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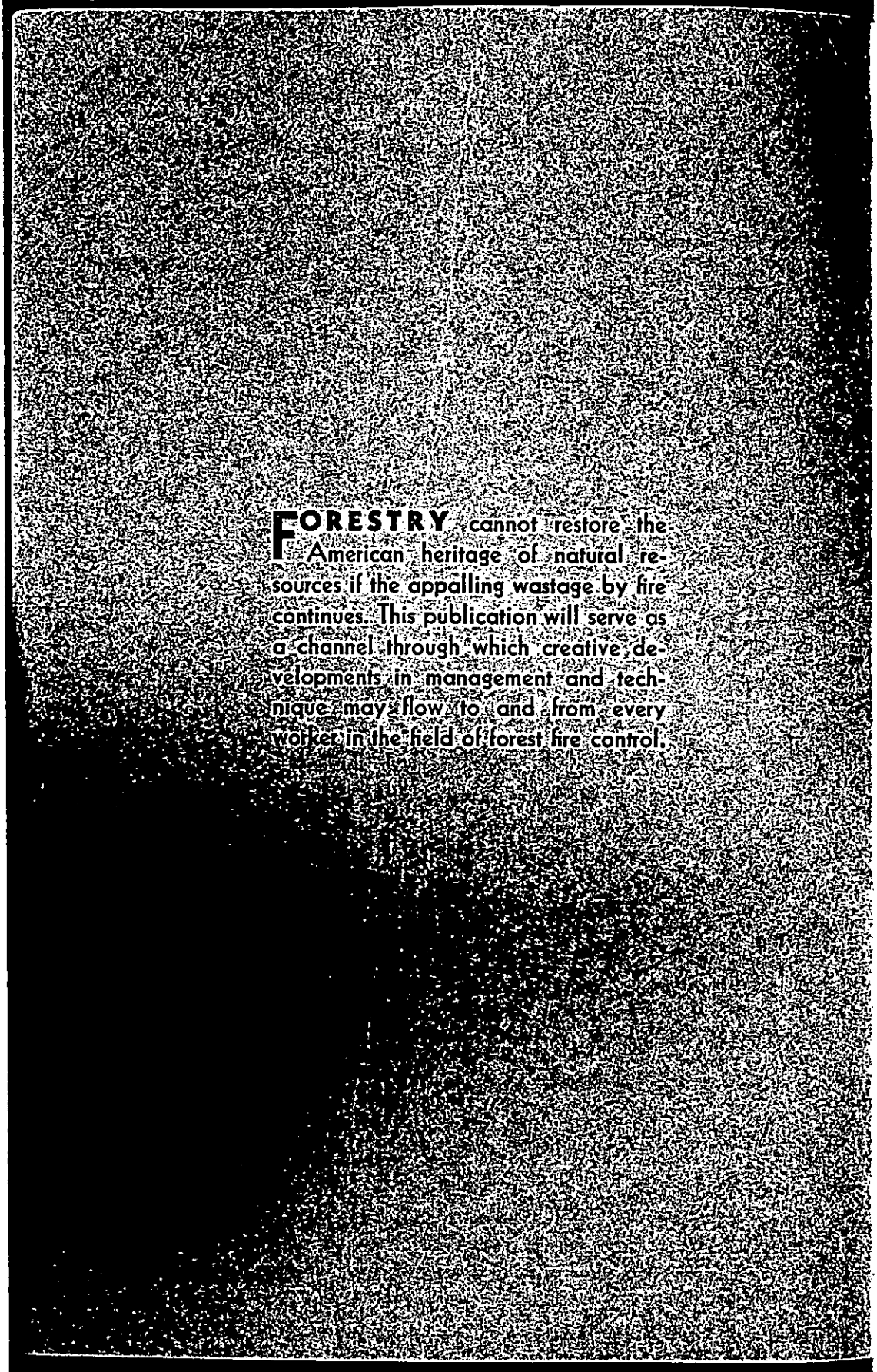
G. B. Burnett

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 technique may flow to and from every worker in the field of forest fire control.

Volume 5 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

FIRE CONTROL NOTES is issued quarterly by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

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, personnel management, 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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ADAPTING ADVANCED PRINCIPLES OF ORGANIZATION AND FIRE-LINE CONSTRUCTION TO CCC SUPPRESSION CREWS

ROLFE E. ANDERSON, BOYD L. RASMUSSEN, AND VERNE V. CHURCH

Siskiyou National Forest

Greater use of 40-man CCC crews in some regions was foreshadowed in the April 1940 issue of Fire Control Notes (The 40-Man Crew—A Report on Activities of the Experimental 40-Man Fire-Suppression Crew) by the statement: "It is believed that this system can be applied to other crews organized from picked CCC enrollees . . ." The Siskiyou organized a number of these crews and here reports on the success of one of them. Region 6 now advised that every CCC Camp is required to have a special 40-man crew, and that steps are being taken to equip these crews progressively.

In 1940, special suppression crews, patterned after the original 40-man crew organized in 1939 on the Siskiyou National Forest and located at the Redwood Ranger Station, were set up in CCC camps and forest-guard organizations on most of the national forests in the North Pacific region. A 40-man CCC crew was organized at the Iron Mountain spike camp, China Flat CCC camp, on the Siskiyou, in the spring of 1904. About midseason, David P. Goodwin, Assistant Chief, Division of Fire Control, in the Washington office, observed this crew on a practice demonstration and was so impressed by its action and apparent high level of morale, that he requested a report on the organization of the crew, methods of training, and accomplishments on fires. The story of experiences and accomplishments which follows might be duplicated by any one of several forests in region 6 where similar CCC crews were trained.

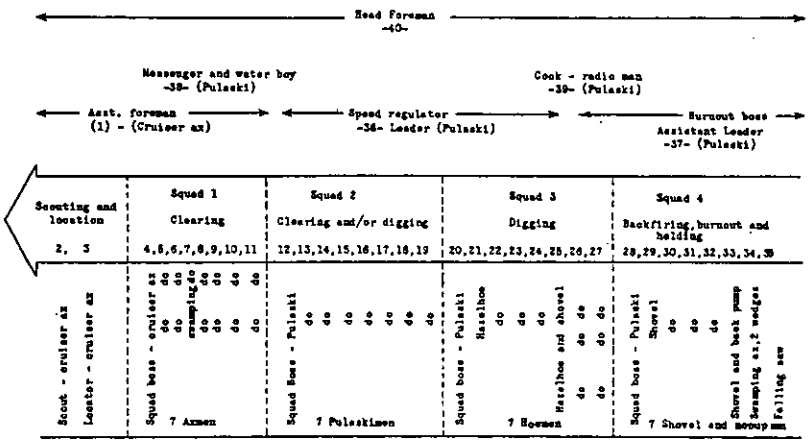
Organization of Crew

1. *Selection of men.*—In making up the China Flat CCC 40-man crew, an effort was made to select enrollees who were best fitted physically and emotionally for fire-fighting duties. The best men were taken from work crews on every work project. In some cases this caused a temporary handicap to current projects, but it resulted in development of a suppression crew made up of better-than-average enrollees. The majority of the men were accustomed to hard work at relatively low wage rates.

Two of the best qualified CCC foremen in the camp, Walter Barklow and Ralph Reeves, were chosen to take charge of the crew—Barklow as head foreman and Reeves as assistant foreman. These men were in charge of the road-construction project on which the crew was engaged while not training or fighting fire. In this way the men

on the fire crew worked under the same foreman at all times, resulting in a unity of thought and action essential for good teamwork and the up-building of morale.

2. *Selection of site.*—The Iron Mountain spike camp, where a road-construction project was in progress, was chosen as the most favorable site for the development of the crew. It provided work necessary for the training and conditioning of the men. It was located in a place where it could provide quick service for two ranger districts; and, not the least important, it kept the crew in a unit during off-duty time. No outside influence interfered with the concentration of interest of every man on fire duty.



Organization chart for the CCC special 40-man suppression crew.

The men were housed in tents which were framed and floored. Mess was provided in a portable frame building. The camp met all Army regulations as to water supply, sanitation, and camp facilities.

Training

Training began soon after the spring enrollment and was carried on 1 day per week during the first half of the summer. After the crew had gained experience on going fires, one-half day per week was considered ample. Intensive training was in progress at the time of the July enrollment and the few recruits that were added to the crew were absorbed into the organization and given individual attention as needed. Training processes were segregated into five divisions: Use of tools; get-away action; fire-line construction; special job training; and off-the-job training.

Use of tools.—Fundamental training in the use of hand tools was necessary because many of the enrollees included in the crew were green recruits. The first step in training was to teach every man the correct use of an ax. Only a relatively few enrollees were judged proficient in ax work following the first tryout. Detailed instructions in handling an ax were given to each unskilled enrollee under the close supervision of the foreman. As the men became qualified in ax work they were excused from further training with this tool.

The individual detailed training was done on road right-of-way logs arranged in safe positions for the unskilled axmen. This step involved training for a minimum of 1 day to a total of 5 days before all enrollees were qualified to use the ax. After the necessary skill was acquired in the fundamentals of ax work, practice was continued throughout the summer on the road right-of-way clearing project.

A similar system was used in teaching the use of digging tools. It was found that less time was required to gain proficiency in these less exacting tools.

Get-away action and travel to fire.—This share of training was considered vitally important because it eliminated much waste of time which would have occurred had the men not known exactly what they should do in getting away to a fire with full equipment. To facilitate assembling of men for roll call, loading into trucks, unloading and receiving packs at the point where foot travel began, the men were numbered from 1 to 40, according to position in the crew. Each man's pack was tagged with his number so that each individual would receive his designated tool. Packs and tools were stored in a separate building at the spike camp and a truck assigned for transporting them.

A separate crew, consisting of the regular spike camp cookhouse staff, who were not members of the 40-man crew, were trained to load this equipment while the suppression-crew members were getting their work clothes and loading into two passenger trucks which were assigned to the crew.

Considerable time was spent practicing get-away on fire calls and by constant practice, get-away time was reduced to 7 minutes when enrollees were at camp at the time of the fire call. Training also included unloading from the trucks at the point where foot travel began and assembling in hiking order with packs and tools. Unloading required 2 minutes and the receiving of tools about 5 minutes. The crew was then hiked over trails and cross country to gain practice and get the "feel of the pack."

Fire-line construction.—The next training step was actual fire-line construction. This training included a demonstration of what a model fire line should be, followed by practice in the construction of such fire line. The crew worked as a unit using the one-lick method of fire-line construction exclusively under all fuel types found on the Siskiyou National Forest. The important element in the one-lick method was the spacing of the men, coupled with the regulation of the speed of construction. This was taught by actual practice of line construction in the various types likely to be encountered on a going fire. Training was carried on 1 day a week until the crew had reached the necessary degree of proficiency, and one-half day per week thereafter even after the crew had gained experience on going fires. Practically all of the line constructed during training was located around slash areas where the work was needed for hazard reduction and fire protection.

Training for special jobs.—Outstanding men were given special training on fire-line scouting, line location, speed regulation, burning out, and cooking. Most of these important jobs were necessarily taught during line-construction practice, although additional training was given off the job. Cooking dehydrated rations required

some experimenting which was done in camp at the cook house by the men selected for the cooking detail.

Off-the-job training.—The foregoing training was done entirely during regular CCC work hours. In addition, however, the foremen gave off-the-job training in safety, fire behavior, and similar subjects.

Recreation and Morale

Recreational facilities available were utilized as fully as possible to build up morale. Each man proudly wore a red felt shield-shaped barge, stenciled "CCC, 40." Considerable competition developed among other members for the "CCC, 40" positions. When the boys went to town on recreation trips, all fire-fighting equipment and clothes accompanied the crew.

Equipment and Supplies

Each member of the crew carried a pack of tools and equipment, weighing about 36 pounds, similar to the ones used by the 1939 Siskiyou 40-man crew. Extra tools and supplies were carried in the supply truck. Lightweight goose-down sleeping bags and ample, condensed, high-quality rations are two essential items of equipment. The ration list was adapted from the list used by the 40-man crew in 1939, and weighed 11⅞ pounds for 1 man 3 days.

Most of the food items were packed in individual sizes, but it was found most practicable not to break some of the items down into individual packages. The quantities were so distributed that each pack weighed about the same. Linen tags were attached to each pack listing the items it contained so that the cook could easily determine which pack to open so secure rations for any one meal. A few sad experiences with spilled food demonstrated that it was important that the rations be packed in cloth sacks as paper bags would not endure the wear and tear of cross-country travel.

The question of whether or not to carry prepared lunches was carefully considered in the operation of the crew. It was decided that prepared lunches would be packed if securing them did not delay get-away action and travel to fire. If the time did not allow for preparation of lunch, the first meal on the fire line was made from items requiring no cooking. Plans were made to obtain lunches if possible en route to the fire by ordering them by phone at some point along the route. This method was used in travel to one fire in 1940.

Fire packs and rations were always stored in complete readiness in the spike camp where they were hung in sequence of numbers in double rows on the walls of a special fire-equipment shed. In case of fire these packs were loaded into a truck in reverse order from which they were issued at the end of truck travel. They were placed flat in the truck bed in tiers three deep. In order to eliminate lost motion and misplacement of packs, the equipment truck driver placed all packs in the truck when loading and removed them when unloading at the point where foot travel began.

Transportation

Two truck drivers, not members of the crew, ate and slept on each of the three 1½-ton trucks used.

Action on Fires

The CCC 40-man crew took complete action or assisted on seven fires during the fire season. The name, size, and dominant fuel type of each of these fires are listed in the following table:

List of fires fought by the CCC suppression crew

Name	Date	Area in acres	Held line in chains	Fuel type
Lone Tree Creek fire	July 6, 1940	7.0	40	MM
Scott Creek fire	July 6, 1940	7.0	51	HM
Green Knob fire	Aug. 7, 1940	32.0	80	MH
Two Mile fire	Aug. 10, 1940	.2	7	MM
Bingham Mountain fire	Aug. 11, 1940	30.0	85	MM
Scott Creek fire No. 2	Aug. 21, 1940	23.0	126	HM
Water Pipe Creek fire	Sept. 1, 1940	15.5	58	MH

No time studies were made on speed of line construction for this crew while on fires, but it is well known that their accomplishments were much greater than those of an average CCC crew of 40 men, and better than the average crew composed of pick-up laborers.

Six of the seven fires upon which action was taken during the season were of incendiary origin. Five of them were located on the Agness Ranger District within a 3-mile radius and were presumably set by the same person or persons. These incendiary fires were set at times when burning conditions were most critical, and the prompt control by the CCC 40-man crew with the assistance of forest guards and other CCC enrollees is considered a fine accomplishment.

The following comments on one fire based on firemen's and dispatchers' notes are indicative of the rapid getaway, fast travel, and hard striking power of this fire-fighting team.

The Bingham Mountain Fire.—The CCC 40-man crew was called at 5:30 p. m., and instructed to proceed to the Bingham Mountain fire. The men were in camp at this time and no time was lost in assembling the crew. Truck travel distance to the fire totaled 31 miles. The crew arrived at the fire at 7:50 p. m., and immediately went to work. Three squads of men were already working on the fire. The 40-man crew took over the line-construction work and the other squads were assigned to line holding and burning out. At 11 p. m. the crew had built 5,610 feet of fire line to control the fire. The fuel type was "moderate resistance-to-control." Along the fire trail there were a number of burning snags and these were felled as the fire line progressed. The crew did an exceptionally fine job on this 30-acre fire.

Summary and Conclusions

In organizing this crew, 40 better-than-average men were selected from all current projects. Because of loss of experienced men during

reenrollment periods, many green men were also selected and much fundamental training was given in the use of hand tools.

It was found desirable that all men in the crew attain a certain degree of skill in ax work. After training the entire crew, the most adept axmen were chosen for ax work on the established crew. Learning to use the hoe and shovel is a relatively simple accomplishment after the enrollees attained a degree of skill with the ax.

As a suggestion for future crews of this type, it is believed advisable to provide a snag-falling or road-clearing project on which to train fellers and axmen beginning about 6 months before the opening of fire season. Experience has shown that at least that much time is necessary to develop green enrollees into experienced timber fellers.

Two CCC foremen are necessary for a crew of 40 men. These foremen must possess real leadership ability and should be well qualified in fire fighting, training, and morale building. Pride in accomplishment must be tactfully instilled into each member of the crew by the foreman. He must be able to mix with the crew in a judicious way and at all times keep the respect of the men.

CCC crews have these outstanding differences from civilian crews of the same type:

1. Qualifications required of candidates for the civilian crews call for experience in use of hand tools. A large percent of CCC candidates are inexperienced and must be given fundamental training in the use of tools.

2. CCC crews will respond more readily to systematic training since they are more amenable to discipline and will adapt themselves without question to the positions assigned in this form of fire-fighting team.

A high degre of morale is the most essential attribute of this type of organization. To cultivate this rather intangible spirit so necessary in a first-rate crew, much attention was given to recreation, good food, and work shifts on the fire line not excessively long with short rest periods as judged necessary by the foreman in charge.

The psychological effect of fast progress in line construction resulting in a quick decisive suppression of each fire attacked gave rise to ever-increasing confidence of each member in the strength of the unit. A series of failures would no doubt produce the reverse effect. It is especially important with an inexperienced crew that the first attempt be successful. Not the least important, from the enrollees' viewpoint, was the distinctive 40-man badge differentiating these men from other CCC men which fostered a healthy pride in the organization.

The special CCC 40-man fire-suppression crew demonstrated that CCC enrollees organized and trained in accordance with advanced principles of organization and fire-line construction were superior to the average CCC fire-fighting crew which does not have the advantage of special training and lightweight equipment; and better than the majority of civilian fire crews composed of pick-up laborers.

OREGON'S "RED HATS"

GEORGE H. SCHROEDER

Assistant Professor of Forestry, Oregon State College

The constant and prompt availability of "snap" crews is most important in the use of a crew like the Red Hats. The author's description of a cooperative approach to the problem indicates how the 40-man-crew principle may be adapted to varying administrative conditions.

During the summer of 1940 the School of Forestry at Oregon State College instituted a program for organization and training of forest fire-suppression crews. Cosponsors included the National Youth Administration, State Forester, United States Forest Service, Oregon Forest Fire Association, and others vitally interested in the protection of Oregons forest wealth. The objectives of the program were:

1. Furnishing the State of Oregon with an efficient fire organization for call in handling emergency fire situations.
2. Training of forest-fire overhead.
3. Furthering the forestry education of participants.
4. Providing deserving students with a means of earning money for school attendance.

Based at a camp on the McDonald State Forest 7 miles from the Forestry School in Corvallis, the crews participated in a unique training program. Two hours of study, 2 hours of training, and 4 hours of hard work on approved N.Y.A. projects constituted the day's schedule. Study included a wide range of practical forestry subjects such as first aid, use of the compass, tree and shrub identification, knot tying, and life saving. Among other things training consisted of practice construction of fire line, scouting of fires, use of hand tools, and long hard hikes over the rought topography of McDonald Forest. Among the work projects were the following: Road and trail construction, road and trail maintenance, thinning of forest stands, pruning of forest stands, soil-erosion control, white pine blister rust control, and snag felling.

During recreation hours some of the men went swimming in the nearby lake, others played games or passed the time by reading the material furnished by parents and well-wishers. Leave from camp was allowed, but not more than 10 percent of the camp strength was granted leave at any one time. Those who were fortunate enough to be on leave went skating at the nearby roller rink or enjoyed a show in town.

Having advertised themselves as ready to report to a forest fire at a moment's notice, the Red Hats were necessarily very highly organized. The basic unit was a squad of 4 men and a straw boss. One of the straw bosses in each group of 10 was the ranking officer, and a foreman was assigned to each crew of 25. Equipped with pick-ups, trucks, and three 25-man busses the camp had ample transportation. Hand tools and mess equipment were packed ready to go at any time. When a fire call came in, the supervisor designated the responsible officer; drivers slipped behind the wheels of the trucks; men who had practiced the procedure beforehand slid tool caches into pick-ups; straw bosses checked off their squads; bed rolls were stacked in the rear end of busses and the men loaded in, caulked boots in hand.

On the fire line the crews worked as originally organized or expanded by absorbing civilian fire fighters into their squads. On at

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least two large fires assistant foremen were detached from their squads and given civilian crews to supervise. Orders were that an assistant be trained for all overhead positions so that supervision would always be available. Since the training program provided timekeepers, torch men, truck drivers, cooks, scouts, and other workmen, members of the crews were often used to facilitate the handling of pick-up labor hired for a given fire. Whenever possible, the foreman of the Red Hat crew involved would rebuild his forces from pick-up labor assigned to him. If such substitution was impractical, however, the crew proceeded with control operations as best it could.

The Red Hat crews were trained in the progressive method of fireline construction. They did not, however, confine themselves to this operation alone, but burned out their line and mopped-up the area after backfiring operations. The men were assigned positions because of aptitude shown in training and practiced the duties of those positions in order that the need for supervision in emergency situations might be minimized.

While on fire-suppression detail the men were paid a minimum of 40 cents an hour plus their expenses, the overhead jobs paying more according to their importance. Agreement on the wage scale was reached with the forest-protective agencies in the area before the fire season. The agencies all seemed pleased with the results and their average daily earnings of $5.48 also proved satisfactory to the fire fighters.

While participating in the base camp training and N. Y. A. work program, the men were only allowed $1 per day, but since this amount covered expenses, it did make it possible to train and organize the crews in readiness for fire duty. The resulting total average earning (fire fighting and N. Y. A.) was $120 per man above expenses for an average enrollment period of 52.71 days. In addition, 24 men were placed in summer jobs with the forest-protective agencies. The average income per man on these positions was approximately $100 a month plus expenses.

The program enrolled a total of 113 men. The largest number enrolled at one time was 87. Three 26-man crews were active during the peak of the fire season, and 2 such crews were available for practically the entire 4 months (June 1 to October 1).

The camp was initiated for the benefit of first-year students in forestry who were unable to obtain other employment. Because of an abundance of summer jobs last year, all except a small number of the foresters were placed in positions before the fire season opened, and the camp was thrown open, therefore, to any young man in need of employment who was physically fit and wished training in the forestry field. Men were enrolled from almost all of the institutions of higher education in Oregon. College men from at least six other States took part and older high-school students proved very good material.

Popularity of the training program is indicated by the fact that, although plans for the summer of 1941 are at this time very incomplete, applications are already on hand from several States showing the interest of young men who have heard of the organization but did not take part in 1940. With a strong force of veterans returning and with the probability of a guarantee of minimum earnings in prospect, it would seem that Oregon's Red Hats have proved their value and established the program as a permanent institution.

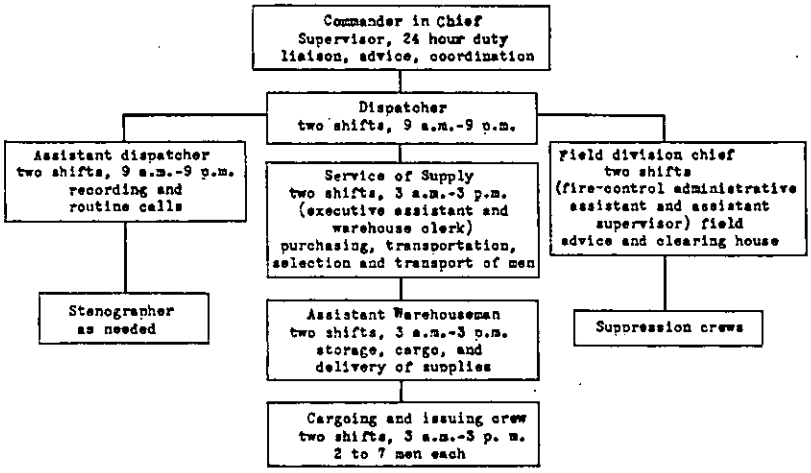
OVER-ALL CORRELATION OF THE SUPPRESSION JOB

F. W. GODDEN

Forest Supervisor, Salmon National Forest Region 4, United States Forest Service

The author was induced to write the following article only by insistence, fearing he might be accused of boasting. He outlines a basic organization plan which is probably much too rare in practice and unfortunately suggests no method short of experience by which the type of training he says is needed can be conducted or acquired. Different conditions and the experience background of local forest officers may necessitate a different division of responsibilities. The chart with the article is the editor's visualization of the organization described.

Much has been written in Fire Control Notes and elsewhere about line organization, the technical phases of fire-suppression planning, equipment, and other features of prevention and presuppression. Very little has been written, however, on over-all forest coordination covering the actual suppression job when a particular forest is having a concentration of fires, some big.



The editor's visualization of the Salmon overall fire-suppression organization.

In the writer's experience in fire suppression in central Idaho for the last 12 years, it has seemed that failure to suppress fires promptly or cope with a bad situation has in large part resulted from poor correlation of the over-all suppression effort on the forest. True, there have been errors made on the fire line and in field technique, but in general these errors have been relatively small when compared with failures to provide adequate overhead or sufficient manpower, a flow of supplies as needed, proper equipment, transportation facilities, or some of the many other things over which the fire boss has

relatively little control. Almost everyone with much fire experience has gone hungry or slept without beds or received crews without tools or seen transportation failures.

The degree of failure has usually been in direct proportion to the size of the job, indicating an organization failure that is difficult to correct through commonly accepted methods of training. The training of an overhead and staff organization that can direct and back up the field forces is a critical need. Dispatcher instructions, fire-control handbooks, job lists, etc., are inadequate in an overload situation when all of the personnel is engaged in suppression, and worry and physical exhaustion are the expected thing. More emphasis should be placed on basic, over-all, organization training.

Beginning with the 1940 season, the personnel of the Salmon National Forest anticipated a suppression overload and organized to try to provide over-all coordination. The organization and training program are outlined in this discussion in order to direct thought and criticism toward this very essential part of the fire job.

A staff organization chart was first made up definitely assigning duties and responsibilities and hours of work to each member of the supervisor's headquarters organization. Needed additional personnel to fit into a off-shift set-up were selected and partially trained ahead of time. The entire organization was patterned on a full two-shift basis through and including the dispatcher's office. The two-shift idea was absolutely essential to enable people to function to the top of their capacities when on the job.

The overhead organization was, of course, headed by the supervisor. The administrative assistant in charge of fire control and an assistant supervisor were designated as field-going suppression overhead. The supervisor fitted himself into the program for the critical overload days as a headquarters officer who would keep in constant touch with all fires, with the regional office, with the routing and the assignment of overhead, with requests for borrowed suppression forces and equipment, and in general to see that no phase of the job was forgotten by the field or the dispatcher or any other link in the organization. Such functions cannot properly be performed by a dispatcher under a constant load of newly occurring lightning fires.

The administrative assistant in charge of fire control and the assistant supervisor went to big fires with radio-communication equipment and acted when necessary as division headquarters officers in the field during the critical days of the fire. They were not fire bosses in the usual sense. They established themselves at a point where diversion of supplies and men was made to the line, at a base camp at the end of the road, or at an airport, where they immediately set up communication with the fire or fires. A ranger or ranger alternate was assigned as actual fire boss. He likewise had radio equipment, which on the larger fires was a *PF* set carried along.

The division headquarters officer acted as coordinator, advisor, and clearing house for the local fire or territory in case of more than one fire. He dealt directly with the supervisor's headquarters on one end and with the fire line on the other. All movement of men and supplies on the fire cleared through him and was coordinated

there. He kept in touch with supervisor's headquarters and alone dealt with it as division chief.

The system set up relieved the headquarters officer of all of the matters that could be acted on by the division chief, relieved the fire boss of thousands of details, and provided a direct overhead check on strategy and procedure. It provided immediate expansion to handle new situations, new fires, large spot fires, and direct correlation between these suppression units. It made possible the prompt and proper attention to many other details that simply cannot be handled by a headquarters officer or central dispatcher.

At the supervisor's headquarters, the dispatching was broken into shifts with a ranger who was an ex-dispatcher taking the opposite shift on about a 12- to 13-hour basis. The shifts changed at about 9 a. m. and 9 p. m., which enabled the regular dispatcher to be on duty to handle all of the regular first-line organization work during the day. The second dispatcher was on duty at night.

A dispatcher's assistant was provided for each shift. He did all routine calling and transimssion of messages, but primarily kept a running log of all action. Each time the supervisor or dispatcher made a call of any importance, a time record was kept with a brief statement of the action. The incoming dispatcher and the supervisor were thus enabled to acquaint themselves quickly with everything that had transpired during their absence; the action record also proved useful in many other ways. Under extreme pressure when things were happening fast with several project fires being handled, a stenographer abstracted and took down a record of actions discussed over the radio or telephone.

The office executive assistant and the clerk in charge of the warehouse were assigned to opposite shifts operated from 3 to 3. These men were in full charge of all purchasing, transport, cargoing of supplies, and selecting, contracting for, and sending out fire-fighter forces. They were advised by the supervisor each day the approximate number of forces that would be on duty for the next 24 or 36 hours. They could guide their purchasing accordingly. They were responsible for keeping sufficient trucks serviced, truck drivers properly rested and ready to go at any time, and for getting supplies to airplanes promptly with complete shipping instructions.

Under the men in charge of service of supply a warehouseman for each shift was also used. His responsibility was the actual storage, cargoing, and delivering of the supplies or forces. The regular warehouseman took the busy day shift and a quickly trained experienced man took the other shift. These two men coordinated their efforts as between shifts. Under them a cargoing and issuing crew functioned on each shift headed by a straw boss who knew the cargoing job well. All supplies that went out were cargoed in canvas, weighed, tagged as to contents, with a routing slip attached. The cargoing crew varied in size from two to seven men, depending upon the work load. This crew likewise operated on a 3 to 3 shift.

All rations were packed according to standard menu lists for bulk lunches to be made at the fire, individual sandwich lunches, hot breakfasts, and hot dinners for airplane transport. A brief ration list was supplied in the event food was to be cooked in camp. These were prepared prior to the emergency. In one instance the crew completely assembled, cargoed, and labeled for pack string delivery

200 man-days' supplies of subsistence and commissary in 15 minutes. Accomplishments of the warehouse organization on the line are summed up in Ranger Lester Gutzman's comment on the Bear Creek fire. The Bear Creek fire was 60 miles to the end of a truck road and 18 miles by foot trail to the west side of the Middle Fork of the Salmon in the Idaho primitive area. It burned 2,460 acres, had 15 miles of perimeter, and was controlled by 200 men during the third burning period. Gutzman said, "This was the first fire in my 18 years of experience on which I never missed a meal or a bed."

Upon receipt of a telephone or radio order from division headquarters to the dispatcher's desk, four copies were promptly made indicating the name of the fire, the items, and the method of transport to be used, naming the particular airplane or pack string if possible. Copies of these orders went to the purchasing division, to the warehouseman, and to the cargoing crew; one was retained at the dispatcher's office. All property and commissary issues were noted on these orders for the warehouse record. Corrections or changes were made and property charges entered on the warehouseman's copy, which was retained as the key copy after the order had been checked and sent. The packing copy went with the order.

Under the system described the supervisor functioned as a commander in chief. He relied on the ranger and the division headquarters officer for field action. He was in regular communication with the fire, the regional office, and neighboring forests. He correlated action between the different parts of the forest, saw that each part of the organization was functioning, and was largely in the business of remembering. Those under the gun are bound to forget; he who is in a detached position is not so likely to do so. The supervisor slept when there was a lull, and there were many during the 24 hours, and he was not particularly overworked. He could consequently do his over-all job better. He was tied to no details except for short periods and where most needed, such as at the dispatcher's desk when a concentration of lightning storms occurred. He then stepped in and helped.

The Salmon organization plan had a thorough test on the forest last summer. It handled 162 fires during the season. At one time during August 22, 23, and 24, in addition to having crews on 1 class C, 1 class B, and 3 class E's that had occurred on the days just preceding, 52 class A's, 8 class B's, 6 class C's, and 2 class D's were handled, with 500 men and no supplemental outside overhead. Fifty-two of the sixty-eight fires occurred on August 22 and there were also many reports that proved to be false. One of the A's, 2 B's, and one D were extra-period fires.

The kind of situation indicated and worse probably can be expected frequently on the Salmon. The fact that there were any extra-period fires and one outstanding mismanaged fire shows a weakness in the organization. It indicates that much yet remains to be done. Improvement will come in fire-line technique, better equipment, and better trained men, but largely in a better correlated organization.

The history of all wars and all military campaigns indicates that organization from the top is one of the primary keys to success. Critical scrutiny of fire-control efforts should therefore include forest and regional organization set-ups. Thought and training directed toward improvement in over-all organization will really pay dividends.

WAR GAMES ENDANGER FORESTS

LEIGH HILLIKER

Forest Ranger, Wisconsin Conservation Department

We do not ordinarily think of the national defense program as adding new hazards to our work. However, the author describes one phase of this program as it affects the fire-protection work of foresters. It is particularly illustrative of the results which can be obtained through wholehearted intelligent cooperation between the Army and a forestry organization.

Central-area forest-protection personnel in Wisconsin had some serious misgivings early in the summer of 1940 when it was announced that maneuvers of the Second United States Army were to be held in the area during August, potentially a month of the highest forest-fire danger. Maps showed the five base camps and scattered training areas covered large tracks of some of the worst fire country in forest-protection districts 9 and 10. A force of about 65,000 men and 7,500 motorized units was expected.

Action was started through the forest-area supervisor's and district rangers' offices to meet the increased risk from smoking, campfires, motors, and visitors. A memorandum listing forest-fire dangers, Wisconsin fire laws, means of preventing and methods of suppressing forest fires, and asking cooperation was sent to Army headquarters. Army authorities responded by including a section in their manual of instructions about fire dangers, prevention, and control. All troop units were given these instructions before leaving home bases. Conservation Commission Order M–171, restricting the use of fire in Wood, Juneau, Jackson, and Monroe Counties was also invoked.

On August 8 a meeting of central-area personnel was held at Black River Falls. At this meeting were Forest Area Supervisor H. T. J. Cramer, District Rangers Vern Hilliker and Einar Jensen, rangers, towermen, cooperating foresters, and conservation wardens in and adjacent to the maneuver area. Radio communication schedules, information to be secured from the Army, labor, equipment, and other details were discussed.

Five rangers were assigned to Army base camps to act as technical advisers to the Army on fire prevention and control and coordinate information to the dispatchers' offices. Assignments were as follows: Cooperative Ranger Pauly to Camp McCoy at Sparto, Cooperative Ranger Sylvester to Warrens, and Ranger Papke to Wyeville, all in Monroe County; Ranger Fisher to Shamrock, Jackson County; and Ranger Hilliker to Camp Williams and Necedah, Juneau County. Extra two-way short-wave radio and truck equipment had been supplied from northern areas so that each man would have a complete transportation and communication unit.

On August 9 a conference was held with the Second Army provost marshal, Colonel Baldwin, and assistant provost marshals, at Camp

McCoy. Provost marshals act as military fire marshals. It was learned that rangers stationed with the Army would be accorded officer's accommodations in the way of quarters, mess, etc. Also that all troops had been instructed in care with smoking, campfires, and motors, and would take the initiative in reporting and suppressing any fires starting. Trench tools, wet sacks, and boughs were to be used and reinforcements of men or equipment were to be called as needed over Army or WCD communication systems or both. Colonel Baldwin stated that the Corps of Engineers had special equipment and skill for fighting large or stubborn fires. Officers were instructed that forest-fire suppression would take precedence over all other operation and to furnish labor to rangers on request.

On Monday, August 12, all five rangers assigned to the "war" were at their camps with fire trucks and radio equipment and engaged in meeting commanders of specialized units, gathering maps, information on type and location of operations, and special fire hazards. In many cases, copies of the field order covering the immediate maneuver or problem were furnished.

Adjacent to each base camp was a training area. The lands consisting of about a township had been previously leased by the Army from the owners and were widely used for cross-country movements. The owner of any land suffering unusual damage was to be reimbursed by the Army Rents and Claims Section. The territory used provided several types of topography from the rugged hills of western Monroe County to flat stretches of marsh and jack-pine plains of central Juneau County. Comparatively small problems in battle tactics, transportation, service of supply, communications, etc., were carried on daily in these areas by infantry, artillery, cavalry, and observation squadrons or combinations of such forces.

Smoke screens were to be reported to rangers in advance and sample pots were set off for the purpose of drilling towermen to distinguish them from forest fires. No incendiary or tracer ammunition was to be used, thus eliminating a serious risk of fire. Blank cartridges were to be used except on the target range. Flying officers explained that flares would be dropped from planes at such an altitude as to be burned out and cold on reaching the ground. Orders were to watch Very pistols closely so that they would not cause fires. Campfires, smoking, and field kitchens were to be allowed only in safe places.

Each ranger followed a similar schedule in gathering and condensing information from the command post each morning on the type and extent of the day's operations and then sent a report by radio and telephone to dispatchers at Friendship and Black River Falls so that areas of greatest fire risk were anticipated. Advance plans and location of units available for fire fighting and communications were also reported. On many days the ranger accompanied troops in areas of hazard, watching for signs of carelessness with fire by soldiers and the public and always ready to rush to a danger spot. Rangers kept in radio communication with towermen at 15-minute intervals.

Old Jupiter Pluvius was very accommodating to the fire-control force, if not to the Army. Some rain fell on 13 of the 20 days of the maneuver period, which made it possible for rangers to return at times to their regular stations and attend to other duties. To many troopers, Wisconsin is the land of swamps, rain, and mosquitoes.

On August 23 the entire Second Army divided into two forces composed of the V Army Corps, called the Blues, and the VI Army Corps, called the Reds. The two forces drew apart and established secret concentrations near Necedah and the Mississippi River, respectively. At 12:30 p. m., August 24, a large "battle" started. Scouts were sent out to locate the "enemy" and report back to headquarters. Forces moved up during the night to the "front lines" in the vicinity of Tomah, Warrens, Millston, and Purdy Valley. The operation was to be continuous, night and day, until August 27, but incessant rain and the fact that the tactical problem was completed ended the battle on General Ford's order the afternoon of August 26. On cessation of "hostilities" the Reds had pushed the Blues back, according to umpires, but the Blues were organizing a counter attack.

During the battle troops, trucks, and other equipment covered about one-half of forest-protection districts 9 and 10. No doubt there would have been more foreset fires if more than twice the normal rainfall had not fallen. The month was the wettest August in some years. Smoldering campfires and burning cigarettes were observed, possibly where a speedy retreat was made, but as a whole the Army gave the forest-protection division and helpers very fine cooperation and service.

Only two fires, burning a total of 2.1 acres, were caused by the Army and required assistance from the forest-protection division.

Errata—January 1941 Fire Control Notes.—In Fire Control Notes for January 1941 appeared an article entitled "A Planning Basis for Adequate Fire Control on the Southern California National Forests," by S. B. Show, C. A. Abell, R. L. Deering, and P. D. Hanson of Region 5 and the California Forest and Range Experiment Station, U. S. Forest Service.

This article was preceded by an "Introduction," intended by Fire Control Notes as a leader, which was written in the Division of Fire Control of the Washington office. The leader should have been printed in smaller type with the indentation customary for such leaders and not in the regular type, under the heading "Introduction."

As the leader was neither written nor reviewed by the authors of the article before publication, it therefore, should be considered entirely independently and should have been so indicated. Any review of that article should be made with this correction in mind.—Division of Fire Control. W. O.

Errata.—The chart on page 78 of the April 1941 issue of Fire Control Notes should have appeared with Arthur A. Brown's article, replacing those on page 90. These two charts on page 90 should have appeared with E. Arnold Hanson's article just preceding Brown's.

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FIRE NEWS BROADCASTS TO FOREST OFFICERS—WITH PUBLIC CONTACT ASPECTS

ALBERT E. STRAUB, JR.

Bighorn National Forest, Region 2, U. S. Forest Service

What is believed to be the newest method of giving the latest up-to-the-minute fire news and information to forest officers and others interested in fire protection; that is, by broadcasting from a commercial station, without remuneration from the Forest Service, was inaugurated at Sheridan, Wyo., in July 1940. Although the programs have direct value on the forest, Straub believes they have at the same time been of far more interest to the public, because of the psychology used in their presentation, than the usual program designed entirely for publicity purposes.

After consulting with the local forest supervisor, the manager of Radio Station KWYO at Sheridan, Wyo., inaugurated a forest-fire protection program to be broadcast as "The Rangers on the Mountain" each morning except Sunday, at 7:15, and on Sundays when fire conditions made a broadcast necessary, the program to be known as "Your Ranger Station Program." The manager of the station is Jack R. Gage, formerly State Superintendent of Public Instruction in Wyoming.

Because it was thought that the public would be more interested if they felt they were listening in on something not meant entirely for their ears, the program was broadcast to the rangers and gave them fire data and other information.

Each day data was furnished radio station KWYO, on going fires, fire-danger station readings from one of the lookouts, weather readings from the local office of the Weather Bureau, time of sunrise and sunset, time signals, fire conditions in general, and the outlook for the day, news of local interest to forest officers pertaining to their work, or information on the movements of both local and visiting forest officers. Some humor was also thrown in so that the program would not bore the listeners. To round out the programs, spot announcement transcriptions, prepared by the Washington office, were furnished, and for another season it is planned to use more of these so that they will not become tiresome.

Following is a complete broadcast as given over KWYO for one morning:

"Good morning. This is the Ranger Station Program. The date is Tuesday, August 13. Sunrise this morning was at 5:07; sunset will be at 7:18. The weather report this morning is * * *. Report from Black Mountain Lookout at 3 p. m.: Northeast wind, 12 miles per hour; wet-bulb reading, 51; dry-bulb reading, 72; relative humidity, 25; fuel stick, 7 percent; no rain reported; deduction for condition of annual vegetation, 3; daily evaporation, 5.9; total cumulative evaporation, 37 plus; fire danger 74 * * *. Get ready to set your clocks and watches (time signal).

"Fire reported 13 miles southeast of Lodgegrass on the Indian reservation. They called for help and a foreman and 25 men were sent from the Turkey Creek CCC camp. They left during the night. No report back yet as to progress.

"It has been called to our attention that the readings as taken from the lookouts do not give a true picture of the actual hazard. For very obvious reasons, the lookouts are located on exceptionally high spots, and as a result of location in the high country, the hazard is never as great as it is in the lower parts of the mountains. So when we get bad reports from the lookouts, you can know that the conditions on the mountain in general are much worse than the reports indicate.

"It is reported from the Forest Service office that the Assistant Supervisor, Mr. Clark, left for the Burgess Ranger Station, where he will remain until Tuesday night. We reported last week that Mr. Connor was making a trip on the mountain and would end up at the Porcupine Station, where we understand he is now and will remain until the end of the week.

"A report from Ranger Post that might be of interest to Ranger Vinacke was to the effect that in the continued search for the body of Donald Long, in Lake Solitude, fires had been built around the shores of the lake and from these fires there had started a creeping fire in the slide rock which fire is reported as still burning. We gather from the report that the fire is not now of a serious nature but will bear watching. Being ignorant of the forest and the way of fires, we made the obvious remark that it must indeed be a dry season when slide rocks caught fire. The boys in the forest office were very nice and explained that these rock fires were not bad and that the only reason they paid any attention to them at all was to keep from burning the tops of some of our higher peaks. Yes, if it were not for the boys in the forestry office we would probably go along never knowing these interesting things about rock fires. *Until tomorrow, have a good day, and no fires.*"

[Bighorn personnel believe that these broadcasts are obtaining the results desired. Information of general and special interest is distributed to various forest officers, to visitors in the forest, and to local communities. Rangers are religiously tuning in when they can, and a great deal of interest is shown generally.—Ed.]

Emergency Rations on the Pisgah.—One of the problems of fire fighting in the Appalachians is to supply "grub" to men on fires. Attempts have been made to provide hot lunches, but usually the lunches were cold or the fire fighters had to walk a long way to get them. Cold lunches, consisting of sandwiches, were next tried, but usually these were soggy and unappetizing.

The emergency rations now used on the Pisgah are prepared for the standard 18-man crew, and are carried in a portable box by the truck driver and water boy. The box is standard equipment on all fire trucks, and accompanies the fire-tool box.

The emergency rations consists of: 2 pounds coffee, 1 pound sugar, 4 pint cans milk, 2 pounds hard tack, 1 gallon fruit, 1 coffee pot, 5 pounds corned beef, 4 quarts pork and beans, 1 gallon tomatoes, 1 can opener, 1 knife, 2 large serving spoons, 2 dozen each of paper plates, cups, and spoons.

Some of the districts on the Pisgah have been using four loaves of bread in the emergency rations, changing the bread daily. The general set-up, however, is the same.—John B. Fortin, district forest ranger, Pisgah National Forest

A PROGRAM FOR THE VIRGINIA-KENTUCKY-WEST VIRGINIA "HOT SPOT"

An analysis of statistics revealed that in the area where Virginia, Kentucky, and West Virginia join, containing but 7 percent of the protected area of region 7, 14 percent of the total number of fires occurred, and burned more than 34 percent of the total area burned. To formulate a comprehensive fire-control program for this "hot spot," State Forester D. B. Griffin, of West Virginia, called a meeting of representatives of the three States concerned and the United States Forest Service. The following recommended program was developed at this meeting:

1. Contact the larger timber landowners and operators and solicit their support in an intensive fire-control campaign in the districts within which their lands lie.

2. Request owners and operators to notify by letter all employees, lessees, and tenants on their lands of their intentions and to solicit their cooperation in the prevention of forest fires on their particular leases and on lands in general. The notices are to be signed by the highest company official that can be reached.

3. Request each company to post a notice on company bulletin boards or at other conspicuous places on its property, warning all employees, lessees, and tenants to use care to prevent forest fires.

4. Where there are inadequate brush-burning laws, ask each company to insist on employees, lessees, and tenants living on its property securing a permit from the company before burning brush or debris on their leases.

5. Request each company to appoint a warden who will have direct supervision of the first-control work on company lands and who will have the backing of the company in such fire-prevention activities as may be initiated and authority to summon employees, lessees, and tenants of the company to assist in fire-suppression work and with whom the State's district forester or his representative may collaborate in the preparation of a definite written fire-control plan for the lands of his company, which will show:

(*a*) Fire-prevention methods to be adopted.
(*b*) The distribution of manpower and equipment.
(*c*) The detection and dispatching system.
(*d*) The set-up for handling the normal fire load.
(*e*) The set-up for handling an emergency fire load with provisions for replacements and reinforcements after regular crews are dispatched to the fire line.
(*f*) Definite assignment of responsibility for the various phases of the fire-control job.
(*g*) Definite detailed written instructions listing the jobs to be accomplished.
(*h*) Provision for follow-up supervision and inspection; coordination of the efforts of all agencies on the company lands or within the community capable of contributing to the forest-fire control program.
(*i*) Selection of a supression crew of from 5 to 25 employees, lessees, or tenants of the company.

(Continued on p. 153)

FIRE-CONTROL WORK IN ISOLATED SECTIONS

J. H. SIZER

Assistant Supervisor, Tonto National Forest, Region 3, U. S. Forest Service

Upon request, the author prepared this article with the thought of raising question about some of the fire-control problems in isolated sections and offering suggestions for meeting them.

Success in fire-control work in isolated sections, as in other places, depends on having the right man at the right place at the right time with the right kind of equipment. To do this with a limited organization of men and equipment is not easy, however. In isolated sections, where fires almost invariably involve the moving of men, supplies, and equipment considerable distances over mountainous terrain on foot or with pack animals, it is particularly difficult. Moreover, the men arrive on the fire line exhausted several hours after the fire is first discovered to find that the fire has developed from an insignificant smudge to a roaring inferno that singes the brush and cover from an entire slope before a tired fire fighter can scramble a dozen yards in an attempt to beat it to the top.

To meet the needs of such a situation, it is necessary to send out a weary messenger with a call for more men, who may arrive a day or two later to find the initial crew worn out but still working at some hazardous point on the line, while the greater part of perimeter of the fire burns on undisturbed. Obviously, the needs are communication, transportation, and a reasonable supply of manpower distributed through isolated fire-hazard areas during fire-danger periods.

Throughout the Forest Service much thought has been given to the problem described and a great deal of progress has been made in organization and in the development of special equipment, ranging from hand tools to fire finders, portable pumps, and radio phones. Airplanes are being used to transport men and supplies, but their use is still in the experimental stage and may not prove the answer in all cases. Most, if not all, of these developments have been put into use throughout the Service insofar as funds permit and local conditions require, but the allotment of funds to isolated areas is not always sufficient to provide needed protection.

In an effort to provide better protection, trail crews, made up of two local, dependable, experienced men, are stationed at strategic points in isolated areas during the fire-danger periods. They are provided with one saddle and one pack animal each and the necessary tools and camp equipment for hand work on trails or fire fighting, and are used in construction and maintenance of horse trails needed for better transportation.

These crews are equipped with an S or SV radio transreceiver set, which, in conjunction with type T stand-by sets installed on lookout points, provides a quick and efficient means of communication. A

fixed schedule is arranged for communication with lookout points, and when a fire is discovered it is reported by radio to the nearest trail crew, which immediately goes to the fire. If additional help is needed, the lookout is called by radio and the next nearest trail crew is dispatched to the fire, and so on.

This arrangement is effective in handling fires in isolated areas until a situation develops in which the number of men available within reach is insufficient to handle the situation and larger crews must be provided. In the fire-organization plan for each ranger district the sources of man power, the numbers of men, tools, and equipment, trucks for transportation, and pack and saddle animals available are indicated. In theory the plan provides that in case of a serious break requiring a large crew, it can be obtained by calling upon manpower and equipment nearest the scene of action. This is all right insofar as truck transportation is concerned, but in handling fires in inaccessible, isolated areas, it may be difficult to obtain sufficient pack and saddle animals without undue delay. Such animals must usually be obtained from local ranchers, who normally turn out on the range the saddle and pack animals they are not using, and although ranchers may have the number of stock indicated on the organization chart, if more than a few head are needed they must be gathered from the range and shod before they can be used. Several hours delay frequently occurs in getting pack animals needed to transport supplies to a big fire.

Under such circumstances it is necessary to walk the fire fighters from the end of truck transportation to the fire, and frequently each man must carry his tools and a small amount of food and water on his back. A fire fighter is frequently well-nigh exhausted by the time he arrives at the fire and his efficiency is materially reduced. An orderly check of men and supplies arriving at the fire is extremely difficult, as men are apt to discard their packs and start work on the fire where they first strike the line. This disrupts organization and frequently results in a surplus of manpower at some points on the line and a shortage of help at others with an unknown quantity of supplies and tools, the location of which is known only to the men who carried them in.

Maintaining a reasonable number of Government-owned pack animals at a point where they can be placed in service on short notice would meet this situation. Such an arrangement might mean locating a pack train where the animals could be transported to the nearest point to the fire accessible by truck, which normally would be the truck supply base for use on that fire. It would necessitate having ready for service trucks equipped with stock bodies and tail-gates suitable for loading and unloading pack animals. Pack trains could go in when men and supplies were dispatched, and delivery of tools and supplies for a fairly large crew could be made at the fire line by the time they were needed. If additional pack animals and a larger crew where found to be necessary, the additional animals could be obtained from other sources in time to avoid disastrous results.

For use in rough mountainous country, such as is found in the southwestern region, where grass is frequently scarce and pastures nonexistent, burros may be more desirable than mules for pack animals as they are more easily kept around a camp, are less apt to stray, will

subsist on scant forage, will carry almost as much load, are easier to load, travel almost as fast, and are less likely to stampede with a pack.

During periods when the pack train is not needed and fire conditions do not necessitate keeping pack animals available for use on short notice, they can be turned out on pasture or kept on forest range with little or no expense until such time as they are again needed. The suggestion for such use of pack animals is not offered as new, but rather as a recommendation for wider use of an effective and economical means of transportation.

Radio on a Forest Fire.—The first use made of radio in Wisconsin Fire-Protection District 7 was to ascertain how far messages could actually be sent and received satisfactorily. In testing best results were obtained in communication from ground to forest-protection lookout towers. The tests were successful over distances up to 18 or 20 miles.

October 3, 1939, was a bad fire day; the humidity was low and the temperature high, and a brisk southwest wind prevailed. Several crews working out of the Hayward Ranger Station had been dispatched to fires and shortly after 3 p. m. the Pipestone towerman picked up a smoke to the northwest. The dispatcher checked with other towermen but because the visibility was poor, the towermen could not see the smoke.

After checking on our map the reading and distance given by the Pipestone towerman and the type of forest cover, it was decided that I would go immediately with a crew and a radio to the fire. When we arrived in the vicinity of the Chippewa Flowage, we spotted a smoke, but it looked so close we were almost certain that it was out on one of the many islands on the flowage. Many comments were offered by the men while the radio was being set up, such as, "Towerman must have been wrong; that smoke is out on the flowage as sure as I am a foot high."

The Pipestone towerman had been instructed to be on "stand-by receive" and was contacted immediately. He informed us that the fire was in the hardwood and hemlock slashing south of the Chippewa Flowage and also south of the Ind'an village called New Post. I asked him to inform the dispatcher at Hayward of our location and that we were proceeding to the fire immediately.

We finally arrived at the fire and soon had it under control, making use of the radio frequently to communicate with the towerman, and, by a combination of radio and 'phone, with the dispatcher and other stations.

Had we not had the radio, I am certain that in this case we would have stopped at the nearest boat landing and gone out on the Chippewa Flowage in quest of this fire, which would have resulted in our not finding it for several hours. The radio set is now taken along to every fire and considered just as important as the regular fire-fighting equipment.—Clarence Johnson, Wisconsin Conservation Department.

Spread of Cheatgrass Increases Fire Hazard.—During the last 10 years downy chess or cheatgrass (*Bromus tectorum*) has extended its range perceptibly on and adjacent to the Holy Cross National Forest. Overgrazed areas in the lower to moderate ranges of elevation and roadside zones have in many places reverted almost solidly to cheatgrass.

In normal years the spread of cheatgrass would cause little concern from a fire standpoint. However, during the last few years the dry seasons have forced consideration of this plant as a serious fire menace. It is understood that Region 1 rates cheatgrass as one of the flashiest of fuel types, and this rating is well substantiated in the few fires which have occurred in this type on the Holy Cross. Because of relatively heavy human use the roadside strips present the greatest hazard.

Heretofore restricted in intensity by elevation, a limited range, and an abundance of moisture, the cheatgrass fire hazard must now be given a high rating in fire planning.—D. S. Nordwall, assistant forest supervisor, Holy Cross National Forest.

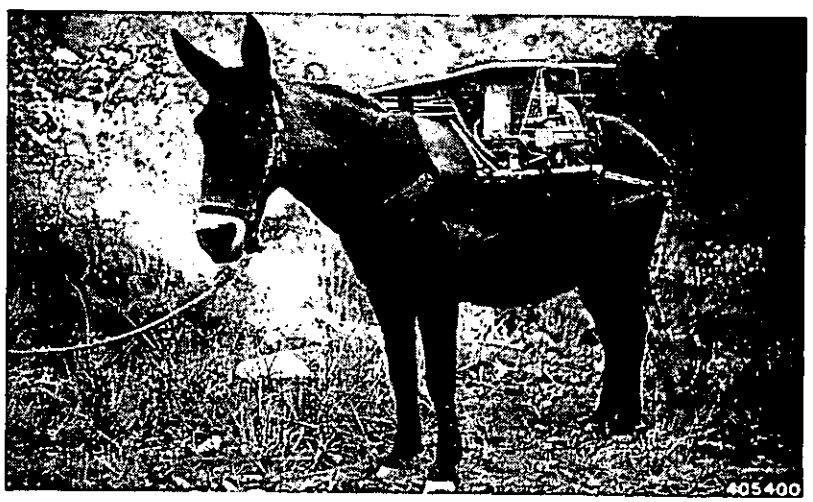
A PORTABLE FLAME THROWER

NEIL L. PERKINS

Los Padres National Forest, Region 5, United States Forest Service

Mobility of tools and equipment over all types of terrain greatly increases their usefulness. This new unit, which was adapted from equipment described in a former issue, will add to our ever-increasing store of knowledge. Local ingenuity has adapted the practice of using a shield for protection in oil and gas fires to forest-fire fighting conditions.

When the mobile flame thrower described in FIRE CONTROL NOTES (July 1940, Mobile Flame Thrower) was sent to Los Padres National Forest for a try-out, Forest Supervisor S. A. Nash-Boulden and his associates were quick to perceive its possibilities. In its original design, however, the flame thrower could be used only on roads or truck trails—a serious restriction to its use on forests where



F-405400

Ready for the trail into the back country with flame thrower on board.

most of the fires occur in rugged country accessible only by steep horse and foot trails.

Los Padres mechanics went to work on the new machine. Removing it from the trailer entirely, they mounted the pump, engine, and a small tank on a special stretcher frame to be carried by two fire fighters. This was better for use on the Los Padres Forest, but involved the services of four men for transportation—two carrying and a two-man relief crew. As manpower in the back country is often at a premium, the idea of mounting the outfit on the back of a pack mule was suggested. The suggestion was met with a series of dubious grins since the idea smacked a good deal of tying a bunch of firecrackers to a mule's tail. However, the supervisor had not handled mules in the southern California mountains for some 30-odd

years without knowing their possibilities. After a special pack frame had been made and tested, "Jack," the selected animal, could carry his snapping, crackling burden quietly and efficiently. Moreover, a dozen of his four-footed associates also have been trained and are now ready to traverse the fire lines under this unusual load.

In field operations with the flame thrower the intense heat at times made it necessary to protect the operator. After considerable experimenting, a tip made by a No. 70 drill was installed at the end of the 6-foot aluminum pipe ¼ inch in diameter.

To give additional protection from the heat, a reinforced asbestos aluminum shield that weighs only 6 pounds was added. The shield is 24 inches wide and 42 inches high, with the top slightly curved. There is a 3- by 3-inch peephole, covered with a Coleman Mica

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Los Padres portable flame thrower in use as a stretcher-type unit. Note the protecting shield.

lens, centered 8 inches down from the top, and a 6-inch handle centered on the shield 19 inches up from the bottom. An oblong hole was cut with a ½-inch radius at the top and bottom 2 inches long to the right of the handle, 17 inches from the bottom, and 9 inches from the righthand side. Through this hole the 6-foot aluminum pipe of the flame thrower passes. It is then fastened in place by bolts through the shield and a bracket fastened to the flame-thrower pipe. The end of the pipe is fastened to the hose or control line and has a slight downward bend for comfort in handling.

On each side of the stretcher two telescopic handles slide inside of the pipe frame and are held in place by wing-nut bolts. When desirable to use this unit stretcher style, the two inside handles are pulled out to their proper position and tightened by the wing-nut bolts. The outside handles have to be pulled clear out of their keeper and placed inside the opposite end of the inside holder and tightened by the wing nuts provided. The operation described, although sounding quite complicated, is actually simple.

The flame-thrower unit is easy to pack. The shield is fastened firmly by wing nuts to the top of the pack, and the flame-thrower assembly fastened to one side of the pack frame in a suitable position to permit packing without difficulty. The 50 feet of hose can be coiled around the pack frame and held in place by a strap on each side.

The engine and pump weigh 49 pounds, the 5-gallon can full of Diesel oil weighs 50 pounds, the 50 feet of hose, frame, and other parts weigh 54 pounds. The unit, therefore, carried in stretcher style, including the 6-pound shield, weighs 159 pounds. The addition of an 11-pound special rubber pad for the protection of the mule makes the total weight 170 pounds, mounted on a pack animal.

The unit, as finally made up, may serve three purposes. First, it can be placed in a truck or pick-up, connected to a barrel of Diesel oil, and used to backfire along roads or any place where it is possible to drive the vehicle. Second, it can then be put on a pack animal, and the backfiring can be continued until the fire line becomes too rough for pack stock to travel. Third, by use of the telescope handles it becomes a stretcher-type unit, and can be carried by men into country accessible only by foot travel.

The whole unit is held firmly on the pack animal by an extra cinch buckled to the exterior part of the frame on each side. This simple device eliminates the use of rope which might cause injury to the mechanical parts of the unit. An empty first-aid can is fastened to the engine frame upside down and contains an extra spark plug, cranking ropes, and tools required for repair work.

The capacity of the tank on the pack or stretcher unit is 5 gallons. The 5 gallons of oil will burn for 18 minutes continuously, or about 30 minutes as used on most backfiring jobs. With two pack animals carrying 20 gallons each, and another 5 gallons in the flame-thrower unit on another animal, it is possible to do a 5-hour backfiring job.

Fires, Insects, and Game.—In the field of agriculture and in agricultural literature there are many facts and much evidence that fire-control men may find useful in their presuppression educational work among the public.

Some people are of the opinion, for example, that by burning off fields, marshes, and fence-rows, they will destroy noxious weeds and insects that attack farm crops. Such burning often results in wood fires. It is true that fires may destroy the weeds, but surprisingly few farm pests are destroyed by burning. It has also been found in experimental work that burning kills the better grasses and forage plants, that burning weeds only destroys the current year's crop, and that seedbed conditions following burning are improved so that the next year's weed crop may increase.

On the other hand, the fires destroy the birds that prey on the insects. The birds would destroy more in one season than would be destroyed by burning in many seasons. Grasshoppers, for example, make up a large part of the diet of pheasants. It is true that pheasants eat a few garden crops, but the damage that would be done by the grasshoppers they eat would greatly outweigh the damage done to the crops by the pheasants. I have never found an agriculture or soil-conservation expert who approved of burning to eliminate insects.

What do these facts and observations have to do with the technique of fire control? Perhaps very little directly. However, they do make effective arguments for use in fire-prevention educational work among farmers. The point here is that fire-control men can make their prevention work with the public more effective by learning to talk the language of the groups they are trying to reach, knowing something of their problems, and of the answers to them.—R. C. Kirkpatrick, forest ranger, Wisconsin Conservation Department.

WATER—THE FIRE EXTINGUISHER

F. W. Funke

Specialist in Fire Control Equipment, Region 5

The beneficial effects of the spray nozzle have been recognized for some time, but the cost of suitable nozzles for forest-fire control work, together with a lack of available information, have been problems confronting many forest officers. The author, after many trials, developed a new and inexpensive nozzle which may materially stimulate this phase of fire-control work.

In the early days of organized forest-fire protection water was considered of questionable value as a supplement to hand-tool equipment. Limited crews and poor transportation being the rule, it was a rare occasion which permitted the use of manpower to haul water. It was seldom that water played a part in first attack. Over the years the picture has changed considerably. Water-using equipment has reached a high state of development, techniques have been established, and in the area which can best be served by tank trucks, water is now the primary initial action weapon.

Of the many factors which have contributed to this development probably the most important is the large percentage of man-caused fires which occur within a relatively short distance of roads and can be reached with tank-truck equipment. Equally important is the fact that a high-pressure hose line in the hands of an experienced suppression man is much more effective in extinguishing a hot fire than the standard five-man crew equipped with hand tools.

The Value of Water in First Attack

It has been demonstrated beyond question that it is always possible to attack a fire directly with water. The judicious use of water enables a crew to secure much more rapid control and hold a greater length of line per man and permits doing a given job quickly and with a minimum of fatigue. Fire perimeter being reduced to the most practical minimum, the result invariably can be expressed in terms of small area burned and low suppression cost.

In first attack it is not always possible to use direct-attack technique with hand tools alone. Rate of spread, intensity of the fire, and other conditions usually create situations which call for indirect treatment. The latter method is an entirely practicable and satisfactory approach; however, it does have one serious disadvantage. In flashy fuels the increase in fire perimeter which must be handled because of the method of attack quite often proves disastrous. It is generally accepted that indirect attack on an initial-action job always introduces possibilities which are hard to evaluate at the outset.

Tests have been conducted at various times by fire-suppression specialists to determine the value of water in first attack. Such tests have never been carried to a conclusion which can be supported by

statistical data because of the simple practical fact that when water is used to support hand tools the action is so completely changed that it bears little resemblance to the usual performance. There is no question in the minds of suppression men as to the value of water in first attack, and while it is difficult to measure the effectiveness of water as compared to manpower, accepted opinion seems to indicate that for an average fire condition, a crew of four men equipped with the usual hand tools and one back-pack outfit is a more effective unit for direct attack than a six-man crew equipped with hand tools. When water is used there is a very definite economic advantage in manpower.

Concurrent with Forest Service development in water-using equipment, the States, counties, and various cooperative agencies have followed a parallel plan from which, it would seem, that the five-man suppression squad equipped with a standard tank truck and its auxiliary equipment has proved to be the most flexible and efficient unit for general fire-suppression work. The power pumper permits attack under conditions which would be hopeless for much larger crews equipped with hand tools. As compared to hand-tool work, the power pumper extends the effectiveness of suppression crews in the ratio of about three to one. However, it should be kept constantly in mind that tanker use must be coordinated with and supplemented by hand-tool work.

Water Volume or Efficiency?

In municipal fire departments the technique developed for the application of water appears to vary as widely as the individual experience of the supervisory personnel. A somewhat similar situation exists in forest-fire control agencies, yet all will agree that the basic principles are the same whether applied to structures or forest cover. On one point at least there is general agreement—entirely too much water is used to do a given job.

With respect to water it is known that:

1. No element or substance has greater heat-absorbing qualities.
2. The efficiency of water as a fire-extinguishing agent depends almost entirely on the surface area of the water exposed to the fire.

If thinking is confined to the potential effectiveness in each gallon of water projected through a hose nozzle, a number of interesting problems appear. A simple test arrangement will answer many questions.

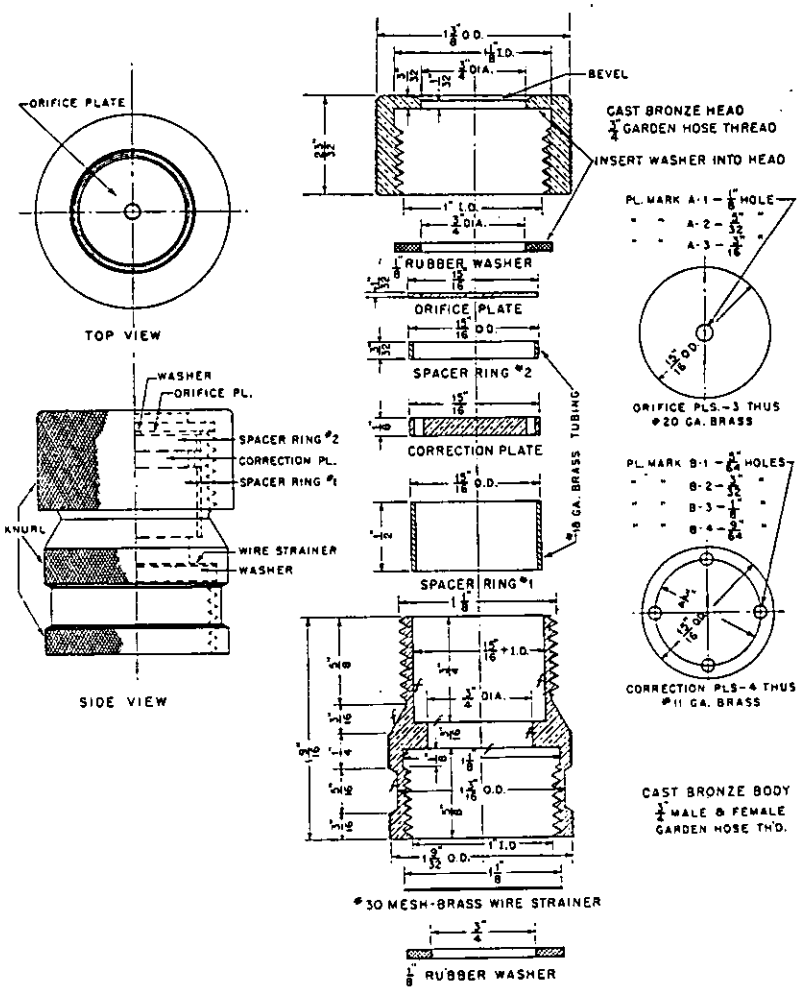
Using 250 feet of 1½-inch hose:

Pump pressure: 95 pounds per square inch.
Nozzle tip: One-fourth inch.
Nozzle pressure: 80 pounds per square inch.
Approximate discharge: 16.3.

Under the conditions given water is flowing through the nozzle at a velocity of approximately 118.9 feet per second at a rate of 0.27 gallons per second, or slightly more than 1 gallon for each 4 seconds of operation. Even with the low pressures indicated a considerable quantity of water is flowing. A ¼-inch stream presents a very small diametrical head to any fire and efficiency is at a low point. Also, it should be quite clear that slight misdirection of the stream can be expressed as waste. Referring again to the rate of flow, 16.3 gallons

per minute, little imagination is required to realize that for a given quantity of water projected through a fire hose, a surprising total is lost. The loss can be reduced by careful application but can never be eliminated. From the standpoint of efficiency, the only useful functions of the straight stream are:

1. Drilling into soil and duff.
2. To reach heights greater than 25 feet.



Hose nozzle designed for use in forest-fire suppression.

Despite the fact that the vapor tip is generally accepted to be the most efficient water applicator known to science, it has not been well received. There are many reasons for this attitude on the part of the field, but it is quite likely that the most important one is cost. Until quite recently, vapor nozzles have been priced well beyond the reach of lean budgets. A second reason and quite as important, is lack of information on the utility of the device.

Nozzle Types

Quite a number of so-called fog nozzles are available but very few produce anything more than a fine spray without resorting to excessive working pressures. Practically all nozzles designed to produce spray or vapor have been developed to meet a particular condition with the result that there is a wide range of performance. None is entirely satisfactory for forest-fire suppression work because:

1. All have been designed primarily for particular applications which are not comparable to the forest-fire problem.
2. Spray velocity is lacking, or, if velocity is available,
   - (*a*) the spray is too coarse,
   - (*b*) the spray is a hollow-cone pattern.
   - (*c*) the spray is a shallow curtain.

The vapor tip was first used in oil-field fires to provide an insulating shield so that cappers could approach intense fires without danger. From this field they have been applied to practically every fire problem.

The ideal vapor tip for forest-fire suppression is one in which:

1. Maximum volume of vapor is produced per unit volume of water.
2. Theoretical discharge velocities are maintained in order to secure maximum projection of the vapor.
3. Vapor pattern is uniformly dense with a diameter of not less than 6 feet at a distance of 20 feet from orifice.
4. Complete vaporization will be secured at pressures not to exceed 300 pounds per square inch for discharge capacities up to 12 gallons per minute.

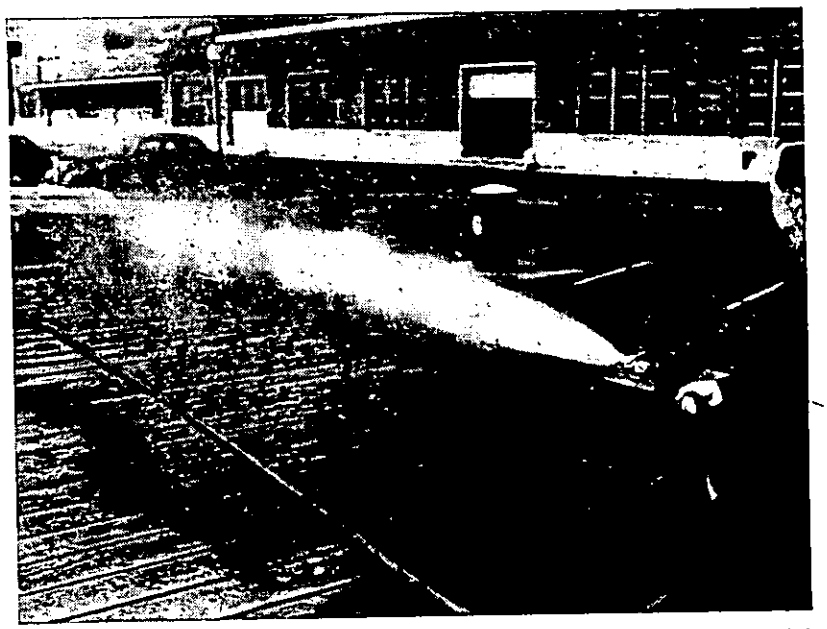
The writer has conducted various experiments with novel designs of spray tips for several years in an endeavor to secure a satisfactory compromise design which would meet the conditions suggested. Early in 1940, a suitable model was perfected which has since been placed in service in the field. An application for patent is pending which, if allowed, will dedicate the patent to public use. The tip is simple in form, can be attached to any standard ¾-inch garden-hose thread, and is so designed that it can be manufactured as a production item. Cost is approximately the same as that of any well made garden-hose nozzle.

Comment on Water Applicators

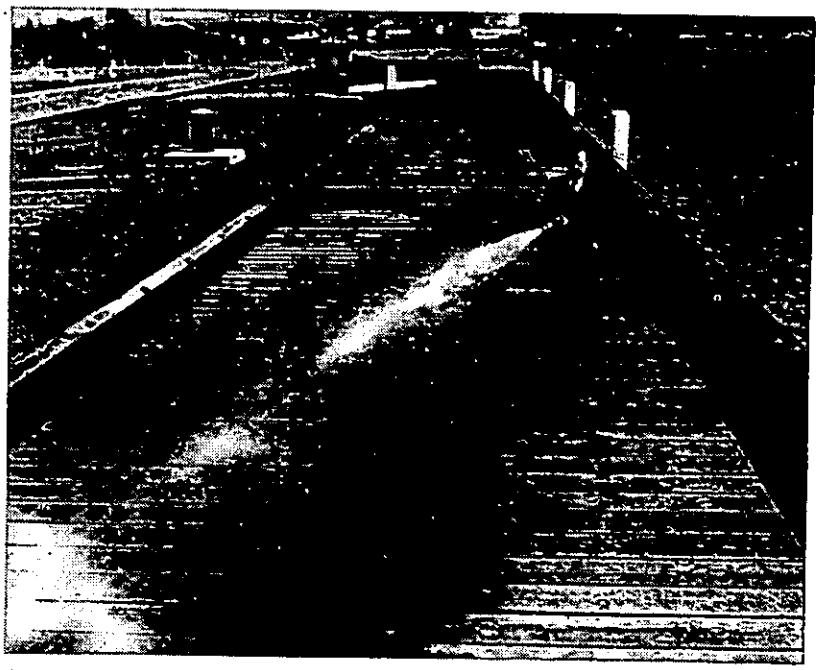
Obviously, the primary object of all water-projecting equipment is to secure maximum wetting effect for a given volume of water. This is true regardless of the type of stream used. Experience with water-projecting equipment makes one realize more and more the extinguishing power of a relatively small quantity of water. When cost of the protection plant is considered and its components analyzed, little imagination is required to emphasize the need for efficiency whether it be water or manpower.

A very simple test with a common garden-hose nozzle using residence-service pressure will quickly illustrate the difference in wetting power of a solid stream and a wide solid-pattern spray. In

The nozzleman's view of the vapor discharge using a nozzle pressure of 250 pounds per square inch, volume being approximately 10.5 gallons per minute. Note the rainbow effect. Diameter of pattern 10 feet from the nozzle is approximately 3 feet. Twelve-inch boards on the dock give an approximate relation of projection distance to diameter.



A quartering view of the vapor showing the general pattern of the projected fog.



A front view showing the dissipation of the concentrated vapor at a distance of 20 feet from the nozzle. The actual blast of saturated atmosphere is much greater than indicated by the photograph: the vapor is so finely divided that it is estimated that not more than 50 percent of it is recorded by the camera.

fire-suppression work power pumpers provide a greater range of pressure and it is possible to break down the water with suitable nozzles so that a fine fog or vapor is produced.

In considering the extinguishing effect of water it is helpful to think in terms of relative humidity. It is known that if the relative humidity increases 30 to 35 percent, fire spread will be reduced to a low point, usually to a rate which is determined by the ability of the fuel to absorb moisture from the air. The rate at which reflected or radiated heat from the fire will dry out fuel in its path will also be affected. Although far from technically complete that simple explanation makes it apparent that there is a definite point at which relative humidity is the determining factor in the control of fire. And, the most practicable method of producing a high relative humidity in the vicinity of fire is by means of the vapor nozzle.

In the nozzle design presented it is possible to utilize the velocity of the stream in projecting a large volume of vapor. With a discharge of approximately 14 gallons per minute at 300 pounds pressure per square inch, the combination of vapor velocity and head resistance results in a heavy inrush of air at the nozzle. The spray expands in conical form from the nozzle presenting a diametrical front of approximately 6 feet at a distance of 20 feet. The velocity is sufficiently high that with a rate of flow of 14 gallons per minute the nozzle is producing a practically saturated vapor at a volume of not less than 10,000 cubic feet per minute. A stream from an

ordinary nozzle with an equivalent rate of flow is estimated to produce not over one-tenth of this vapor volume.

In buildings or other confined areas, a vapor projection such as that described has maximum effect. While convection currents created by open fires in brush and timber stands reduce the effectiveness of the vapor to some extent, even under these conditions it still is by far the most efficient method of water application available. Any vapor spray is better than a straight stream if the fire can be reached with it.

Efficiency of Per Diem Guards.—Per diem guards can usually be so selected with respect to location that they are able to attack the average fire in the assigned area more quickly than any other person. Normally the transportation available to any per diem guard compares favorably with other transportation in the locality, and the equipment furnished him by the Service should be adequate.

In selecting the man, consideration should also be given to qualities of leadership, fire-fighting experience, and general ability. In other words, the local per diem guard should be the best prospect available.. His efficiency and the results obtained in both presuppression and suppression depend very largely on the efforts of the ranger or other individual responsible for the organization.

On the Santa Fe National Forest per diem guards are generally dependable and most effective. While observation on this forest has shown that the initial enthusiasm of a per diem guard may be the result of personal liking for the ranger rather than of belief in the prevention and suppression of fires, he will normally come to agree in the main with the Service policies and will carry on under successive rangers. A number of per diem guards on the Santa Fe have served continuously for more than 20 years. They are frequently contacted by the rangers, group training is given when feasible, and a special bulletin is used in an effort to keep them on their toes. As a rule these men can be depended upon to handle lightning snags and small fires without assistance from the regularly paid organization. Many of them are experienced on larger fires and make excellent foremen. They are actively on 71 percent of the fires that occur and have handled as high as 25 percent in a year without help from the regular force.

Frequently the influence of a good per diem guard in prevention work with local people is more important than his efforts on actual suppression. They can, and do, save the ranger and his helpers long hours of travel and work, to say nothing of worry. They save the Government a considerable amount in burned area and cost. In the opinion of the Santa Fe fire force a good per diem guard group is the backbone of the fire organization on any district where such a group is available.

On the other hand, it is agreed that per diem guards do not get the constant exposure to fire prevention and suppression material that, for example, CCC personnel does. They are accustomed to working short-handed and, with some exceptions, do not turn out the finished job of a special crew. Also, these men have their own work to do, are apt to be away from the phone, and cannot be expected to match the starting time of a drilled stand-by unit.—Perl Charles, assistant supervisor, Santa Fe National Forest.

A PROGRAM FOR THE VIRGINIA-KENTUCKY-WEST VIRGINIA "HOT SPOT"

(Continued from p. 140)

6. Provide for collaboration between the States and between the States and national forests in the areas where interstate fires, or fires threatening State or Federal lands, are likely to occur.

SLOPE INDEX DETERMINATIONS

H. M. SHANK

Forest Supervisor, Idaho National Forest, Region 4, United States Forest Service

For those areas where slope is an appreciable factor in the spread of fire, the technique of mapping slope indexes offers possibilities in the study of previous fires which may show correlations that could be used by fire-control men in future suppression jobs.

Forest administrators have long recognized that slope is an important factor in the rate of spread of fires and, to some extent, in resistance to control. Some investigators have systematically examined the problem and made some important discoveries of slope-spread relationships.

Most of these investigations, at least insofar as the writer is aware, have been made on controlled-burning operations and on slopes with selected degree of steepness; in short, they have been controlled experiments. Such conditions are desirable from an experimental standpoint. The studies should produce a maximum of dependable conclusions with a minimum amount of original data. They fail, however, to furnish any basis for classifying a forest or parts of it as to slope or a practical method of applying the knowledge gained from these experiments and studies.

Without having made a recent review of available literature, Show and Kotok found that fires spread at a rate approximating the square of the wind velocity. Curry and associates found certain fairly definite relationships between rate of spread and slope and that slope and wind were interchangeable within certain limitations.

On the majority of western national forests, a range of slope up to 50 percent is quite common for distances of several miles. For short distances, slopes of 70 to 80 percent are common. Accepting the correctness of the findings referred to, it would have to be conceded that slope alone is of vastly more importance than wind alone, since it is obvious that the range of slope is normally greater than is the range of normal wind movement or even abnormal wind movement, except in rare instances of gale or hurricane conditions.

For areas that are topographically mapped, a slope index is exactly determinable quickly and easily within the limits of error of the map itself. Along a line of given length, slope in percent is:

$$S=\frac{Ci}{d}$$

in which C is the number of contours intersecting or crossing the line, i the contour interval, and d the horizontal distance.

The principle suggested can be applied to an area of any size or dimension, by gridironing with as many lines as desired. A forest of a million acres, if in roughly the shape of a square, would be approximately 40 miles on the sides. The gridironing of such an

area at 5-mile intervals in two directions and the calculations might, for example, be completed in a single day. Even that degree of intensity might not be required. With each line divided into uniform parts and the count for each part tabulated separately, tests could be made that would prove or disprove the necessity for proceeding beyond a certain point to keep the results within a fixed limit of error.

It is hardly necessary to point out that the larger the map scale (and greater the detail), theoretically, the more precise the results would be. Within the range of map scales ordinarily available, however, this seems to be unimportant. Some tests were made on an area with a map scale of 1:25,000 and a contour interval of 50 feet, a part of which was subsequently mapped on a scale of 1:125,000 and a contour interval of 100 feet. The average error for 25 pairs of slope readings for identical horizontal distances was 2 percent, accepting the value from the large-scale map as being correct. The maximum error on any pair was 7 percent.

It seems probable that the best value that could be obtained for "effective" slope would be along lines at right angles to the axis of a mountain range. It is obvious that a line paralleling the main axis of a range not cut by deep canyons would show less slope than those at a 90° angle.

The writer has been guilty of some loose thinking and talking about steepness of slope and seems to have plenty of company. Slopes steeper than 65 percent for distances greater than a mile are just about nonexistent, except in places such as the Grand Canyon.

The principle outlined might be used to particularly good advantage in analyses of big fires, the area of which could be gridironed to any desired degree of intensity. Provided analysis of fire behavior by slope classes produced significant relationships, the result would be invaluable in setting up corresponding action standards for areas on the same forest, assuming that the classification is made by areas rather than for the forest as a whole.

Harvesting the Berry Crop.—Forest rangers or patrolmen in their contacts with blueberry pickers often hear the remark, "If we had another good forest fire, we could have berries again." With the right approach that remark opens the way for convincing argument against the popular notion that burning the woods increases subsequent yields of berries.

In harvesting this food crop of the soil and forests, people come close to nature, and often will tell eagerly of signs of deer or bears that they have seen. As a rule the berry pickers are in a receptive mood. They can be interested in an explanation of how the berry bushes grow, how experiments have proved that fire does not necessarily contribute to a good crop of berries, how fire will completely destroy the berry bushes if the area is burned too excessively, and that moisture is the important factor in yields.

Often local happenings will supply the most persuasive facts. For example, fire burned over several marshes in Lincoln County, Wis., in 1933. In 1935, a wet year, one of these marshes yielded blueberries in clusters as large as grapes. The following season was, however, extremely dry. And the blueberry crop was very poor.

Isn't that good technique in fire-prevention education?—John Zach, forest ranger, Wisconsin Conservation Department.

DETERMINING THE DESIRABLE SIZE OF SUPPRESSION CREWS FOR THE NATIONAL FORESTS OF NORTHERN CALIFORNIA

P. D. HANSON

Lassen National Forest, and

C. A. ABELL

California Forest and Range Experiment Station, U. S. Forest Service

In the July 1940 issue of Fire Control Notes, "Effect of Size of Crew on Fire-Fighting Efficiency," Donald N. Mathews indicated that studies in Washington and Oregon had shown that "there is a strong tendency for output per man-hour to decrease as the size of the crew increases." This statement, bearing on only one of the factors to be considered in controlling fires, is given support by the present authors, who here analyze data under conditions where hand-constructed lines must be depended upon for the control of most fires. Studies such as these will help the dispatcher to answer the question: "How many men should be sent to this fire?"

The major steps used in the fire replanning project in California discussed by P. D. Hanson, I. C. Funk, and E. L. Turner in the October 1940 issue of Fire Control Notes (A Study of the Volume and Location of the Fire Load and the Determination of an Effective Presuppression Organization to Handle It. Fire Control Notes 4: 161–172, 1940) were: (1) to measure and locate fire load; (2) to provide for expected changes in fire load; (3) to evaluate suppression station locations; (4) to provide proper protection for special areas; (5) to determine the desirable size of crew for initial attack; and (6) to determine the best locations for tank trucks.

The purpose of the present report is to describe the method of analysis and the data used in determining the desirable size of crews for initial attack.

Preliminary data on three factors were used for this study, as well as for other phases of the replanning project. The first factor was the established time standards for initial attack in the major inflammability zones that have recognizable differences in rates of fire spread. Accepted time standards are a necessary basis for the inevitable adjustments between desirable size of crew, desirable speed of attack, and a reasonable intensity of preparedness. The time standards used in this study were established by S. B. Show and E. I. Kotok in an earlier analysis published in 1930 as U. S. D. A. Technical Bulletin 209, The Determination of Hour Control for Adequate Fire Protection in the Major Cover Types of the California Pine Region.

The second factor was inflammability zone maps, which were used in classifying individual fires and to facilitate studying occurrence groups as indicators of expected fire load. Delineation of inflammability zones, based on the study by Show and Kotok and later re-

vised for comprehensive planning of transportation systems in 1936, was used in the present analysis.

The third factor was initial rate-of-spread data on free-burning fires, which served both to characterize the inflammability zones and link them to the data on desirable size of crew, expressed in this study according to initial-spread rates. Calculation of initial rates of spread for individual free-burning fires (see California Forest and Range Experiment Station mimeographed research note 24, issued 1940, "Rates of Initial Spread of Free-Burning Fires on the National Forests of California," by C. A. Abell) was done as a part of the current replanning project. Through these data on rate of spread the requirements for size of crew are tied to inflammability zones and the established time standards.

The main characteristics of the two important inflammability zones germane to the discussion of crew size are briefly: Northern California inflammability zone 1, containing much of the flash-fuel type and generally found at lower elevations, occupies some 5½ million acres within the Forest Service protection boundaries. The established travel-time standard for this zone is 30 minutes or less. Fires which spread from the start increase in perimeter at an average rate of 20.6 chains per hours, with but approximately 25 percent spreading faster than the average. Zone 2, in less inflammable cover, occupies 7 million acres, for which the established travel-time standard is 1 hour or less. The average rate of perimeter increase for zone 2 is 9.1 chains per hour. The greater part of the fire load with respect to both number and severity of fires occurs in zone 1, which is consequently the heart of the fire problem.

For estimating the desirbale size of crews, approximately 8,400 fires that occurred in northern California during the seasons of 1925–37, inclusive, were grouped first, according to rate of spread in 7 classes and then according to the number of men who controlled them. For this purpose the number of men included those initiating attack plus those making up the first reinforcements if they arrived within a reasonable time. From the tabulations for each rate-of-spread class individual curves were prepared which showed (in percentage of total) for each of the 7 classes, and for the average of all fires, the cumulative percentage of fires which have been controlled by different numbers of men. These curves are presented in chart A.

Since the fires shown in chart A were controlled by the numbers of men indicated, it is reasonable to assume that this set of curves represents successful action which can be repeated; that is, the fires certainly were not undermanned, because they were controlled, but, on the contrary, must have been overmanned to some degree and therefore contain a certain factor of safety.

To study this degree of overmanning an investigation was made of 1,030 suppression crew reports, on each of which was stated the crew foreman's judgment of the number of men in the initial attacking force that he considered necessary to assure control of the fire when he and his crew arrived. These suppression-crew reports were identified with the original individual fire reports and constitute a representative sample of more than 12 percent of the 8,400 cases which form the basis of this study. Computations of the relation-

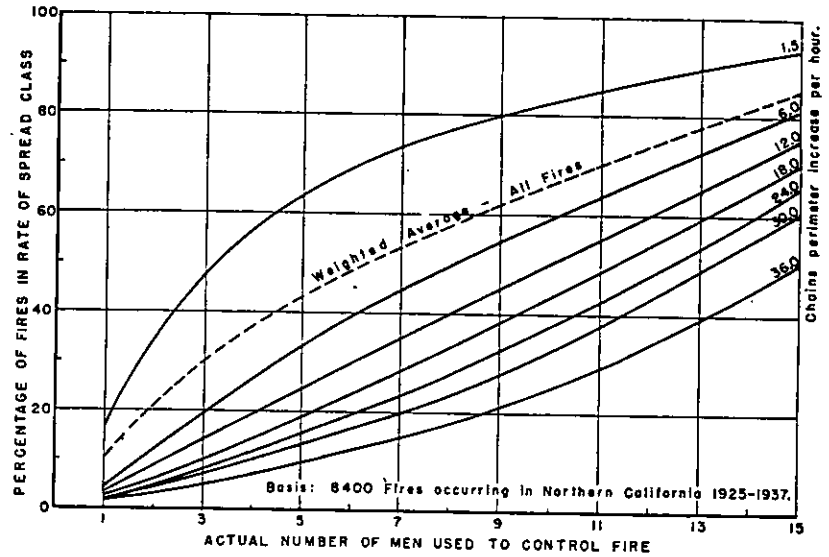


Chart A.—Percentage of fire in seven rate-of-spread classes actually controlled by different numbers of men (includes first reinforcements).

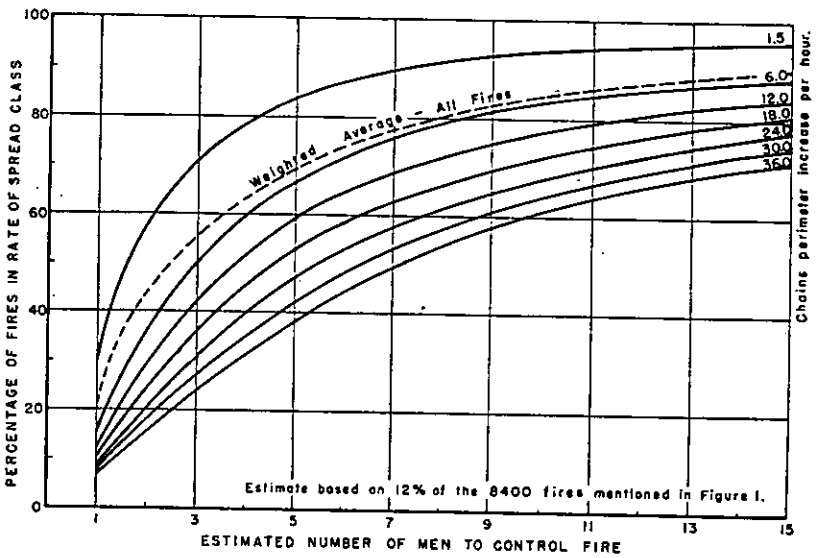


Chart B.—Percentage of fires in seven rate-of-spread classes which was estimated could be controlled by different numbers of men.

ship between the number of men that actually controlled the fire and the number that in the foremen's estimation would have been adequate were made independently for two sets of data. The first was based on 464 fires that occurred on the Shasta National Forest, and the second upon the 566 remaining fires, which occurred on other northern California forests. The two relationships derived in this way agreed very closely and were therefore combined.

On the basis of these combined data the curves in chart A were elevated to show the potential suppression capacities of different size crews. The resultant curve set, chart B, is the best basis yet obtained for determining what should be expected from different sizes of crews in fuels with different rates of spread. For example, these curves show that where the average rate of initial perimeter spread is 20 chains per hour (inflammability zone 1), one-man attack has controlled about 2.5 percent of the fires and the top estimate of one man's potential capacity to control is 10 percent of the fires spreading at this rate. It thus appears evident that one man should be considered inadequate in this zone when fire danger approaches or exceeds normal.

Recognizing that a good presuppression organization should make available at the majority of fires, within a reasonable length of time, at least 1 and preferably 2 or even 3 reinforcing crews, in addition to a crew making fast first attack, and considering maintenance cost and difficulty of rapidly transporting the larger crews, this study leads to the conclusion that a crew of about 5 or 6 men would be the most efficient size in areas of rapid rate of spread. Reference to chart B will show that a 5- to 6-man crew may be expected to handle well over half of the fires in zone 1 (average perimeter spread rate 20 chains per hour). Enlarging the effective attacking force to 10 or 12 men would raise the percentage to a little less than 75. Building the crew up to 15 men would, according to these curves, add only another 5 percent of the fires to the control capacity of the crew. The rapidly diminishing benefits from relatively large expenditures for salaries thus indicated shows definitely the undesirability of larger crew units. In addition, consideration of the cost of equipment to transport larger crews and the slowing down of travel resulting from larger trucks led to the judgment that it was better to maintain smaller, faster, 5- to 6-man units more widely distributed and to count on the mutual supporting actionof these crews to enlarge the attacking force when and where needed.

A similar line of reasoning indicates crews of 3 to 4 men to be the most efficient size for inflammability zones 2 and 3, in which average rates of perimeter increase are 6 to 9 chains per hour. For any zone the size of crew decided upon depends to a considerable extent on whether or not reinforcing crews are available within a time which bears a reasonable relationship to the hour-control requirements of the zone. If they are not available, the size of crews mentioned would appear too conservative.

The use of tank trucks should tend to decrease the size of crews only slightly, since the necessity of allowing some measure of safety for handling faster spreading fires is evident. In zone 1, approximately 25 percent of the fires will spread faster than the average of 20 chains per hour. The 5- to 6-man crews with planned supporting action will catch some of these fires, the number depending on the size of the fire when the crew arrives and on other circumstances. On the average, it would take a crew of 15 to 20 men to build line as fast as the average fire makes perimeter in this zone. Obviously smaller crews are able to control some of these fires only because they cut off the head and thereby reduce the initial spread rate. On faster fires and in more difficult situations water or power line-building

equipment or both are necessary to do this and to increase the percentage of the more difficult fires that will be caught on initial attack. All crews still must be prepared to handle the majority of fires through hand-constructed lines, and the tankers should be considered as a means of making the crews more effective in stopping faster spreading fires rather than as a justification for reduction in crew size.

The Stathem Fire-Finder Disc.—The article, The Stathem Fire-Finder Disc, by Paul Stathem, which appeared in the July 1940 issue of Fire Control Notes, is interesting and the method described has possibilities. However, the use of the disc may result in difficulties not only in flat and low rolling country, as the author admits, but in rough, broken country as well. Where the lookout is stationed in the center of a topographic system that recedes in concentric circles, the disc would operate best, but as the topography differs from such a pattern many errors become possible. The sketch is illustrative.

Is the fire at A, B, C, D, or E?

Although Stathem's theory is otherwise sound, in practice the location of a spot fire within 100 yards by use of his disc would be coincidental rather than the general rule, since the constant and probable errors of the disc added to those of the fire finder would lead to inaccuracies generally greater than 100 yards. However, the idea seems valuable and the instrument might well, with the use of proper trigonometric functions, prove a sound, supplementary device in the location of one-shot fires.—William P. Dasmann, Ochoco National Forest.

A Fire Organization Training Device.—A mechanical device for training personnel in the fundamentals of organization on a fire line was developed and used with some tangible results on the Wallowa National Forest in the spring of 1939. It was used only as one part of the entire program of fire training.

A piece of heavy cork gasket is used as a base to which a map, preferably a fuel-type map drawn on a topographic map, is tacked. Ball-head pins of various lengths and colors are also placed on the cork opposite a legend, which has been previously prepared. The legend may, for instance, indicate that a long pin with a red head stands for a foreman of a shovel squad, and smaller pins of the same color may represent laborers with shovels. All conceivable positions on the fire line may be thus designated by different types of pins.

To simulate actual fire conditions as closely as possible the trainee may select a map of an area with which he is familiar. The instructor may state conditions affecting the fire, such as wind and other weather conditions, rate of spread, available labor, equipment, etc. The trainee finally is given the task of lining out his crews, represented by the pins, according to instructions on fire-fighting fundamentals previously given.

Training by use of the map device described may be suited to any particular job on a fire line and may be adjusted to the abilities of the trainee. It may reach a climax when actual weather reports, fuel-type maps, calculation of probabilities, strength-of-force plans, suppression plans, etc., are all brought into the picture and integrated with the final organization. As the training progresses other variations may be revealed which may test the theoretical abilities of even the best firemen. The training need not necessarily be limited to jobs on the fire line.

The combination of color, manipulation, and working with actual facts and plans helps to crystallize in the trainee's mind the multitude of factors which must be considered in any particular position.—Richard P. Bottcher, assistant forester, Region 6.

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INFORMATION FOR CONTRIBUTORS

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

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

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

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

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