failure.

The red streamers were clearly visible to ground crews immediately after the cargoes left the plane. No streamers were torn off when cargo was dropped through thick timber. No expensive equipment was lost on the two 1953 project fires, and the fire boss had a better check on all specialized fire equipment dropped.

The communication system on any project fire may be established within minutes by using the streamer system while hours are required if each package must be unpacked when streamers are not used. When cargo chutes become hung up in snags and trees and the package is marked with a red streamer the package must be released by use of linesman's climbers, safety belt, and rope and lowered gently to the ground. This will avoid damaging expensive equipment such as the VHF radio. On fires where the number of cargoes is five or less or where special equipment is not used, streamers are unnecessary.

The red steamer aided materially in locating first-aid equipment (stretcher and sedatives) dropped for an accident in the 1953 season. No delay was experienced in giving the victim first-aid treatment to relieve severe shock and pain.

The streamer method is simple and seems foolproof. The Payette National Forest warehousemen favor this system for all project fires where cargo is dropped.

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A Safe Way to Fell a Burning Snag

The idea of burning snags down is not new but with the increasing difficulty of finding qualified fallers, the practice is becoming more important from a safety standpoint.

Snags that are too dangerous to saw down because of falling bark and limbs can oftentimes be burned down by throwing additional fuel such as limbs and small chunks around the base. The object is to increase the amount of heat at the base to speed burning. If the snag is partially rotten at the base, this increased heat will burn it down. If the snag has a solid heart, the limbs, bark, and rotten wood burn off, and the solid part can then be felled with a reasonable degree of safety.

The procedure is usually limited to night time or periods when danger of spotting and spreading is low. However, if the snag is already throwing sparks, the added heat may not increase the danger, and by speeding up the burning it is often possible to get the snag down or at least burn off the loose fuel before the wind increases.

Examples of situations where the procedure is practical:

1. One man or small crew makes initial attack on a lightning fire during the night or early morning. Fire is well established in snag and there is no chance of putting it out. By increasing fuel at the base, snag will either burn down or limbs and top will burn off so it will be safe to fell before the heat of the day.

2. Large fire controlled at night by direct attack or backfiring. Burning snags along the line will cause fire to spot across the line when the wind comes up if they are not felled.

Night crews can contribute to the mopup job by burning as much fuel as possible inside the line. Pile limbs and small logs against large logs and at the base of snags.

Safety measures.—Personnel must always be alert to the possibility of falling limbs or the tops burning off. Fuel can be thrown from some distance away, but "widow makers" can bounce 20 feet or more. Keep "heads up" whenever in the vicinity. It is easy to throw the fuel and still keep an eye on the upper part of the snag.

Fire burning hot from the base normally burns off lower limbs first, thereby reducing the danger of falling limbs bouncing from limbs below.

If the snag has no pronounced lean and direction of fall cannot be ascertained, pile on the fuel and then keep all personnel far enough away to be in the clear while the snag burns down.—R. W. ASPLUND, *Fire Control Officer, Plumas National Forest.*

RETAINER CLIP FOR TROMBONE PUMPS

MERLE ALDRICH

Fire Officer, Michigan Department of Conservation

Many refinements which contribute to efficient action in fire control are simple devices that promote orderliness and neatness in handling and storing various tools or apparatus. Examples are legion and may be observed at any modern equipment depot. Most of them have been developed by fire officers themselves, and in too many instances have remained obscure because information about them has not been published nor disseminated for use by other agencies.

One such device was developed in Osceola County of the Baldwin District of the Michigan Department of Conservation. Figure 1 shows the application fully and reduces necessary explanation to a minimum. The device has been simply called a retainer clip for trombone pumps. Fire officers accustomed to the use of slide action pumps have all been troubled with their tendency to open up to the full extent of the telescoping tubes, and become liable to damage; at the very least the condition defeats good usage of the pumps, and disorder in storage or transport usually results. The situation becomes troublesome when pump cans are transported on rough roads and vibration causes pumps to become extended.

As shown, clips may be manufactured from curved stiff wire, and the only tool required is a pair of pliers. The loose ends are joined by a wire splicing sleeve, thus eliminating welding, soldering, and twisting.

Based on experience to date, the best material for manufacturing the clip is standard copperweld wire with a steel core. The natural curve of the wire as it comes from the roll, gives the proper spring effect when the prongs are bent at 90 degrees to the curve of the wire. Made in this way the clip has adequate strength to hold the pump parts firmly in retracted position, and yet the spring action is sufficiently soft to permit quick removal from the pump handle. When detached from the pump, the clip is sufficiently compact to permit being carried in a coat pocket, or it may be slipped beneath a belt with the prongs pointing outward.

The clips are kept on the pumps while in storage or transport, and may be readily removed when they are to be put to use. Since manufacture is very simple, supplies of clips can be made up as time permits.

In the Baldwin district where the clip was developed, it has been successfully used since 1948 and fire officers attest to its convenience and usefulness. By preference of individual fire fighters,

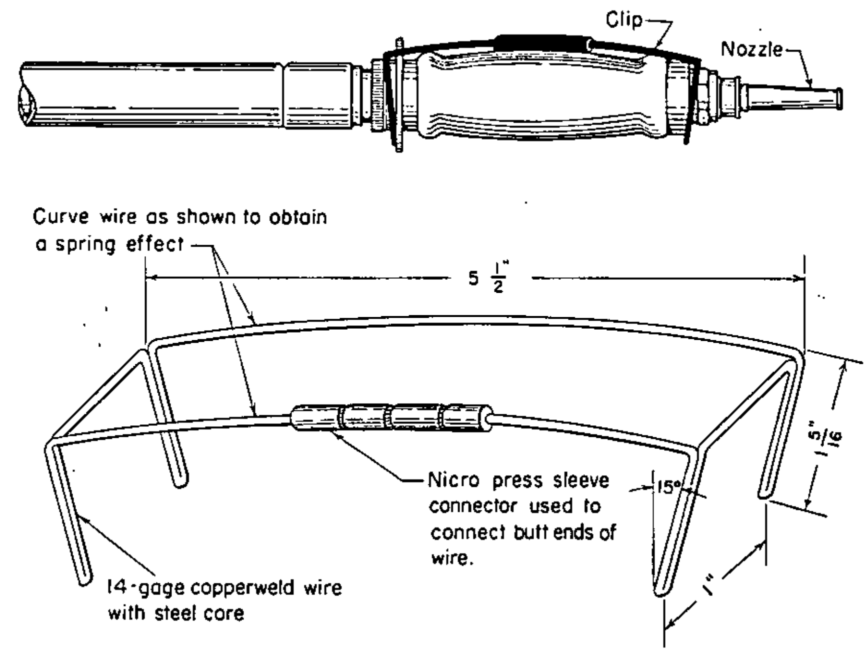

FIGURE 1.—Retainer clip for trombone pumps.

trombone pumps are widely used. As far as storage, transport, and application are concerned, their tendency to become extended and awkward to handle has been the major objection to them. The retainer clip corrects this fault completely, and it requires no conversion or additions to the commercial pump assembly as furnished by manufacturers.

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"How Forest Fires Get Started in Cumberland and Morgan Counties, Tennessee," is the title of an attractive and stimulating report recently published by the Tennessee Department of Conservation and the Tennessee Valley Authority. It is a searching analysis of fire cause in a high-incidence, two-county area of the Cumberland Plateau. Methods used, facts revealed, and conclusions reached are described in detail. A limited number of copies are available; those interested may obtain copies by writing either of the publishing agencies.

TRACTOR-PLOWS VS. 60 MILES OF INCENDIARISM

JOHN W. COOPER

Assistant Forest Supervisor, Mississippi National Forests

How would you like always to have crack 22-man fire suppression crews available, never tired, ready to go in 30 seconds, and without any payroll to make?

This analogy is based on statistical analysis of production rates of firelines in the Coastal Plains section of the Southeast by handtool crews compared to rates of production by the light 18-25 horsepower crawler tractor and Ranger Pal plow. These analyses covering several thousands of fires have shown that these light plow units teamed up with 3-man crews can build and hold as much fireline per hour as a 25-man handtool crew. As a matter of fact, the quality of the line built by these plow units, hauled by 1½- to 2-ton trucks, is far superior to the line a 25-man crew could build. On the higher class danger days, a high-quality line completely cleared becomes more important. On these higher fire danger days, the handtool crew is generally run over by the head of the fast moving fires in the flashy fuels of the Southeast so that the statistics for such days actually belie the potential of hand crew production.

An outstanding example of the speed and effectiveness of the Ranger Pal plow units can be cited by a description of suppression action on the Leaf River-Black Creek Districts, Mississippi National Forests, on January 24, 1953. On that date, four inebriated young men strung out an estimated 1,000 sets of fire along a total of 60 miles of road in 2 hours and 17 minutes. Wind velocity was 20 miles per hour and fuel moisture down to 5 percent. All sets were made on the leeward side of the road so as to take full advantage of the high winds. The route of travel was carefully planned and was, in general, at right angles to the wind direction insofar as available travel routes would permit.

These series of sets were all controlled in exactly 10½ hours from time of discovery of the first set. The majority of the sets burned together and control was affected around 17 different fire areas. The same district fire organization had to suppress 3 additional incendiary fires covering 108 acres set by other parties off the "60-mile route" during this epic afternoon.

In a country where a spread of 5,000 acres in 4 hours is not uncommon, the suppression of this series of sets with a loss of only 3,637 acres is nothing short of phenomenal.

The present Leaf River and Black Creek Districts were administered as one district prior to 1950. They embrace a total protection area of 356,624 acres. When the two districts were set up in

1950, a decision was made to continue handling the fire organization as a single unit under one dispatcher. A Memorandum of Understanding was drawn up between the two rangers and approved by the supervisor authorizing the dispatcher to assign crews and equipment without regard to district boundaries. First line defense on these districts is primarily by the light crawler tractor and Ranger Pal plow with 3-man crews. A total of 9 Ranger Pal units, one heavy disk type fireline plow with medium-sized crawler tractor, and one 1-ton, 4-wheel-drive truck with 200 gallon tanker made up the list of mechanical equipment assigned these districts.

From Weather Bureau reports and local observations, the dispatcher had predicted a Class 4 fire danger day for Saturday, January 24, 1953. On the basis of this prediction, only 6 plow units were manned prior to the discovery of the first of the series of sets. When this holocaust began, crew foremen for the four unmanned plow units and tanker were contacted by messenger at their homes within a radius of 10 miles. Each of the foremen picked up his helpers and all plow units and the tanker were fully manned within 1 hour of discovery time. It is estimated that at least 3 or 4 hours would have been required to recruit enough hand labor to have been equivalent to the production potential of these four plow units, and even then, it is doubtful if any number of men could have held a line across the head of these fast moving fires. It is further estimated that if there had been 4 less plow units available that the burned acreage would have been at least 25,000 acres instead of 3,637.

The first in the series of sets was discovered at 1:00 p.m. with the peak of the burning day still ahead. Attack on this first series of sets was made by two Ranger Pal units 12 minutes after discovery and these sets were brought under control exactly 2 hours later at 170 acres. The final control line was closed around the last of the series of sets at 11:30 p.m.

Seven minutes after discovery of the sixth series of fires, an eleventh plow unit was enroute from the Biloxi Ranger District 44 miles away. Two hours later this unit was in action on the line. On discovery of three additional sets, the second Biloxi District plow unit was called and 2½ hours later it was in action. This latter unit was a heavier and slower type.

A thirteenth plow unit was called from the Chickasawhay District 31 miles away at 2:30 p.m., but its departure was delayed 1½ hours because of going fires on that district. Two handtool crews of 4 men each were recruited to catch first line mopup to relieve plow units for line construction. The entire control organization may be described as 13 tractor plow units and 1 tanker and a total of 51 men. Total perimeter of all fires controlled by this organization in 10½ hours added up to 67 miles.

Suppression technique under such adverse conditions was advisedly modified to a limited extent. The crews wisely bypassed three of the earlier sets which were heading into the jams of wide creeks in order to cut off the head and flanks of other sets where no help from natural firebreaks could be expected and heavy losses were imminent. The crews correctly hit heads of the most potentially dangerous sets, cutting the head and flanks off, and in a number of instances leaving the back of the fire burning until the heads of other dangerous sets could be controlled. Since it was prescribed burning season, leaving the backs of some of the fires was equivalent to a good prescribe burn, whereas the heads of the fires were rolling through the tops of the trees 50 and 60 feet high and causing considerable mortality.

Wind velocity was sufficient to cause the head fires to jump a 100 foot highway right-of-way. Therefore, for the information of anyone not familiar with plow operation, it should be pointed out that we do not expect the plowed line to hold the fire, but merely to serve as a place from which backfire can be set. The plow lines usually hold the backfire when assisted by a safety man with a back-pack pump or a tanker unit, particularly on the flanks and back, but trouble is frequently encountered with breakovers across the head. With high winds, it is advisable to use two plows, the second plowing a line fairly close outside of the first line across the head after which the plows can be split to take the opposite flanks as individual units. When two plows are not available to throw across the head on high windy days, it pays to move out far enough ahead to permit the single plow unit to double back across the head before starting backfire. Of course, the plow unit should be held on the head and not allowed to start down the flanks until the backfire and head have burned together.

Oh yes, what about law enforcement? We got on that, too, with a couple of men and at the time of this report the culprits were awaiting trial in Federal Court under $5,000 bond each.

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Pumps Uncoupled from Back-Pack Cans in Truck Toolboxes

The clip on the back-pack tank frequently does not hold the pump securely. If the pump is made secure by a strap, the inner plunger often slides out, becomes dirty or bent and sometimes broken. A simple coupling was therefore designed so that the pump can be detached and carried inside the fire toolbox. The length of hose left on the tank should be made long enough so it can be carried in the same clips that held the pump. (The clips will have to be bent slightly closer to hold the hose.) The same end of the connector should always be used with either the pump or the tank, preferably the male end of the connection on the tank. This allows free interchange of tanks and pumps, and the gasket which is in the pump section is not so apt to be lost as it will be carried inside the box.—H. W. JANELLE, *District Ranger, Alabama National Forests.*

PREVENTION PAYS OFF ON THE TOIYABE

LYLE F. SMITH

District Ranger, Toiyabe National Forest

The Alpine District of the Toiyabe National Forest embraces some 343,000 acres within its protection boundaries within the Carson River Drainage in California and Nevada. More than 28,000 acres is in private ownership.

The major uses on the district are grazing, recreation, and timber harvesting. In 1953, more than 12,000 head of sheep and 5,000 head of cattle grazed on all lands on the Carson Watershed within the Forest boundary. In addition, approximately 30,000 people spent nearly 150,000 days' visits to enjoy the recreation facilities in the area, and approximately 8 million feet of timber was harvested by 6 timber operations.

The normal population within the area (Alpine County is one of California's smallest in population) is about 600; this is swelled to 50 times as many during the summer months by forest users. Four transcontinental highways traverse the district over mountain passes into central California.

Up until the past 10 years, the "East Side" Sierra region was considered as "asbestos," that is, it wouldn't burn. As other thinly populated and little used areas in the West have witnessed, an influx of population and users has brought about an ever increasing risk of fire. This, coupled with an invasion of "bronco" and other undesirable annual grasses, has increased the hazards of fire. The fuel is flashy and has a high rate of spread and a high resistance to control.

Up to 10 years ago, the protection agencies merely put out what few fires occurred without any questions asked. "It was part of the job and a contribution-return to the taxpayers." Organizations were small, prevention was almost unheard of, and enforcement rare.

About 1940, Ranger Robert Gardner was assigned to the Alpine District. Fire occurrence on this district was increasing to an accelerated degree in the period following 1940. Protection forces, prevention, and enforcement had not kept pace with the load. The 1947 season was almost disastrous. Almost 16,000 acres were destroyed that year by a series of man-caused preventable fires, a total burn of more than 5 percent of the area under protection. Residents were just as careless as recreationists. Within a period of 5 years, more than 10 percent of the district had been burned off. Residents and users, as well as Forest personnel, were alarmed. The day dawned with the realization that the "asbestos" would burn. Presuppression forces were maintained at the same levels and there was little outlook for additional presuppression assistance.

Ranger Gardner started a reorganization of the protection forces at his command. The people of Alpine County clamored for better protection. Gardner dove-tailed his reorganization of forces with demands of the people into the small but significant word COOPERATION. The County purchased an $8,000 pumper and housed it at Woodfords, in the center of the hot spot. Volunteer firemen were organized and trained in forest and range fires as well as structural fires. The County purchased 2 pumpers for use by the Forest Service. Within the Forest organization studies were made that resulted in the closing of the only lookout on the district because of its ineffectiveness in detection. The operator was added to the fire crew as a "prevention patrolman" to contact the residents and users. California State fire laws were, as a whole, adequate but had some loopholes. The loopholes were plugged by the passing of County ordinances.

The results? Here are the results for the year 1953 which was considered "bad" on the district from a burning condition as well as a record standpoint: Total number of fires, 21; total area burned, 272 acres (eight-tenths of 1 percent of area under protection); total man-caused fires, 7 (1 by tourists or recreationists, 6 by residents and forest industries); total area of man-caused fires, 267 acres (1 fire burned 260 acres); number of fire trespass civil cases settled or pending, 4; number of fire prevention law enforcement criminal cases settled, 13.

The campfire permit that is required in the State of California provides an opportunity to make a prevention contact. We have placed the fire permits in strategically located business houses throughout the County. The issuing agents are instructed to give a personally delivered short fire prevention message with each permit. This is helpful to tourists receiving the permit as well as serving as a reminder to the business resident. We find only a few fires occurring from permit holders within our County.

The prevention patrolman has regularly scheduled routes of travel on the district at times to meet the greatest number of people, i.e., Saturdays and Sundays late in the morning to early evening. During his travels, he only averages about 10 miles per hour. He is given "salesmanship" training to enable him to meet the public in the most friendly manner.

In camping areas the patrolman uses the fire permit as a means of meeting the people. To those with permits, he never fails to leave a short prevention message. To those who have failed to obtain a permit (through ignorance) he issues the permit with a little longer message. The repetition of contacts acts as a continual reminder. We have yet to receive a complaint from anyone who has been bothered or inconvenienced by these repeated contacts.

Fishermen and hunters along the streams and roads are given an informal short prevention "chat" when visited. Local residents are given the same treatment, as well as a hazard reduction survey of their property.

During his patrol, the prevention man sees that people are camping on the safest possible areas. Campground facilities are not adequate on the district to confine all the campers within the improved camping areas. "No Camping" areas are posted whenever possible. A short, friendly discussion usually results in people moving from dangerous locations to safer areas. A personal safety approach on these problems brings results. We often even help them pack and relocate.

When violations occur, such as failure to extinguish a campfire before leaving, smoking in dangerous area, etc., the citation law of California is used. A "Notice To Appear" form is filled out which states the violation and the date and time the violator is to appear in the Justice Court. When the violator acknowledges the form by signing it, he promises to appear. Failure to do so can result in a bench warrant being issued for his arrest.

When the violator is not present at the time of discovery, the citation is left with instructions to appear at the guard station. Any and all identification is noted on the citation to make it known that we know who the violator is. At no time does the patrolman make an arrest or indicate he is making an arrest.

When the violator appears at the station, the ranger or assistant ranger discusses with him his violation and fire prevention.

By talking with the ranger, the violator usually realizes his mistake and is willing to make amends. If the violation is minor, we usually let the incident serve as a reminder; however, if the violation is of a major nature or the attitude of the violator too complacent, we issue another notice to appear and make arrangements for a quick hearing in the Justice Court.

The ranger or assistant ranger always attends these Justice Court hearings with the prevention patrolman in presenting the evidence. Previous and continual contacts with the local Justice of the Peace results in a complete understanding of the necessity of fire prevention.

The results of the Justice Court hearings are always given notice in the local newspapers. The published result of a tourist's violation is usually not seen by the tourist because of the limited distribution of the local paper, but the local residents who read the local papers are kept aware. When residents are violators, the results are rather embarrassing, but as yet no animosity has resulted, and usually more respect has been obtained.

It is difficult to gather vital evidence during an initial attack on a going fire when the primary job is to get the fire under control. We attempt to contact each person at the scene of the fire and arrange a later time or date to secure their statements. This is done after the fire is controlled, either at the scene of the fire, their locations, or at the fire station. The discussion is made individually and not as a group. The person is encouraged to talk as much as possible at the interview, the pertinent facts are obtained and analyzed, and action is taken. The local law enforcement officers are most cooperative in helping us interview the people involved, to speed up the process while the impressions are still vivid in the minds of the people. Too often delay causes forgetfulness and omissions of pertinent facts.

Our first objective in fire cases is to attempt to secure suppression and damage costs to relieve the taxpayer of the burden of paying for other people's mistakes. Our second objective is to bring the violator to justice. Depending on the nature or degree of the case, civil or criminal action or a combination of both may be used.

BILGE HAND PUMP FOR FILLING BACK-PACK PUMP CANS

ANNE C. ALLEN HOLST[1]

Chief, Forest Fire Experiment Station, Cedar Hill Fire Department, Cowesett, Rhode Island

Most fire departments now have a tanker-truck to augment their back-pack pump men in forest fire control work. While these tanker-trucks, in nearly every instance, must stick to roads and trails, the back-pack pump men can range deep into the fire area, whether it be steep hillsides, across a swamp, or in the deep woods. The practice of having to return to the tanker-truck, or to tie up a hose line from the tanker, to refill these back-pack pump cans is almost universally practiced.

This returning to the tanker-truck, which is operating with its hose lines as a separate unit in an area possibly quite a distance from where the pump-can man is working, is a costly procedure from many standpoints. Too often, a small source of water is available in the area where the pump-can man is working, but no handy method of filling his or his fellow operators' pump-can tanks is available. The tying-up of a portable power pump at such a small water source simply to refill pump cans is not good strategy. What is an efficient solution?

Of course, there is always the collapsible pail—but water sloshed from a pail is an awkward way of filling the pump can during the stress of a fire. More water goes on the ground than into the pump can in many instances. And the dripping can is unpleasantly wet when placed on the wearer's back. A decidedly better solution is the simple matter of adapting a marine hand bilge pump for filling pump cans through a rubber hose.

There are many models, both inexpensive and expensive, and of varying capacities, on the market. They range in price from a high of around $40 for an all-brass, large-capacity bilge pump, down to $3.95 for an inexpensive galvanized steel bilge pump of 10 gallons per minute capacity.

The true measure of a hand pump's capacity is the number of strokes per gallon. The largest pump, mentioned above, weighs 15 pounds, and has a capacity of 3 strokes to the gallon. While the large capacity is desirable, the pump's weight precludes its use for

[1] C. F. Ritter's article on handtools in the January 1954 issue of FIRE CONTROL NOTES, points up the fact that despite the flood of machinery designed or adapted for forest fire control work hand-powered tools are still needed for efficient control. This article has been written to call attention to another hand-powered tool not now associated with forest fire control work, but whose possibilities seem good as an effective aid in forest fire control.

forest fire control work. A single-action brass bilge pump, weighing but 1⅝ pounds, with a capacity of 4 strokes to the quart, and costing $5.40, would be more practical. More expensive, and weighing considerably more (7¼ pounds), is a brass double-action bilge pump with suction hose, strainer, and discharge hose, selling for $15.90 and having a capacity of 3 strokes to the quart.

All bilge pumps, if they do not already come equipped with a strainer, should be fitted with a strainer of reasonably fine mesh to keep dirt out of the pump cans. A carrying strap can be rigged so that ease of transportation is assured.

No "best" pump has been selected from the many tested, as too many factors enter into the conditions governing the use of bilge pumps for forest fire control work in different areas. All are good pumps, however, and are readily obtainable from commercial boat supply houses.

Bilge pumps come in two styles: Those resembling a hand tire pump, with a foot hold to steady the pump on the ground while pumping through a suction hose; and those without a suction hose, which are simply operated by having the open end of the pump barrel stuck into the water source and the pump held in the hand while pumping.

Bilge pumps will operate in smaller sources of water, and in shallower water, than most any other type of pump, power or manually operated. This should be a big selling factor for bilge pumps for forest fire control work.

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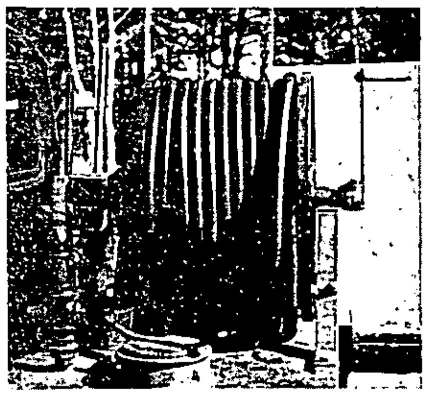
Crank for Live Hose Reel

A crank for winding hose on a live hose reel was made as follows: a 1½-inch driving cap, dressed round, was screwed on to the axle of the reel. The crank was made from a section of ¾-inch pipe around a bolt handle secured to a 1- by ⅜-inch strap iron. This bar, of proper length to safely clear fire toolboxes or other objects, was then welded to a section of pipe union which was secured to the driving cap by set screws.

This crank, which can be made from various salvage materials, permits one man to reel up the hose with ease and guide it for level winding.—WILBUR R. ISAACSON, *District Ranger, Chippewa National Forest.*



PORTABLE HOMEMADE HAND PUMPER

H. W. JANELLE

District Ranger, Alabama National Forests

About a year and a half ago we made an analysis of the fires occurring on the Talladega Ranger District. One thing this study showed was that 2 out of every 3 fires on the district were either started or stopped on a highway, road, or woods road that could be traveled by a truck. Another point we determined was that a large number of these fires were discovered while still very small, usually roadside sets. It was obvious that if we could get water to these fires quickly we could accomplish two things: (1) Cut down on the acreage by catching them small; and (2) cut down on the costs by reducing mopup time through use of water. A slip-on pumper unit seemed to be the answer, but the cost of such a unit was so high that, in our case at least, it was doubtful we could justify the expenditure. Therefore, we decided to make up an economical little "pumper unit."

The unit consists of a 55-gallon drum mounted on a frame in a horizontal position with the filler hole up (fig. 1). A regular hose faucet is screwed into the small opening of the drum, a length

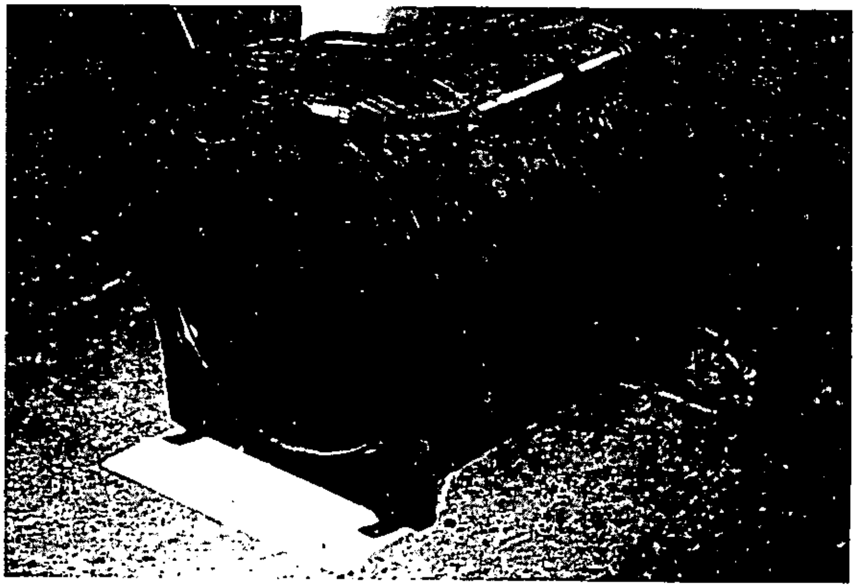


FIGURE 1.—Front view of homemade pumper unit, showing the two iron fasteners that slip into the truck seat brackets and secure the unit to the bed. Clamps that hold the pump are also visible. The hose is wound around two supports welded to each end of the tank. Note the garden-hose coupling that serves to fasten the pump to the hose.

of garden hose fastened to the faucet, and the pump from an Indian back-pack pump attached to the outlet end of the hose. This unit has been used with 100 feet of hose, and is capable of emptying the water when the nozzle is 25 feet higher than the drum.

It can be mounted in the bed of a pickup, the back of a jeep or, as in our case, a station wagon after removing the double seat in the back. Two pieces of angle iron are bolted to the frame supporting the drum so that the unit can be slid into the bed of the station wagon, using the same brackets that held the seat in place. One large wingnut secures the back end of the unit to a bolt set in the bed of the station wagon. It requires no more than 20 to 30 seconds to install or remove the unit; only the one wingnut needs to be tightened or loosened.

The unit proved very effective on small roadside fires which we were able to reach in a hurry because the light vehicle is much faster than a heavy truck or plow unit. We have also used it on mopup; and it is surprising how far the 50 gallons of water will go when applied with the back-pack pump. Although this unit has its limitations, it has proved effective for both control and mopup on roadside fires. It has more than paid for itself in a few weeks of this first fire season.

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Accessible Compartment for Pack Box

A constant source of irritation on a pack trip is having to carry lunches, binoculars, sign plan, camera, and the many other little things necessary for district administration on your saddle horse or else unpack your pack horse for every little need. This can be partially solved by building on the end of the pack box a small compartment that is accessible while the box is on the horse. This compartment can be constructed in a standard pack box that fits inside the regulation canvas pannier by adding a partition about 6 inches from the forward end. The canvas cover of the pannier will protect the compartment from debris or rain and can easily be raised to permit access. The diamond hitch or other lashing on the top pack doesn't prevent access if the rope is slid closer to the horse. This still maintains a good tight pack. The remainder of the pack box can be enclosed by a plywood lid that prevents rodents and other prowlers from raiding your supplies. Further information can be obtained from the author.—JOHN W. DEINEMA, *District Ranger, Teton National Forest.*

FIRE HOSE VULCANIZING PROCESS

WILLIAM H. LARSON

Chief Fire Warden, Washington Forest Fire Association

For some years it has been apparent that there is considerable waste in the necessary practice of severing and recoupling or discarding cotton rubber-lined forest fire hose each time a hole appears. Because of our interest in this problem, we obtained a copy of Forest Research Misc. Pub. 1, "The Wright Hose Vulcanizer," plus blueprints, from the Canadian Department of Resources and Development. This publication dealt with the repair of 1½-inch unlined linen hose, but we adapted the process to the repair of cotton-jacket, rubber-lined hose.

Only hose that is nonserviceable because of mechanically injured spots should be repaired. To this end, the injury should be clamped off and the remainder of the hose tested for strength and serviceability. Hose injuries should be divided into 2 groups: Those with holes under ½-inch in length and those with holes more than ½-inch in length. The former can be repaired by the process described here, but the latter must be cut and spliced. This is because there must be an area of hose fabric around the injury large enough for the necessary strength to develop in the adhesion of the patch.

Patches can be cured on any vulcanizing machine with flat plates 3 inches square or larger, one of which can maintain a constant temperature of 300° F. while the other is unheated. If it is impossible to cut the heat off one plate, a piece of insulating material can be used. Additional tools needed are a stitcher wheel, a sharp knife, a small toothbrush, and a ¾-inch paintbrush with bristles cut short for added stiffness.

Materials required are as follows: Rubber nail-hole patches (rayon reinforced); black cushion rubber, 1/32-inch gage (plastic backed); black rubber cement; cleaning solvent for rubber; and tire talc powder in small oilcan with spout.

Patches are made in the following manner:

1. Thoroughly clean with solvent and toothbrush the hose fabric of the area to be patched. It is handy to keep the solvent in an oilcan with small-diameter spout for this.

2. With sharp knife, trim the radial threads (woof) from the injury so that stray threads will not be found in the completed patch; they would act as a water passage. These radial threads are the principal load-bearing members, so the hole should not be lengthened by cutting more of them than are injured. In any event, the patch will not support an injury that is more than a half inch in length.

3. Grasp the hose in a manner to keep it rounded. Insert the spout of the talc can in hole and liberally coat bottom of hose with talc. Make sure the powder does not touch the top half of the hose around the hole; it would prevent adhesion of the inner patch.

4. Still holding hose so talc does not touch the top, lay a 1-inch square piece of cushion rubber, plastic backing down, over the hole and coat the top of the patch with cement.

5. Using toothbrush handle, immediately push the patch through the hole all the way to the bottom of the hose on the line of the diameter of the hose. This requires some care to prevent poking a hole in the rubber.

6. The patch will stick loosely to the toothbrush handle, resembling a folded umbrella sitting on the bottom of the hose (fig. 1). Press the top of the hose down against the upturned points of the patch and alternately release the pressure, sliding the hose up and down the brush handle as though opening and closing the umbrella, until the patch is flat. While flattening the patch, keep the brush handle against the bottom of the hose to keep the patch from dropping off and away from the center of the hole. Do not touch the top half of the hose to the talc-covered bottom until the patch is flattened. When the patch is flat, stick it firmly to the under side of the hole by pressing the hose together. The plastic backing stiffens the rubber patch enough to perform the above maneuvers, and it does not interfere with vulcanizing. Hereafter, keep the hose reasonably level so that the talc does not run away from area to be patched; the talc keeps the hose from sticking together.

7. Apply two liberal coats of cement to the hose fabric on an area the size of the patch, allowing each to dry in turn.

8. Apply a third coat of cement, and when tacky remove the plastic backing from a patch and press onto the fabric. Rub with a stitcher.

9. Place a piece of muslin over the bottom hotplate, or dust with talc, and press the patch firmly in the vulcanizer.

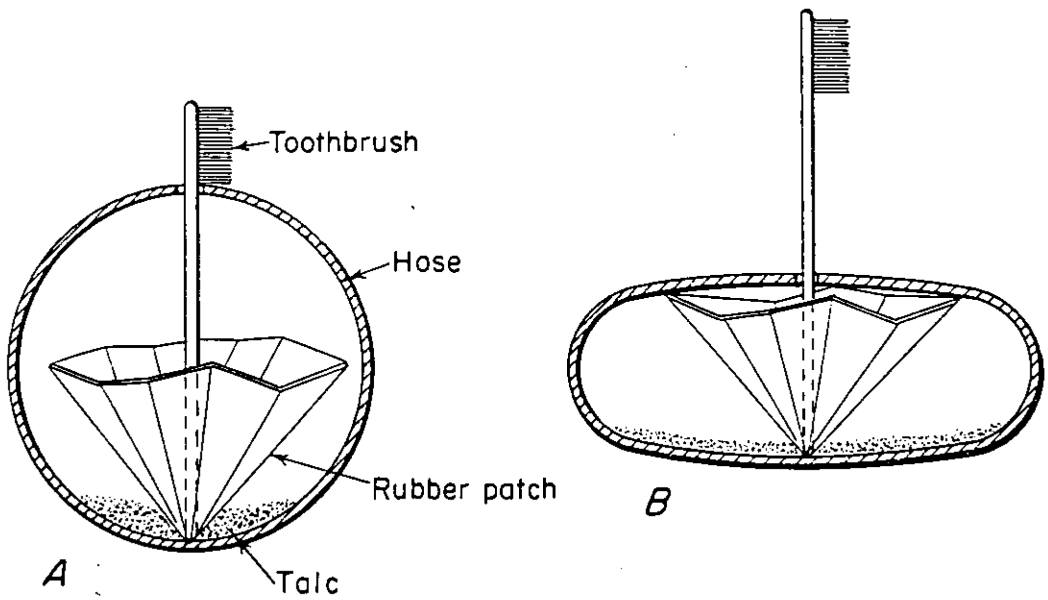

FIGURE 1.—*A*, Toothbrush handle in proper position to apply patch; *B*, hose alternately pressed and released only to upturned points of patch until patch is flattened.

10. Cure at 300° F. for 35 minutes.

11. Remove and grasp the flattened edges of the hose immediately. Squeeze them together sharply to pop the hose open. Allow the patch to cool 24 hours or longer before it carries a load.

The above method produces a patch of satisfactory physical characteristics, which does not weep. A few practice trials should be made on short lengths of hose to master the technique of placing the inner patch.

The patches we produced reacted to loads applied with fire-fighting pumps as follows:

Pressure (pounds)	*Pressure applied (hours)*	*Result*
350	1½	1 burst
350	1¾	Do.
350	2	Undamaged
160	3½	Do.
150	1¼	Do.
250	1	Do.
300	1	Do.
350	¼	Do.

Bursts originated in center of patch and ruptured 3½ inches of the fabric, lengthwise, showing that the hose-fabric tension was near its maximum strength.

Splices are applied in an entirely different manner, and a modification of the commercial vulcanizer is required. The Wright vulcanizer consists of a top and bottom plate, with heating elements and thermostatic control device. The plates are squeezed together by a screw and handle, and follow guides. Side pressure is exerted by two horizontal blocks, unheated, operating on slides with a screw attachment (fig. 2, *A*). Though not tried by us, it

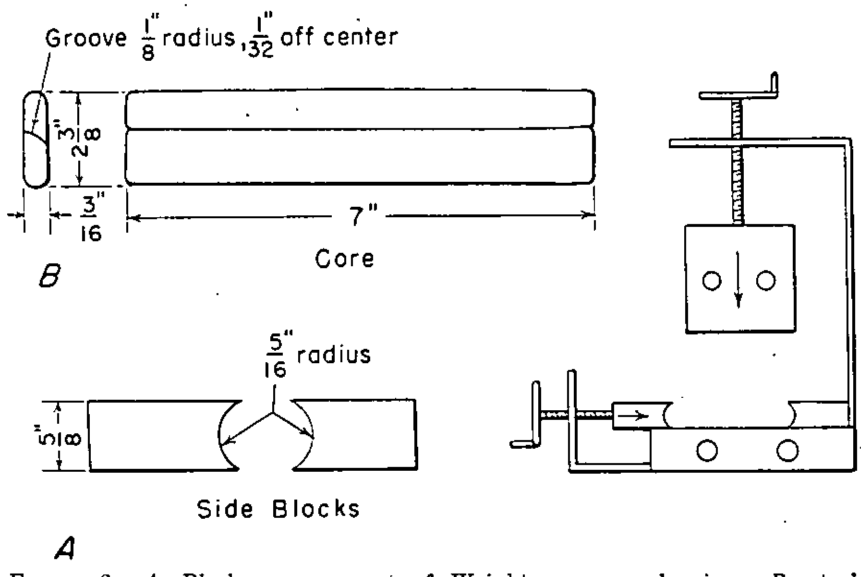

FIGURE 2.—*A*, Block arrangement of Wright-process vulcanizer; *B*, steel core used in Wright hose vulcanizer.

would seem that a commercial vulcanizer with plates 5 by 3½ inches, capable of maintaining 300° F. top and bottom, could be adapted by welding the side blocks to a "C" clamp or "Vise-Grip Welders Pliers."

It is necessary to insert a steel core into the hose at point of join. The steel core was cleverly designed for the Wright hose vulcanizer (fig. 2, *B*). The off-center placement of the radius center of the complementary curvatures allows the core segments to be easily removed by merely squeezing the edges in a vise to collapse them.

Materials for the splice: Tire talc powder; black cushion rubber, 1/32-inch gage (plastic-backed); rubber cement;[1] and 18-ounce hardlaid cotton duck saturated with rubber cement.[2]

Technique of splicing (fig. 3) is as follows:

1. Cut injured spot from hose, leaving a clean vertical cut on each end.
2. Clean hose fabric and rubber liner with solvent.
3. Apply 4 coats rubber cement about 2½ inches wide on each severed end of the hose fabric. Allow each coat to dry.

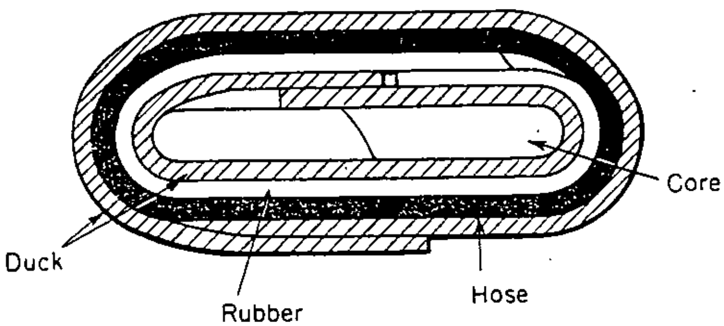

FIGURE 3.—Arrangement of hose and steel core in splicing cotton-jacket, rubber-lined fire hose.

4. Powder steel core with talc. While assembling splicing materials, care must be taken to minimize the amount of this talc rubbed onto the rubber materials.
5. Lay the core segments together and wrap a piece of impregnated duck 2½ by 6 inches around them. Cement the lap and stitch down. Arrange to have the lap on a flat side near one edge of the core.
6. Cement the duck—wait until tacky—and, starting at the edge of the lap of the duck, wrap with a piece of cushion rubber with backing removed (1½ by 5 inches). Stretch slightly so it laps on itself on the flat side of the cores. Stitch to the fabric. A

[1] An accelerator is required in either the cement or cushion rubber for curing. Since only one layer of this rubber is put inside the hose, a cement can be used that contains the accelerator. This cement is a specialty item not generally used by tire vulcanizers. It may also be used with the patches.

[2] This can be made for the job by repeated coats of rubber cement containing an accelerator applied to the duck. Allow each coat to dry, and repeat coatings on each side until the cement no longer soaks into the fiber.

double lap of either fabric or rubber on the edges of the cores will make it difficult to fit the cores inside the hose because of the width.

7. Apply cement liberally to inside of each severed end of the rubber hose lining and to the outside of rubber on the steel cores. Working rapidly while cement is wet, collapse the core segments to allow slack and slip them with the assembled rubber and fabric half way into one end of hose. Shove the other hose end over the assembly until both ends meet over the center of the rubber assembly on the cores.

8. Flatten the core segments—they should be a snug fit inside the hose—and press the hose to the inside assembly with the stitcher.

9. If the two hose ends have parted slightly in this process, fill the groove with layers of narrow strips of cushion rubber, each layer stitched in.

10. Cement the hose jacket again, and when tacky wrap with a piece of impregnated duck 4 by 7 inches with the lap on the opposite side of the cores from the inner laps.

11. Cover with a single layer of muslin, or powder plates with talc, and place in vulcanizing machine, screwing all plates tight. Cure for 30 minutes at 300° F.

12. Remove from machine and peel off muslin immediately.

13. While still hot, place in vise and squeeze edgewise to collapse the core segments; flake them out of the hose.

14. Wait at least 24 hours before applying a load.

Splices, made as described, successfully withstood the following tests with fire-fighting pumps: 3½ hours, at 160 pounds pressure; 1¼ hours, at 150 pounds; 1 hour, at 250 pounds; 1 hour, at 300 pounds; and ¼ hour, at 350 pounds. During the tests, the spliced hose were periodically flexed into circles of 10-inch radius while under load. The tests ended at 350 pounds pressure, because the couplings began to come loose from the hose owing to the repeated flexings.

Despite its stiff appearance, the splice distends into a circle at less than a hundred pounds pressure, and will offer no hindrance to rolling if placed in the outer half of the roll.

Although the processes described here gave satisfactory results, this should be considered an interim report. Certain refinements, and the need to extend the process to other types of hose, are evident. Some of these needs and refinements are:

1. A semicured vulcanizing sheet stock with flexible rubber and a light synthetic fabric of about 500 p. s. i. burst strength is needed. (It may be possible to make patches of this which would hold larger holes, and splices would be stronger and more flexible.)

2. This process has been applied to standard 1½-inch cotton rubber-lined forest fire hose only. The process in the above-mentioned Canadian publication applies to unlined linen hose. The process should be extended to the new lightweight hose with very thin rubber linings and synthetic fibers in the jacket. The imponderables here are amount and duration of heat the lining and

jacket will stand without weakening, and adhesive qualities of the vulcanizing stock to the part-synthetic fiber.

It is hoped that this paper will stimulate interest in further research on this problem by other individuals and agencies.

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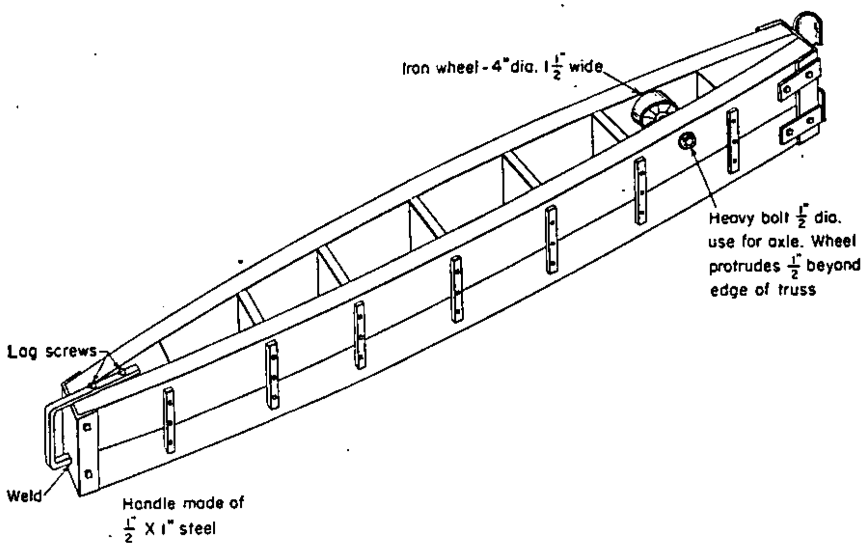
Safer Loading Truss

The loading truss shown in the accompanying sketch has been modified by the addition of the steel handle, and the small wheel mounted within the truss.



The addition of these minor improvements has made the trusses much safer to handle. The handle provides a good gripping surface for pulling the truss off the back of a truck, and the wheel permits the truss to roll easily on and off the bed when a slight lift is exerted on the handle.—*Lower Michigan National Forest.*

SUMMER BURNS FOR HARDWOOD CONTROL IN LOBLOLLY PINE

R. J. RIEBOLD

Forest Supervisor, South Carolina National Forests

The occurrence of hardwood understories in loblolly pine stands on the Atlantic Coastal Plain and their relation to the regeneration of loblolly pine has been discussed by Chaiken.[1] He described the usual condition as follows:

"This condition is illustrated in a stand now under observation at the Santee Experimental Forest in South Carolina. It is a well stocked pure loblolly pine stand 50 years old on a 90-foot site, in which fire has been excluded for at least 15 years. A tally of the understory reveals over 5,000 stems per acre; about half are below breast height and the others mainly in the 0 to 1-inch class. There are also nearly 4,000 stems of woody shrubs per acre. Thus there are about 9,000 competitors in the understory."

The composition of the typical hardwood understory has been described by Chaiken as sweetgum, blackgum, southern red oak, water oak, willow oak, and such woody shrubs as southern waxmyrtle and gallberry. On the drier sites, many of the same species occur plus post oak, turkey oak, blackjack oak, and hickories.

Chaiken has also discussed the treatment and control of the understory hardwoods by chemicals and by fire.[2] A suggested treatment of hardwood understories in immature even-aged pine stands is periodic applications of winter prescribed fires. Such fires will usually kill aerial parts of hardwoods up to 1 to 2 inches in diameter. The hardwoods sprout, but the sprouts can again be killed by winter fires just before they reach the 1- to 2-inch d. b. h. class. This practice had been adopted as part of the management of the Francis Marion National Forest, which surrounds the Santee Experimental Forest.

It was soon observed, however, that there were many areas on which understory hardwoods could not be controlled by winter fires. Too many of the hardwood stems were too large. On these areas, which had been protected from wildfire for 15 years, the use of winter fires for hardwood control had been delayed too long. The purpose of the prescribed summer fires described in this article was to render such areas suitable for hardwood control through winter fires.

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[1] CHAIKEN, L. E. THE BEHAVIOR AND CONTROL OF UNDERSTORY HARDWOODS IN LOBLOLLY PINE STANDS. U. S. Forest Serv. Southeast. Forest Expt. Sta. Tech. Note 72, 27 pp., illus. 1949.

[2] CHAIKEN, L. E. THE USE OF CHEMICALS TO CONTROL INFERIOR TREES IN THE MANAGEMENT OF LOBLOLLY PINE. U. S. Forest Serv. Southeast. Forest Expt. Sta., Sta. Paper 10, 34 pp., illus. 1951.

The effects to be expected from summer fires were known in general from the writings of Chaiken and from observations of the effects of wildfires. It was to be expected that summer burns would kill hardwoods 3 to 4 inches in diameter, thus reducing a large part of the hardwood stands to sprouts which could be treated by winter fires. The techniques of summer prescribed burning were not so well known. Accordingly, a few trial areas were set up upon which to gain experience in handling summer prescribed burns.

One block was burned in 1949, two in 1950, and two in 1951. The conditions on these blocks were similar. In each case, the even-aged loblolly pine overstory was 30 to 40 years old or older and had been thinned for pulpwood to a basal area of about 80 square feet. Measurements were not taken but site indexes are about 70 to 80 feet.

According to the management plan, the rotation age is 80 years. None of these stands was to be reproduced in the near future and no reproduction was desired at this time. The hardwood understory was heavy and many of the stems were more than 2 inches in diameter. Each area had received a winter fuel reduction burn 1 or 2 years previously. It was, of course, necessary to reduce the 15-year accumulation of fuel by a winter fire before attempting a summer burn. The conditions under which each of the areas were burned is shown in table 1.

TABLE 1.—*Date of prescribed burn and burning conditions on 5 selected blocks, Francis Marion National Forest*

Block	Area	Date of burn	Burning conditions				
			Days since ½ inch rain	Fuel moisture	Wind velocity	Burning index[1]	Air tempt.[2]
	Acres		*Number*	*Percent*	*M. p. h.*		*F°.*
Von Holland	130	8/12/49	5	6	1-2	4	93
Rice Field	300	6/27-29/50	9	5	4	10	99
Clayfield	500	6/29/50	19	5	3-4	15	94
Honey Hill	650	6/25-27/51	13	3	3-4	20	95
Echaw	300	8/29/51	7	3-4	2-3	10	95

[1] Type 5 C W Meter.
[2] Maximum at Santee Experimental Forest.

These areas were burned by strip fires. The term "strip fire" is used locally to describe one in which narrow strips, 25 to 100 feet wide, are set afire in succession, each burning with the wind into the previously burned area. The use of strip fires is necessary in order to take advantage of the wind to carry the fire and yet not have an uncontrolled head fire going.

The results on each of the areas were similar. Except in damp, low places or areas of thin hardwood fuel, practically all 4-inch hardwoods were killed. Many 6-inch hardwood trees were killed.

Some survived but with basal scars almost encircling the stems. The pine crowns were not scorched. After a year or two the dead hardwood stems are down and there are only low sprouts on the areas. The woods have an open and parklike appearance which is in marked contrast to the almost junglelike understory on adjacent unburned areas. The hardwoods on the areas are obviously now easily controlled by periodic winter fires as needed. The few hardwoods which escaped the summer fire may safely be ignored for the time and treated as individuals at the time of regeneration of the pine stand. Since the areas were relatively small for prescribed burning and the work was experimental, the costs per acre were about one-third more than the usual cost of winter prescribed burning. Including planning, plowing, and burning they ranged from 20 to 30 cents per acre.

All areas except Von Holland are on the Wambaw Ranger District and were supervised by District Ranger William E. Howell. All of these burns were carried out by Fire Control Aid John T. Hills, Jr., who has had more experience with prescribed burning on the Francis Marion than any other member of the organization. The success of these experimental summer prescribed burns is due largely to his knowledge of fire behavior and his skill in controlling it. He furnished the data on burning conditions reported in this article. As a result of these tests of summer burning, Hills has the following comments to offer:

"1. A number of sample checks should be made over the area to be burned in order to determine moisture content of the lower layer of fuel. If the partially decomposed litter is not damp severe damage to the pine may result. This is believed to be a better index than number of days since rain.

"2. Wind velocity should be from 1 to 3 m. p. h. If less than this the fire cannot be controlled. If higher, the heat does not rise and damage hardwood crowns. Heat at base or stem level is also dissipated too quickly. The light wind will remove hot air between hardwood crown and pine crown preventing scorch in the pine.

"3. The distance of stripping should not be more than 25 to 100 feet varying with the amount of fuel, also size of hardwood. If lines of fire are farther apart there is the tendency to create a chimney effect and in each instance severe scorch will result.

"4. In older stands of loblolly, particularly in bottoms, there is usually a buildup of fuel at the base of the trees. Sometimes the winter fire does not remove this rough because of damp conditions. Care should be taken not to burn such areas with summer fire because of the concentrated fuel."

This condition was observed on the Clayfield block where partial basal girdling of overstory pines occurred.

It is evident from these tests that summer fires can be used to reduce hardwood understories containing stems with diameters too large to be killed back by winter fires in middle-aged loblolly pine stands. The work is difficult, however, and requires exceptional care and skill in prescribed burning. Even under such treatment, some risk of damage to the pine overstory is present.

PRIVATE-COUNTY-STATE-FEDERAL COOPERATION GETS RESULTS IN UTAH

R. CLARK ANDERSON

District Ranger, Cache National Forest

The main line of the Union Pacific Railroad is a double track road through Weber Canyon in North Central Utah. Six miles east of Ogden, Utah, this line passes through a rugged, narrow canyon about 4 miles in length, a portion of which is appropriately named Devil's Gate. It then passes east through the gently sloping valley of the Weber River where it winds along among cultivated fields and farm houses. It leaves the Weber at Echo Junction passing through a broad 30-mile canyon known as Echo Canyon and out onto the flat plains of Wyoming.

Since the driving of the Golden Spike at Promontory Point in 1856 completed the rail span of the continent, range and forest fires have been started by sparks coming from the stacks of the iron horses that rode these rails. And along these lines—as all over the nation in those early days—these fires were looked upon as insignificant. They were just a thing that had to be lived with. Anyway, what damage did they do? That grass and brush on the sidehills and plains was not worth much. It would come in again.

Soon after the turn of the century the concept of protection and conservation of *all* of the nation's natural resources began to change. By the early thirties there developed a national appreciation of the value of all plants and animal life. Especially was it found that plants are essential in keeping the soil in place to prevent erosion and consequent siltation and damage to downstream improvements.

In 1935, the boundaries of the Cache National Forest were extended so that the Federal agency could assist in fire control work. The steep portion of Weber Canyon near Ogden was included in this addition. There followed an act in the 1937 Utah Legislature which made it unlawful for any private landowner to allow a fire to go uncontrolled on his own land, either to endanger his land and improvements or those of his neighbors. This act also set up a fire control agency to cooperate with private owners, and other governmental agencies in the State, including towns, cities, and counties. This agency was called the Utah Board of Forestry and Fire Control. This board was set up in 1941 as an amendment to the 1937 law.

It was an obvious fact, in sizing up the fire job in the Northern Utah area, that the Union Pacific Railroad right-of-way through Weber Canyon was a problem area. The east bound track was located above the west bound and was consequently closer to the unprotected grass and brush, which becomes tinder dry on this hot south exposure in late summer. Coal-burning engines doubled up on this stretch and, laboring mightily to haul loaded trains up the rather steep incline, naturally threw large sparks far up the slope. Most of the Weber and Echo Canyon rim is through a canyon that is narrow and winding, thus obscuring the baby fires from the section crews working elsewhere in the canyon. The resulting large fires on steep rocky terrain were exceptionally difficult and costly to control. In the 13-year period, 1939-51, there occurred in the lower Weber Canyon portion more than 25 fires, 3 of which grew to over 300 acres in size. The others were over 10 acres with the exception of one Class A (under ¼ acre) and two Class B (¼ to 10 acres). During this period other disastrous fires occurred in the upper or Echo Canyon area.

By tackling the problem on a cooperative basis, the railroad, the Utah State Forester, and the U. S. Forest Service have accomplished much.

1. The railroad has reduced the number of coal-burning engines. During the fire season they agreed to send as few as possible of the coal-burning variety on the Ogden-Green River run in the interest of holding down the fire hazard. Where use of coal burners is necessary, the railroad tries to schedule them between 6:00 p.m. and 10:00 a.m. during period of lowest hazard.

2. The railroad constructed a 10- to 15-foot fireline above the tracks, in all portions of the lower canyon where a bulldozer could work. This line is worked each spring upon advice from the Forest Service as to the proper time to do the work before the fire season. In portions of the canyon where a fireline is not possible the section crew burns a protective strip each year at the same time.

3. In the upper canyon the Summit County Commission and the State Forester jointly finance a patrol and prevention guard for the county. Much of his time in early season is spent in advising and assisting the railroad in fireline construction and burning out above the right-of-way. He also checks on any engines which are "spark throwers" and the railroad immediately removes these machines from service until arrestors are repaired.

4. The cooperative program has been worked out by means of a meeting each spring in which Federal, State, county, and railroad officers are represented. A plan for the season is agreed upon at this meeting.

5. Each spring the counties, State, and the Forest Service jointly conduct fire training schools in the three counties (Weber, Morgan, and Summit) crossed by the railroad. The company sends each of their section crews and even extra gangs, who will be in the area for the summer, to these schools. Each of the foremen of these crews is deputized as a Deputy State Fire Warden.

6. The Forest Service, the State, and the railroad exchange current lists of men who are available for fire fighting in case help is needed.

7. An attack plan is worked out whereby the railroad takes initial action on any fires that occur when and where they have men available. Usually the Forest Service or the county receives

first call. They check the railroad to see if men are available or already on the railroad fires. The Forest Service fire guards, who are stationed in the lower area, and the State-county guard in the upper canyon take first action on all fires that come to their attention, the railroad, the county, or the U. S. Government reimbursing them, depending on the land ownership involved. A written cooperative agreement on the various responsibility and action phases of this job are at present being worked out.

8. The Forest Service supervises action on all fires within the forest boundary that threaten Government land and in the absence of qualified overhead from the railroad on railroad fires. The State Fire Wardens in each county (usually the sheriff) supervise work on fires which are not caused by the railroad and which are on private land within the forest boundary or are outside the boundary.

A combination of these activities has borne fruit. (1) There were no fires caused by the railroad in the lower canyon in 1953 despite a long and critical fire season. (2) In 1952, several railroad fires were set early in the season. All were attacked and suppressed at less than ¼ acre except one, which reached two acres in size. (3) First attack by railroad crews on other fires has been extremely helpful. These crews have also provided extra trained fire fighters for use of other agencies. All of these men have undoubtedly become more fire conscious and have spread fire prevention to others.

As a result of the combined efforts of all interested groups, the railroad fire problem in Weber Canyon has been minimized. Especially is the railroad, and the transcontinental highway it parallels, much safer from flood damage which usually follows removal of the protective vegetative cover from the steep slopes above.

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Reinforcing Rear Bumpers of Pickups

Rear bumpers of pickup trucks often become bent from backing into something in the woods, especially when on night fires. The bumper also serves as a step in loading men into back of truck. The edge of the bumper is narrow and when wet is slippery and unsafe to use as a step. These disadvantages have been remedied by installing a piece of 2- by 10-inch pine or oak plank inside the bumper, the plank being cut to fit the curve of the bumper. It is fastened in place with two ⅜-inch carriage bolts through the plank and the flat iron supports on the bumper. Since bumpers are designed to absorb some shock, a space of 1½ to 2 inches can be left between the curved edge of the board and the inner edge of the bumper. This plank provides a safe step for getting in and out of the truck, prevents the bumper from bending easily, and cuts down noise considerably. It can be painted to harmonize with the truck and to prolong its life.—H. W. JANNELLE, *District Ranger, Alabama National Forests.*

CALIBRATION OF FUEL MOISTURE STICKS USED IN THE EAST AND SOUTH

RALPH M. NELSON

Southeastern Forest Experiment Station

The moisture content of forest fuels, however estimated, is a major variable in any system of fire-danger measurement. It is doubly a controlling factor in the system developed by the Southeastern Station because it enters into both the buildup index and the daily burning index as measured by the type 8 danger meter used throughout the Northeast.

A simple method of estimating moisture of lightweight materials, such as hardwood leaves, dead weeds and grass, and pine needles, was developed some years ago by the Southeastern Station. In field practice, three basswood slats, which constitute a set, are exposed 8 inches above the forest litter on wire supports. To obtain a close approximation of the moisture content of lightweight fuels, a set is suspended at one end of a pivoted beam-type scale designed by G. M. Byram of the Station. The balance is so constructed that the sliding counterweight can be moved to correspond to the oven-dry weight marked on the slats. The other end of the beam then points directly to the moisture percent on a vertical arc graduated from 0 to 50 percent. Thus, no converting of stick weights to moisture percent is necessary.

In addition to indicating the moisture content of surface fuels, the sticks are used to determine the buildup in fire danger. This is done by summing buildup factors derived from daily fuel moistures. For example, percents of 3.9 or less have a factor of 10 and those over 20 have a value of 0. Intermediate percents have values ranging between these extremes. The buildup index reflects the progressive drying of lower fuel and upper soil layers. When fires occur during periods when the buildup index is on the increase, they burn more deeply and become progressively more difficult to control and mop up.

Each year the Southeastern Station processes and distributes about 1,300 sets of fuel-moisture indicator sticks to about 650 fire-danger stations scattered from Maine to Texas. These stations are operated mainly by State and Federal agencies but also by industry and a few schools and military installations. Because of the widespread use of these fuel moisture sticks, it was thought that a brief description of the several steps involved in processing would be of interest.

Basswood slats 18 inches long, 2-3/8 inches wide, and 1/8 inch thick are procured from manufacturers of venetian blind stock. The material comes fairly free of defects but is sorted to remove all cracked, knotty, or discolored slats. A small hole is bored at one end of each slat through which a small metal grommet is riveted. The purpose of the grommet is to permit easy suspension from the hook on the scale when moisture determinations are made.

Basswood slats when exposed under field conditions lose a certain amount of weight through weathering. To minimize this loss, they are pre-weathered on racks (fig. 1) for several months until they have lost approximately 5 percent of their weight. Length of exposure depends upon season of the year. We find that slats weather faster in summer than in winter and faster during hot, rainy weather than at other periods. The point at which slats have lost sufficient weight is determined by the periodic weighing of test sets—the original oven-dry weight of which is known—placed at intervals among the sets being weathered. After proper weathering, slats are inserted in a rack and oven-dried according to the following schedule: 2 hours at 68° C., 1½ hours at 80°, 1½ hours at 92°, 16 hours at 105°. Forced air circulation is used in the oven at 92° and 105° temperatures. With our equipment, 56 sets constitute a charge.

Slats are next taken from the oven in groups of three and quickly weighed as a set to the nearest 0.1 gram on a beam-type balance to determine the oven-dry weight. Weight and serial number are penciled lightly on each slat. The oven-dry weight of a set, to meet standards, must be between 90 and 105 grams. If an occasional set falls outside of this range, a lighter or a heavier slat, as may be required, is substituted until weight requirements are met.

After oven-drying, the charge (56 sets) is placed overnight in a forced circulation humidity chamber. The purpose is to identify those sets which absorb moisture either too quickly or too slowly. Approximately 300 grams of water placed in a pan inside the chamber is sufficient to raise the average slat moisture to the desired amount of 4 percent. Following humidification, the sets are again weighed and the median moisture content of the 56 sets calculated. Those deviating from the median value by more than 0.4 percent are put to one side and later redried and rehumidified. If they fail a second time to meet the allowable deviation they are discarded. Another point of value resulting from this humidifying

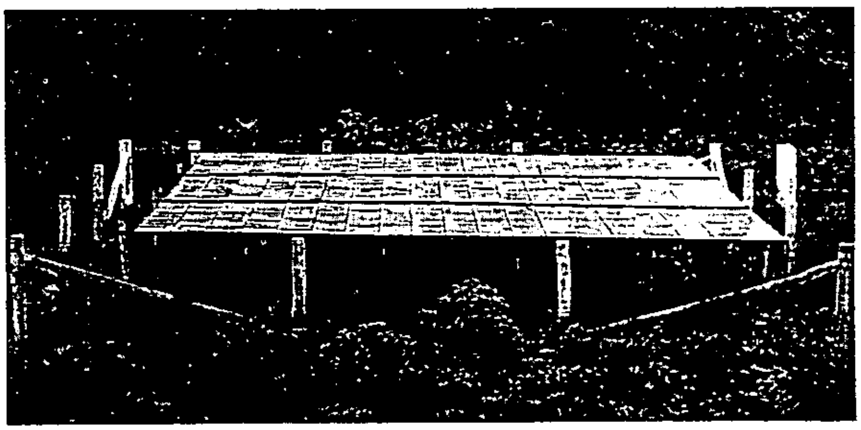

FIGURE 1.—Approximately 2,700 basswood slats are being pre-weathered on these racks.

step is that any sizable errors in determining oven-dry weights are immediately detected.

Finally, sets that meet above specifications are permanently marked on the less weathered side of each slat in indelible pencil with the year, serial number, oven-dry weight of the set, and stamped, "Expose Other Side." Because sets lose approximately 0.5 gram during each of two 6-week periods of field exposure, a weathering correction card is prepared for each set. Following this, sets (fig. 2) are individually packaged in envelopes and are then ready for mailing. Distribution is made twice a year to all danger station observers except those in northern New England and the Adirondacks, where a single set is sufficient.

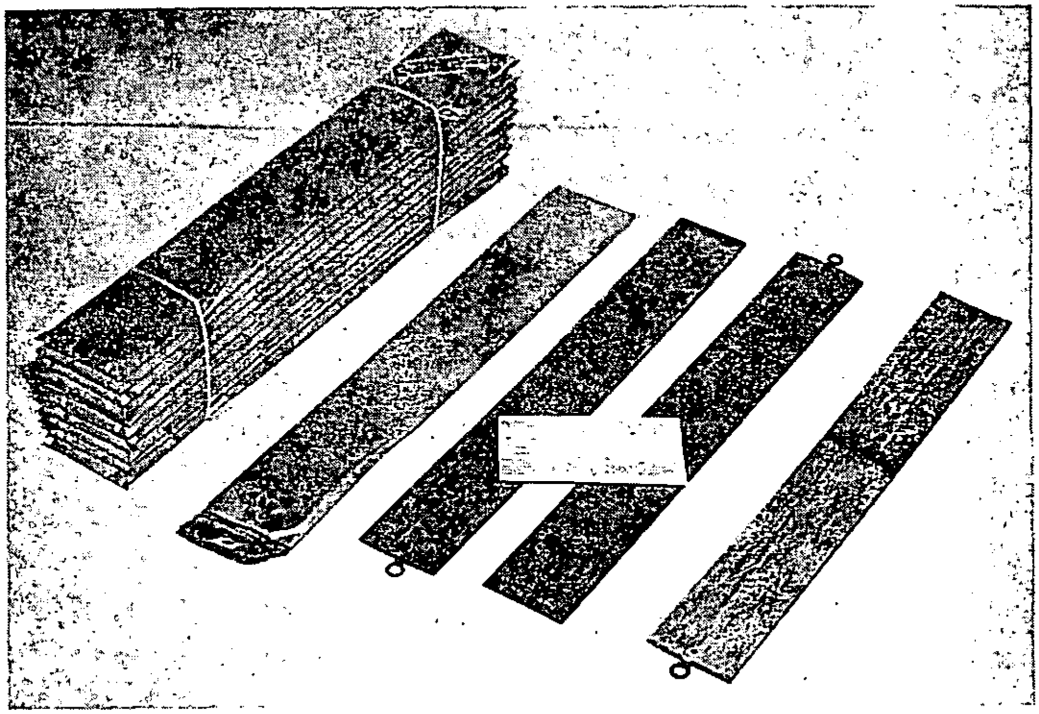

FIGURE 2.—Sets of calibrated fuel moisture sticks ready for distribution.

Readers who desire additional information regarding our fuel moisture sticks and their use are referred to the following publications:

Byram, George H.
The Appalachian fuel moisture scale. Jour. Forestry 38: 493-495. 1940.

Lindenmuth, A. W., Jr., and Keetch, J. J.
Fuel moisture sticks are accurate. U. S. Forest Serv. Fire Control Notes 9 (4) : 18-21. 1948.

Jemison, George M., Lindenmuth, A. W., and Keetch, J. J.
Forest fire-danger measurement in the eastern United States. U. S. Dept. Agr. Handb. 1, 68 pp., illus. 1949.

Keetch, John J.
Instructions for using forest fire danger meter type 8. Southeast. Forest Expt. Sta. Sta. Paper 33. 1954. (*Also in* Fire Control Notes 15 (3) : 40-46, illus. 1954.)

PRESCRIBED BURNING IN THE NORTHERN ROCKY MOUNTAINS

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Prescribed burning got its start in the longleaf pine region of the South, where silviculturists discovered that controlled burning of the forest floor litter not only increased timber productivity, but improved grazing and wildlife habitat, served as a fungus control measure, and reduced dangerous fuels.

Such fuel reduction is of major importance here in the northern Rocky Mountains, where the dense stands of reproduction and fire-killed trees, steep slopes, and extremely dry fire seasons create optimum burning conditions. Fuel reduction is designed to rid the forest of areas containing dense, highly flammable fuels, and to increase the economic value of the land. Both suppression and presuppression costs are reduced by the resulting lower fire hazard.

Areas of dense fire-killed timber can produce only a scattering of green timber for the many years that nature is disposing of the dead trees, at most no more than 10,000 ft. b. m. per 100 years. The same type of area, however, when prescribe-burned, can produce at least 20,000 ft. b. m., and the best sites can increase volume production to as much as 40,000 or 50,000 ft. b. m. per 100 years.[1]

Since the outbreak of the spruce bark beetle epidemic in Idaho and Montana in 1951, prescribed burning has been used very successfully as a means of destroying these insects (fig. 1). Areas of infested Englemann spruce are usually clear-cut, because the perecentage of infestation runs very high, often to as much as 100 percent. The logging leaves a great deal of slash and tops as well as unmerchantable trees, all of which contain a large number of beetles. These areas are then broadcast burned, the result being the death of the beetles.

Generally speaking, the best time of year to prescribe-burn is in the fall. In the northern Rockies a moderate rain usually comes during early September, followed by a period of warm, dry weather. This is the time when most burning is done. No attempt to burn should be made when conditions are not good enough to assure a clean burn. A general guide for weather and fuel conditions needed to accomplish the desired type of burn is as follows: (1) Relative humidity 25 to 50 percent; (2) wind 8 m. p. h. or less; (3) fuel moisture 8 to 12 percent; (4) burning index 30 to 40.

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[1] LYMAN, C. K. PRINCIPLES OF FUEL REDUCTION FOR THE NORTHERN ROCKY MOUNTAIN REGION. U. S. Forest Serv. North. Rocky Mountain Forest and Range Expt. Sta. Progress Rpt. 1, 98 pp., illus. 1945.

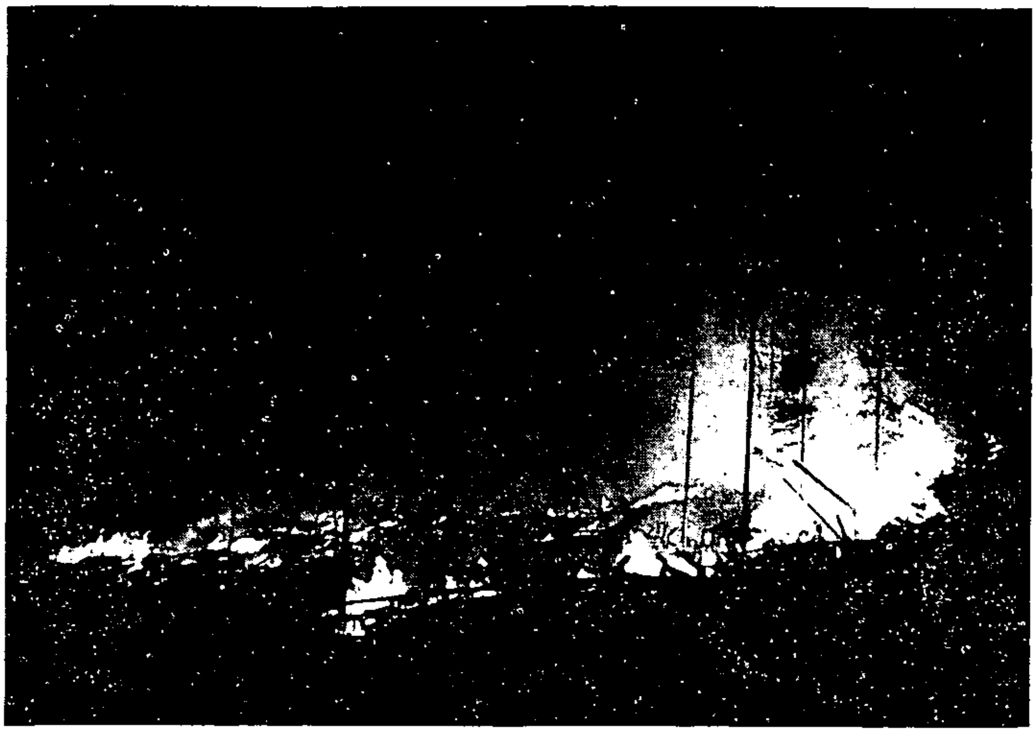

FIGURE 1.—Broadcast burning of slash on a logged-over area in the Lolo National Forest infested by spruce bark beetles. Standing trees are western larch, a fire-resistant species, which will serve as a seed source to regenerate the area.

Proper planning of a prescribed burning project is of vital importance. The area to be burned should be prepared well in advance of the planned date of burning. Then there should be a certain amount of leeway to allow the project manager to take advantage of weather conditions.

The preparation of an area usually consists of constructing firelines around the proposed burn, felling dangerous snags, and in some cases felling standing timber to assure fuel continuity. Arrangements for an adequate control force should be made. This will depend upon the characteristics of the area to be burned.

On moderate slopes, lines may be built most economically by bulldozer. On slopes up to 60 percent and in light fuels the hand trencher may be used, but on steep slopes, lines must be built by hand.

All snags that are likely to throw spots should be felled within 200 to 300 feet inside the line. All rotten and shaggy barked snags near the outside of the line should also be felled. All dangerous snags should be felled on small areas and on long narrow areas.

Dozer piling along critical sectors and the burning of these piled areas well in advance of broadcast burning reduces risks.

Mr. Lyman states that, "Experienced judgment is necessary to size up fuel conditions and to determine the most desirable flammability conditions to wait for. The most desirable condition for heavy fuel types is a calm, quiet afternoon with overcast skies and relative humidity between 20 and 34 percent. Fuel moistures of 6 to 9 percent are best, depending upon fuel type."

The Weather Bureau can predict suitable weather for burning. Ideal conditions would be a period of calm weather followed by rain a day or two later. This would lessen the mopup job which is necessary on most burns.

Since wind is the most variable adverse condition that threatens the success of a prescribed burning project, it is the condition that should be watched most closely. In the northern Rockies, morning winds are generally from the east, since the sun warms the east slopes first. Then the winds shift to the south and increase in velocity. During midmorning, upslope winds start with the rising of heated air from lower elevations. The upslope winds continue until late afternoon when downslope winds start as a result of cold, heavy air draining back into the lower elevations. Highest wind velocities usually occur in midafternoon.[2]

A knowledge of fire behavior is necessary in prescribed burning. The project chief must know the air currents created by fires, how to draw fires together, how to lead fires into different areas of the burn. He must know when to set fires in certain areas of the burn so that all of the fires will draw together and assure a good burn.

The element of timing cannot be overstressed. Proper timing of sets prevents spot fires, and it determines the effectiveness of the burn. This is the main reason that propane torches are preferred in firing. They are fast and dependable.

While the afternoon is generally the best time to burn, under certain conditions night burning is more advisable, especially when daytime burning hazards are very high and there is considerable danger of spotting. Night burning also enables one to take advantage of the downslope winds. The fire can be set along the upper edge of the burn, and the wind moves it downhill until the fire builds up its own updraft and reverses. Then another row of sets is made below the line of fire and the lower fire draws the upper fire down to it. Under certain conditions fires may thus be led down a slope. This method is not considered to be the best because there is considerable danger of losing on the uphill side as a result of lack of heat inside. Fires have a natural tendency to spread uphill.

A better method of firing on the slopes is to set a triangle of fire well inside the proposed burn, and to allow heat to develop well downhill and inside. Then the fire can be worked in a point uphill to the line and led out to the line on all sides by progressive firing. Buffer strips can be used to ease fire up to the line. Care should be taken to fire right up alongside the line in progressive firing, and to set hot fires well inside to draw the fire away from the line.

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[2] BARROWS, J. S. FIRE BEHAVIOR IN NORTHERN ROCKY MOUNTAIN FORESTS. U. S. Forest Serv. North. Rocky Mountain Forest and Range Expt. Sta., Sta. Paper 29, [122] pp., illus. 1951.

On level ground the circular method of burning can be used with a high degree of success. Hot fires are started in the center of the area to be burned, and they pull air in from all sides. Then fires are set around the outside of the circle and are drawn in to the center.

The key to success in controlled burning lies in a competent control force. This enables the use of hot fires without the constant danger of their getting out of control. All the equipment deemed necessary should be on hand: Tankers (fig. 2), dozers, trenchers, anything that makes the burn safer. Of course there is a financial limit. Therefore, it becomes necessary to use fires in such a manner as to never get more fire than the control force can handle.

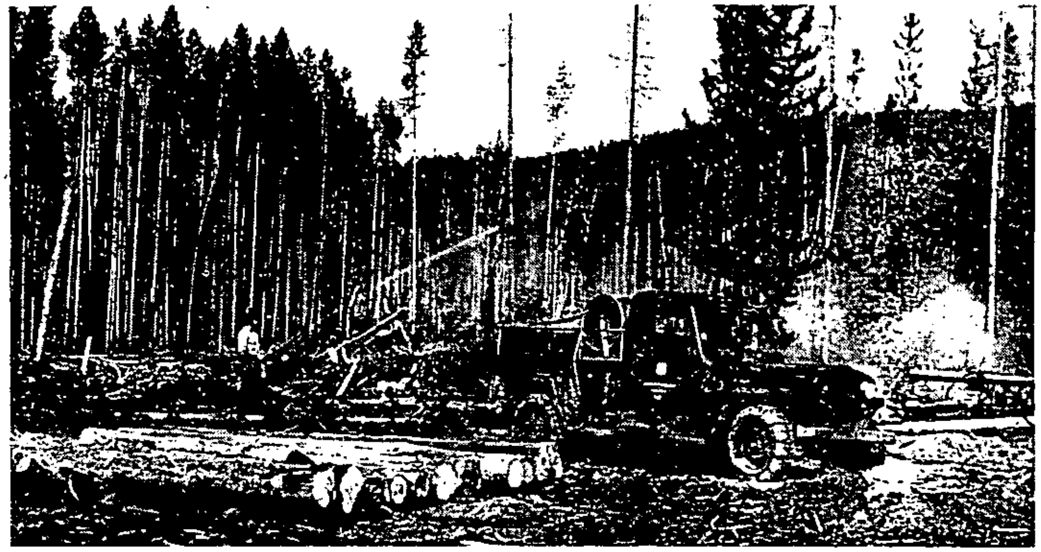

FIGURE 2.—A jeep tanker being tested prior to the broadcast burning of an area of lodgepole pine slash, Deerlodge National Forest, Mont.

In prescribed burning there can be no set guides to be used on any particular area during any season. Each region has its own topography, fuels, and weather, and each area within a region has fire-affecting peculiarities all its own. Before burning, therefore, each area must be studied carefully. Slope, wind, fuels, any factor that might possibly affect fire behavior must be carefully noted, and a detailed plan of action must be made to suit each specific proposed burn.

Fire has taken its place along with the other tools of the silviculturist, and it promises more uses and benefits as we become more familiar with its effects.

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.

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