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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE · U. S. DEPARTMENT OF AGRICULTURE

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Volume 3 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

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The value of this publication will be determined by what Forest Service officers, State forestry workers, and private operators 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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CONTENTS

Because of unforeseen circumstances volume 2, 1938, consisted of but one issue. Yearly subscribers will, however, receive four complete copies of the publication.

RECENT DEVELOPMENTS IN LOOKOUT TOWERS

H. R. Jones

Assistant Chief Engineer, Division of Engineering, U. S. Forest Service, Washington, D. C.

The issue between steel and timber lookout towers has been the subject of vast amounts of correspondence, charges, counter charges, and high emotions. The author, however, presents here a dispassionate factual statement on the present status of tower purchases and designs.

Previous to 1933 lookout towers purchased on the basis of plans and specifications were of structural steel.

About that time there were coming into use in this country, timber connectors which, in comparison with ordinary bolted or spiked joints, greatly facilitated the transmission of stress through joints in timber structures. The connectors as used in Forest Service lookout-tower construction consist of metal rings which are placed between two timbers, the connecting bolt passing through the center of the ring. The ring, with half its width projecting into the contacting face of each timber, transmits the stress from one timber to the other. These connectors are commonly used in CCC portable camp buildings.

The development of the timber connectors and resultant increased possibilities for economical use of timber led to its consideration for lookout towers, a matter in which the lumber industry and the Forest Service were much interested. An attempt to purchase towers showed that the industry was not prepared to produce prefabricated timber in competition with the steel industry, where prefabrication was a long established practice. However, in view of the Forest Service's interest in developing the economical utilization of woods, eight towers were purchased on a specification restricted to timber, as an experimental project. Reports of this project indicated that fabrication was decidedly defective, causing long delays during erection. As a result, tower bids were again limited to steel.

Pressure on the Forest Service to consider timber gradually increased as the timber industry improved its methods of prefabrication and the large purchases of towers in connection with the CCC program so stimulated this pressure that the subject was reopened.

In the meantime, some timber designs had been worked up in the regions. Region 6, which had been the most active in this connection, was asked in August 1936 to review the entire tower problem, considering comments and plans from all Forest Service regions. The study consumed 5 months. The report indicated conclusively that prefabricated timber structures could compete with steel, at least on the Pacific coast, and since plans for some timber towers were practically completed, a purchase then about to be made was handled on bids providing alternate offers on timber and steel. On that and subsequent proposals there have been purchased 135 timber towers.

Region 6 timber designs and Region 7 steel designs were selected as standard to be used for all purchases of towers within the range of sizes and heights they included.

In order to provide steel and timber plans for towers of practically equal heights—a necessary condition for competitive bids—considerable revision of existing steel plans and new steel designs was made in Region 7. Designs have now been completed for the following towers:

Towers for 14- by 14-foot lookout houses: Steel—30 feet, 41 feet 3 inches, 54 feet, 67 feet, 83 feet 1½ inches, 100 feet 4½ inches, 120 feet. Timber—30, 41, 54, 65, 83, 100, and 117 feet.

Towers for 7- by 7-foot cabs: Steel—30 feet, 41 feet 3 inches, 54 feet, 67 feet 6 inches, 82 feet 6 inches, 99 feet 9 inches, 120 feet. Timber—30, 40, 52, 66, 82, 99, and 119 feet.

Height is measured from top of footing to approximately the cab floor level.

The Washington Office usually purchases timber or steel towers for 7- by 7-foot cabs complete with timber or steel cabs. Towers for the 14- by 14-foot house are purchased usually without the house which is made of lumber for both timber and steel towers. Purchase and erection of the house are handled by the office ordering the tower. A recent purchase was made of steel towers complete with prefabricated lumber houses, and it is hoped that this will prove feasible.

The specifications recently used for competitive bidding between steel and timber do not take into account any differences, advantages, or disadvantages of the two materials, except that freight charges are considered and purchases are on the usual basis of lowest cost at rail point to which shipment is made. The specifications, therefore, may not actually provide for competition on a truly equal basis. The problem of arriving at equality in this respect is complicated by the fact that a few of the differences are considered to be debatable, and others vary with locality. To illustrate:

(*a*) Fire hazard is considered to be a disadvantage of timber. Treatment with fire resistant material is a possible development.

(*b*) Depreciation or life term is considered equal. No records are available which would substantiate a difference here, assuming that the time consideration is held within a period usually applied for accounting purposes.

(*c*) Maintenance costs are unknown, but records are being obtained. A period of several years will elapse before conclusive figures are available.

(*d*) In the eastern part of the country inspection costs have been greater for timber than for steel. Because of inadequate inspection some poor material has been received recently, necessitating reinspection of towers at several places. Accurate fabrication is a prerequisite for economical erection, and it is reasonable to expect that some day prefabricated timber of standardized quality of material and workmanship on a par with the product of steel fabricating shops will be available.

(*e*) Records have been kept of the erection costs of timber towers, and erection costs will be kept on the steel designs which will provide accurate comparative information.

(*f*) The cost of lightning protection is greater for the timber tower.

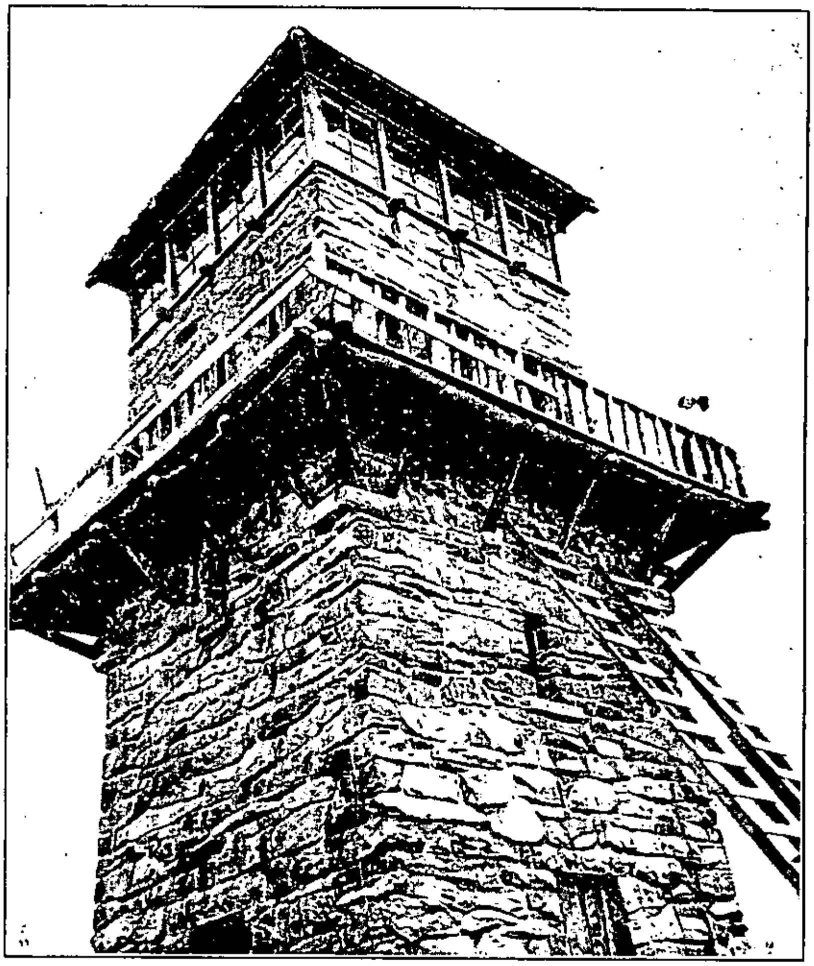
(*g*) Transportation from railroad to tower site is more costly for the timber tower because of its greater weight, particularly where pack horse transportation is necessary. Comparative weights taken from the Region 6 report will illustrate this point:

Shipping weights of 100-foot tower and 7- by 7-foot cab

	Pounds
Steel	18, 200
Timber, Douglas fir	27, 000
Timber, southern pine	31, 000

These weights do not include cement, sand, gravel, or water for the concrete footings. Total hauling costs will be influenced by the local conditions controlling the availability of these materials.

If hauling cost per ton-mile from rail point to tower site were definitely determined, it would be a simple matter to consider this cost difference in making award. Similarly, the other differences, insofar as they can be definitely determined, could be evaluated.



Byrne Memorial Tower.

The lookout tower is not ordinarily considered for structures of monumental character. The accompanying photograph of the Byrne Memorial Tower, designed and constructed by Region 8, in memory of John B. Byrne, a former supervisor of the Nantahala National Forest, indicates the possibilities of lookout towers for the purpose. What could be more appropriate?

DETERMINATION OF THE RATE OF SPREAD OF FIRE IN THE SOUTHERN APPALACHIANS

George M. Jemison

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Rates of spread vary in a bewildering way. It would be easy to yield to the temptation to throw up our hands and say that it is useless to try for anything but good guesses at the rate a given fire will spread under given conditions of fuel, weather, and topography. The saner attitude is to keep digging away at the effect of this or that factor on rate of spread in the belief that in time the intricate puzzle will be solved by the creation of something that can rightfully be called the science of rate of spread. The author is doing just this for the specific combinations of conditions involved in the southern Appalachians.

Rate of spread of fire in specific fuel types under given conditions influences all major phases of forest-fire control, but accurate data on this subject are difficult to obtain. Estimates only are often used as a basis for planning fire-control needs.

Concepts of fuel type and fire-danger rating are new, especially in the East, and the probable rates of spread associated with different combinations of fuel type and fire danger are difficult to estimate. Actual measurements of fire behavior are desirable for even preliminary presuppression and suppression plans.

Three possible ways of obtaining rate of spread data for different fuel types and fire-danger classes are: (1) Analysis of fire reports accumulated in past years; (2) observation of actual forest fires; and (3) study and measurement of experimental fires ignited in specific fuel types and burning under measured conditions.

Because most fire reports contain no data from which fire-danger class and fuel type can be obtained without intimate knowledge of the fires in question, the first method usually yields a limited amount of fire-behavior information. This method has an additional disadvantage because rate of spread in chains of perimeter per hour must be derived from estimates of perimeter on arrival and hours since origin or discovery. The figure obtained on rate of spread is likely to be biased because of the tendency to overestimate perimeter in rough country under the pressure that usually accompanies arrival at a fire. Since time of origin is seldom known accurately and some spread usually precedes time of discovery, the use of either of these as a basis for computing elapsed time results in some degree of error. Finally, few fire-danger rating schemes permit determination of danger class from fire reports, because fuel-moisture content at the time of a fire is seldom known.

The second method requires a large, well-trained, and widely distributed group of observers if the study of actual fires is to be profitable. It is probably more adaptable to eastern fires, where the initial attack usually is made by crews, than it would be in the West, where smoke chasers are used.

The use of experimental fires, a very desirable method, requires expensive preparations and is all but impossible in mountainous regions where fire behavior is complicated by topography, a variable difficult to control. Also, the hazard in setting fires on days of high danger in fast rate-of-spread fuel types prevents study of fires under extreme conditions. This is especially significant in most forest regions, because major losses in acreage and greatest suppression costs result from a few bad fires. On the Pisgah National Forest in North Carolina, for example, during the past 6 years, only 3 percent of the 466 fires accounted for 56 percent of the burned acreage. All of these fires occurred on days when the fire danger was class 4 or 5, the two highest ratings on the Appalachian fire-danger meter. Similarly, 40 percent of the total suppression costs were required by only 12 percent of the total number of fires, eight out of ten of which burned on class 4 or 5 days.

The Appalachian Forest Experiment Station, cooperating with Forest Service Regions 7 and 8, has combined methods 1 and 2. The approaches used may be of interest to others.

Rather than attempt to rate fuel types in the conventional terms of low, medium, high, and extreme rate of spread and resistance to control, 14 modified timber types were defined with special reference to the factors thought to contribute most to spread and resistance. The initial procedure of classifying fuel types in the Appalachians, which differed somewhat from the methods used elsewhere, was started by the Region 7 office of fire control in cooperation with the experiment station. It is believed that much more uniform recognition of these basic types by field men is made possible by this method. Of course, the 14 types can be reclassified into low, medium, high, and extreme groups as soon as rate of spread and resistance to control becomes definitely established for each type.

The first approximations of rate of spread and resistance to control were made in September 1937, by C. A. Abell, then of this station, who used data from reports of 1,560 fires on which fuel type had been identified by Region 7 rangers. The descriptive classification of the 14 types enabled these men to code the fire reports for the past 7 years and show the fuel type in which each fire burned. Although no attempt was made to correlate rate of spread and fire-danger class by fuel type in this preliminary study, the data were arbitrarily divided into groups to represent ordinary, moderate, severe, and extreme burning conditions.

The first determinations of fire occurrence and behavior in relation to fire danger were made from analysis of Pisgah National Forest fire records for 1932 to 1937. Such an analysis of reports for previous years could be made because the present form of the Appalachian fire-danger meter permits the rating of danger from the records obtained at any first order weather station. The analysis,[1] in part, produced the results shown in table 1. These data must be considered as preliminary because they are averages for two major fuel types, and danger classes were determined from only one station. However, the trends are very definite and the relation between danger classes is well shown.

[1] For a complete report of this analysis see Technical Note No. 27, February 1, 1938, Appalachian Forest Experiment Station, Asheville, N. C.

TABLE 1.—*Relation between class of fire danger and occurrence, rate of spread, and area of fires* [1]

Class of fire danger	Occurrence probability		Percent of class days on which fires occur	Rate of spread, perimeter per hour (origin to arrival)		Average perimeter increase per hour during corral	Average final area per fire
	Fires of all causes	Exclusive of debris burner and incendiary fires		All fires	Fires attacked within 12 hours		
				Chains	*Chains*	*Chains*	*Acres*
1	1.0	1.0	2.5	1.3	4.6	3.2	3.9
2	1.8	1.4	5.5	3.2	7.1	6.0	4.2
3	8.0	4.0	18.0	8.2	10.6	8.0	7.4
4	22.8	9.5	39.0	12.8	17.1	9.1	25.0
5	56.2	28.6	59.5	16.2	20.0	9.9	45.8

[1] Based on 440 to 467 fires on the Pisgah National Forest, 1932-37, inclusive. Class of fire danger from Asheville, N. C., weather records, using Appalachian fire-danger meter.

The preliminary rate-of-spread data for the various fuel types and danger classes are being systematically checked on the southern Appalachian Mountain forests by a corps of 125 trained CCC fire observers. This work was carried through the 1937 fall and 1938 spring fire seasons, and some features of it have produced worthwhile results. These fire observers, who are carefully selected and trained by the station, accompany suppression crews to fires and have no duties other than measuring and recording certain data on fire behavior.

When an observer reaches a fire, his first job is to mark its perimeter by blazing a line around it as quickly as possible. If fires are in very rough country or are so large that to encircle them would require more than 20 minutes, the fire boss supplies an estimate of perimeter, as in the past. When the blazing method is used, the observer, with an assistant, carefully chains the marked perimeter after the fire has cooled down sufficiently for him to locate the blazed line. In many cases this method supplies a more accurate rate of spread figure than would otherwise be obtained.

Rangers or their assistants are responsible for identifying the fuel type at the spot of the fire as one of the 14 standard classes. Observers were initially trained to describe character, volume, and arrangement of dead fuel on the ground, but because of the varying conditions on actual fires and the resulting confusion this phase of the work was soon dropped.

Fire observers are equipped with four 16-ounce tin sampling cans in which they collect surface litter. These samples are mailed to the station, where the fuel-moisture content is determined. This procedure furnishes more accurate fuel-moisture data for danger rating than does measurement at an established fire-danger station some distance from the fire.

Other factors necessary for rating fire danger are obtained at the nearest danger station while the fire is burning, a procedure probably satisfactory for rainfall and humidity. Wind velocity varies greatly with locality, however, and measurements at the nearest station may not truly indicate winds at the fire. An attempt was made to train fire observers to estimate wind velocity, but this was discontinued when it became apparent that the results were grossly in error. Unfortunately, the use of wind instruments is too expensive.

The essential features of the method of rate-of-spread determination used by the Appalachian station in cooperation with Forest Service Regions 7 and 8 are:

1. Classification of fuel types strictly on the basis of stand characteristics with special reference to dead fuels. Although requiring a more detailed initial classification this procedure is more accurate than some of the others because it eliminates chances for personal errors.

2. Analysis of fire reports to obtain preliminary rate-of-spread data for each fuel type. This method of fuel-type classification facilitates accurate identification of fuel type for each fire report.

3. Preliminary determination from fire reports of fire behavior associated with each class of fire danger. Definite trends of differences in rate of spread under different conditions can be established by this method.

4. A detailed check of preliminary rate-of-spread determinations by means of observations on going fires. Experience has shown that CCC observers can obtain better measurements of perimeter on arrival than have been obtained in the past. Collection of fuel samples at fires for later moisture determination is well worth while, but in the Appalachian region estimation of wind velocity and detailed description of character, volume, and arrangement of fuel has not proved satisfactory.

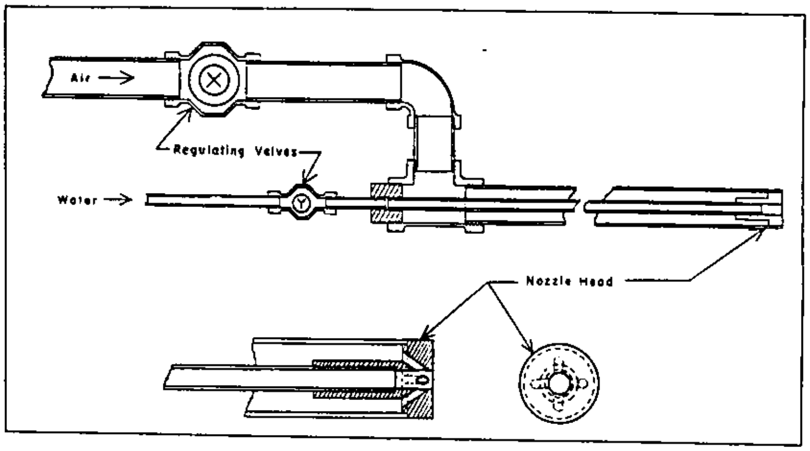
TESTS ON THE USE OF COMPRESSED AIR IN FIRE SUPPRESSION

C. LORENZEN, JR.

Formerly junior engineer with the California Forest and Range Experiment Station, U. S. Forest Service

Everyone knows that the efficiency of 10 gallons of water in fire suppression depends on the way it is used. Testing the relative efficiency of chemicals and water doesn't mean much unless the water is used in the most efficient way. What is the most efficient way of using water? In a solid stream? In the form of spray? Under high pressure? Or low pressure? Mixed with air under pressure? If mixed with air, how much air, how much water, and under what pressures? The author records one attempt to find more efficient ways of using water.

The use of compressed air in fire suppression has been suggested to control backfire, to remove litter in fire-line construction, and to increase the efficiency of water. At the Spokane fire-equipment



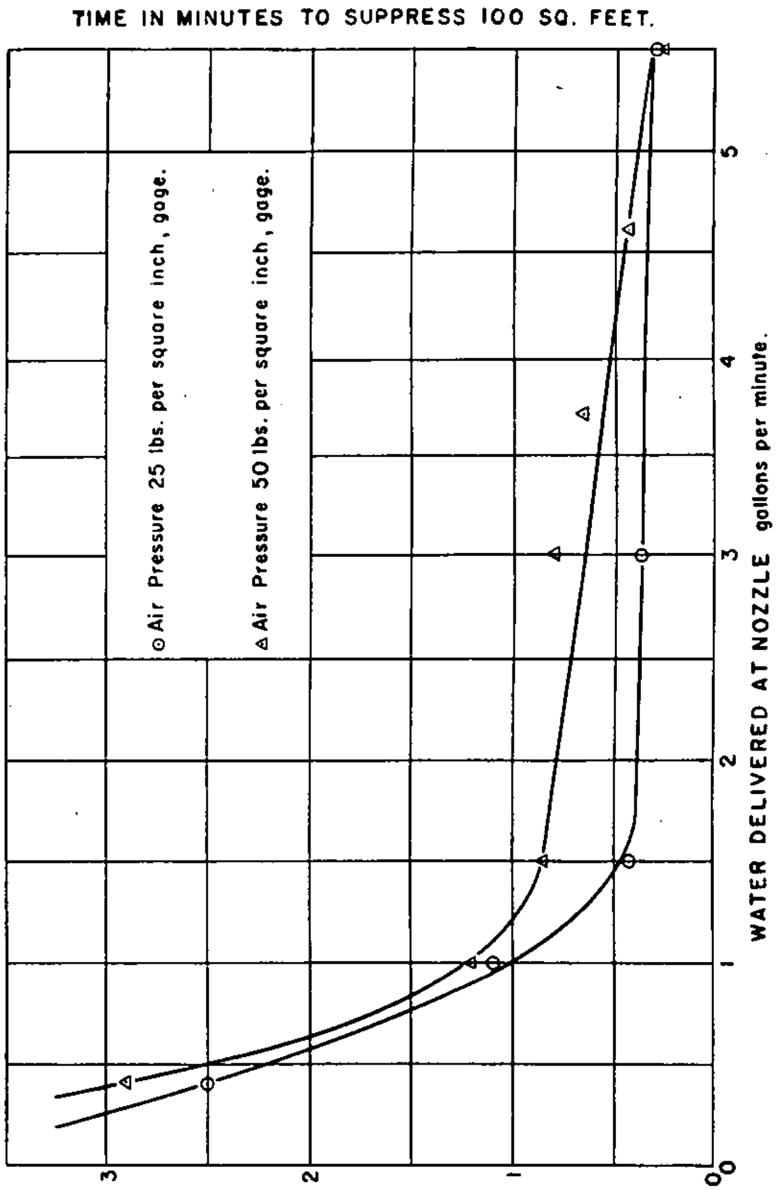
Air-water nozzle.

conference (1936) this subject was assigned to the California Region for investigation.

A few preliminary tests served to demonstrate the impracticability of using compressed air for the rapid removal of forest litter in fire-line construction. The remaining tests were concerned with the use of air-water nozzles for fire suppression.

After some experimenting a nozzle embodying a mixing chamber was developed by F. C. Lindsay, formerly on the Plumas National Forest, for obtaining different air-water rations. Water pressure was kept constant at 30–40 pounds. The water-flow rate was varied by adjustment of a regulating valve in the line.

To test the efficiency of the nozzle at various air-water ratios, 17 small fires, averaging from 10 to 15 feet in diameter, were burned in fairly clear plots of ponderosa pine litter. The fires were set under conditions of little or no wind and were allowed to spread to a predetermined size. The rate of suppression with the nozzle was then measured, the time to knock down the flame and to completely mop up the smouldering litter being recorded. Water for the tests was supplied from a 450-gallon tank truck, and air was obtained



Air-water ratio efficiency.

from a portable compressor. Water pressure of 30–40 pounds per square inch gage was held constant throughout this series of tests, and water-flow rates over the calibrated range were used at air pressures of 25 and 50 pounds per square inch.

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The data obtained in these tests (see chart) show that there exists a very definite optimum value of water rate for a given air pressure. For higher air-water ratios (above this region) the effectiveness of the nozzle drops rapidly, while for lower ratios there is a rapidly increasing waste of water. The curves show the optimum occurring at a water rate of about 1¾ gallons per minute for an air pressure of 25 pounds per square inch. The curves for air pressures of 50 and 100 pounds per square inch were of similar shape. For these rates the data indicate that any air pressure above 50 pounds per square inch is undesirable.

Comparison of the action of the air-water nozzle with that of the conventional water-spray nozzle was obtained on six additional ponderosa pine test fires. In each test a plot was measured, divided into two equal areas, and burned off. The different methods were then applied to the two areas and the total mop-up times recorded. The water rates for both methods were equal in each case, giving a direct indication of the effect of the addition of air to the water. The time difference in each test was too small, compared to the total suppression time, to indicate any superiority for the air-water nozzle. Similar suppression time tests on 6-foot sections of burning logs showed no appreciable time difference between the use of water-spray and air-water nozzles.

Although the tests showed that the air-water nozzle was not superior to the water-spray nozzle for fire suppression, two valuable suggestions were obtained. First, the optimum air-water ratios found suggest that optimum flow rates and nozzle types for given water pressures could be determined by similar experiments for water-spray nozzles. Second, while the additional oxygen supplied the fire by compressed air is a disadvantage, the force added increases the penetrating power of the stream without increased water consumption. It would, therefore, appear desirable to test the use of CO_2 gas under pressure in lieu of compressed air.

FOREST FIRE-FIGHTING PUMPS

Forestry Branch, Department of Lands and Forests, Ontario, Canada

Fire Control Notes hopes to serve fire-control men in Canada as well as in the United States. This contribution on fire pumps is, therefore, particularly welcome. Moreover, a discussion on portable pumps is very much in point on the southern side of the international boundary at this time. A special effort is being made by the Forest Service of the U. S. Department of Agriculture to raise specifications—and get manufacturers to follow. This organization, like the Ontario Forestry Branch, leans toward lighter weight for portable pumps. The present specification prescribes not to exceed 75 pounds for one-piece units and not to exceed 100 pounds for two-piece units. In the two-piece units the heavier of the two pieces may not exceed 60 pounds.

During the last 25 years or more manufacturers have been designing and building different types and sizes of gasoline-driven, portable, fire-fighting pumps for use in forest-fire protection, with the idea of finding one unit which would be satisfactory to all forest-protection organizations. Such a unit seems to be but another dream; certainly it has not yet materialized. Possibly the protection organizations are expecting too much, but some are still striving to obtain units suitable to their own particular set of conditions, one organization leaning more toward a heavier unit, another toward a lighter unit. Ontario falls in the latter class.

The general specifications of a fire-fighting unit most suitable to meet conditions in the Province of Ontario call for one which would be:

1. As light as good construction and simple reliable operation will permit, weight in any case to be less than 100 pounds.
2. Compact and of a form suitable for back packing and aircraft shipment; the unit to have a low center of gravity and wide base, in proportion to size, for ease in set-up; delicate or easily damaged parts to be protected, as far as possible, by the design of the unit.
3. Capable of pressures up to 200 pounds (higher pressures are not desired in view of the danger of hose damage); volume capacity to be as uniform throughout the unit's working range as practicable; unit to deliver at least 20 gallons per minute at 150 pounds pressure.
4. Capable of operation against any variation of load on the hose line, so that the entire flow may be cut off or the unit operated against no load without damage to the unit or interruption in water supply.
5. As economical of fuel and oil as is consistent with the required pressure and volume capacity.
6. Easy and economical to repair and service.

In attempting to construct a unit suitable to conditions in Ontario and with these rather severe limitations, it was necessary to investigate the capabilities of a great number of possible combinations of motors and pumps, since no existing unit fulfilled the requirements. The unit which has finally been assembled has characteristics which can be conveniently listed against the stated requirements as follows:

1. Weight approximately 80 pounds.
2. Dimensions of base 23½ by 11½ inches, height 12 inches. Spark plugs, carburetor, and fly-wheel adequately protected. Base flanged for back packing and fitted for pack straps; lifting band provided at the point of balance.

3. The unit will deliver 28–30 Imperial gallons per minute at 200 pounds pressure, 35 gallons per minute at 150 pounds pressure, and 40 gallons per minute at zero pressure.

4. The unit is self priming; can be run with delivery cut off or with open discharge. This is accomplished by the use of a special relief valve which opens as the motor loses speed. A part of the valve mechanism is linked to the throttle, thus providing a control when running against light loads. The throttle may also be operated manually. The unit has no running gas tank; fuel is supplied by an automotive type fuel pump. A small gravity tank, for starting, is included in the fuel system. The unit has no grease cups; the motor is self oiling from the fuel supply. The pump shafts are mounted on ball bearings which require lubrication once a year. These bearings are protected from watei and grit.

5. The power head of the unit is made up of a light, two-cycle, water-cooled gasoline motor with a normal operating speed of 4,000 r. p. m. Average loads will allow a speed of approximately 3,500 r. p. m. The motor's horsepower rating at this speed is approximately 7.5. The fuel consumption, following an 85-hour test run at full throttle, averaged slightly less than 1 gallon per hour. Oil is mixed with the gasoline at the rate of ¾ pint to 1 gallon of gasoline.

6. Repairs to major working motors part should not be required under 500 hours running time. Replacement of main running parts when required will aggregate approximately $35. The pumping surfaces are completely replaceable for less than $15. Because of the design of the pump, pumping surfaces do not touch, so that wear is almost entirely dependent upon the sand content of the water. All pumping surfaces are of rust-resistant material.

Once properly set up and started, the unit should require no attention other than the replenishing of the fuel supply.

SYSTEMATIC GUARD TRAINING BY TELEPHONE

R. F. Cooke

District Ranger, Mount Baker National Forest, U. S. Forest Service

We all know that fire-guard inspection on the ground can be supplemented effectively by use of the telephone. But knowing the large potential value of the telephone for inspection, supervision, and maintenance of zest is one thing, while making actual use of it for those purposes is quite something else. Here is one busy forest executive who has an interesting accomplishment to report.

The telephone has been used incidentally in training guards on the Mount Baker National Forest for several years, and the last 2 years its use has been on a planned basis. The results are gratifying. It is our observation that although telephone training does not replace personal contact training and inspection, it reduces considerably the amount of time needed for field contacts.

Under a planned system of telephone training, a fake fire report is required from each lookout once a week. The location of the supposed fire is platted by the protective assistant, and any items in the report that do not check with the platting are called to the lookout's attention. Usually he is told only that he has made a mistake and asked to find and correct it. If he finds the mistake himself, he is more likely to remember and not make it again. The report is next platted on the lookout panoramic photograph, and the protective assistant calls the lookout's attention to any additional local landmarks that show up in the picture (a strong reading glass is useful in studying the picture and picking out landmarks).

In using CCC enrollees as emergency lookouts, it is often necessary to detail a man who has had some training but is unfamiliar with the country. These men can be given a good working knowledge of the area they observe by platting the location of streams, lakes, ridges, etc., on the panoramic photographs and giving them the names, azimuths, and vertical angles over the telephone. They can then shoot the points with the fire finder and spot them on the map. Personal inspection has shown that this system enables the men to acquire a good working knowledge of their territory.

Every 2 weeks the protective assistant makes up a list of 20 to 25 questions, using the guard handbook and lookout manual as references, and telephones them to all the fire guards. These questions are worded for a "yes" or "no" answer as much as possible. Starting about 2 days later the protective assistant calls each guard separately and takes his answers to the questions. They should all be correct as the men have their handbooks and manuals for reference. In this way the ranger can be sure that the handbooks and manuals are read and correctly interpreted. Following are a few sample questions:

1. Would a dirty sack on the wet bulb of the psychrometer cause an erroneous humidity reading?
2. What is the correction factor used when orienting one fire finder with another?
3. What would be the correction by the above factor if the lookouts were 20 miles apart true north and south of each other?
4. Is it permissible to use equipment from your fire-chaser outfit around your lookout station?
5. Is section 36 in the northeast corner of a township?

A fourth step in this telephone training: Once a month each guard is asked to make up a list of 10 or more questions on any points of his job on which he desires more information. These questions are telephoned to the protective assistant in a session with all guards on the line, and as each question is read by the man giving it, the protective assistant asks another guard to answer it. If no other guard can answer the question, the protective assistant answers it or refers it to the district ranger. I consider this one of the most important steps, as it clears up many things for the guards. It also trains the protective assistant, and often the district ranger, because frequently points are brought up that he never thought of in making presuppression plans.

In addition to the schedule as outlined, individual problems are given the guards at odd times for them to work out: To recreation or administrative guards, hypothetical problems of law enforcement or public contacts or whatever their line of work may be; for firemen, problems in chasing, what route they would take to reach a fire in a given location, what they would do under certain given conditions on a small fire; for lookouts, calculation of fire size from fire-finder readings, routing of men to a fire in a given location; for the more experienced guards, problems in dispatching, calculation of man power needed for a given size fire in a given location under certain conditions, and action in unusual circumstances. Following are some problems that have been used:

1. A small party of visitors stops at your station and asks you the route to Mount Shuksan. They say they have never climbed a mountain before and their clothes and equipment look unsuited for mountain climbing. State what action, if any, you would take in these circumstances.

2. The rate of travel on this district is 25 miles per hour on roads, 2 miles per hour on trails, and 1 mile per hour across country. A fire is reported in sec. 11, T. 40 N., R. 10 E., and fire fighters have to come from Glacier Ranger Station. How long will it take them to reach the fire? By what route of travel would you send them?

3. A small fire is 33 feet wide on the north side, 330 feet long on the east and west sides, and 66 feet wide on the south side. What is the area in acres and how did you arrive at the answer?

4. You are acting as dispatcher and there are three small fires reported at the same time, in green timber, one each in secs. 1, 24, 31, T. 39 N., R. 8 E. You have available to send at once three CCC men, inexperienced, and three regular trail men who are experienced fire fighters. What men would you send to each fire? Would your action be any different or would you take any further action if the fire in section 1 was in an old burn with many snags?

To my mind the telephone is one of the best devices in guard training if put to its fullest use. A trip to a remote lookout may take 2 days' travel for a few hours' training; whereas, if you have 15 minutes to spare, you can be in contact with the man by telephone in a few seconds. With the telephone 99 percent of the available time may be spent in training; whereas, in a trip to the station 80 percent of the time may be spent in travel and only 20 percent in actual training. Trips to the guard's station should not be abandoned, however, as these contacts stimulate the guard and make him feel that he isn't a forgotten point on the map not important enough for a visit from the ranger. Also, it is not possible to see over a telephone a disorderly station or a poorly kept fire cache, or vice versa, for criticism or compliment.

A CHECK ON FIRE PREVENTION METHODS

G. L. Fraser

Fire Protection Officer, Region 5, U. S. Forest Serviec

The author is a specialist in charge of fire-law enforcement in Region 5, where experience has shown that heavy emphasis on fire-law enforcement is vital. The effect of such aggressive enforcement needs to be analyzed and measured in every possible way. In no other way can we determine how much of the good of fire-law enforcement is nullified by the ill will and harm which it may engender. The effects of aggressive fire-law enforcement everywhere might well be checked by the methods outlined by the author. Where weak law enforcement prevails, comparable checks to determine the wisdom of that policy should be equally valuable.

Lighting, maintaining, or using a campfire upon any brush, grass, or forest-covered land which is the property of another between April 15 and December 1 of any year without first obtaining a written permit from the owner, lessee, or agent thereof is comparable to hunting without a license in California.

Our fire trespass regulations with respect to the control of campfires are quite adequately supplemented by section 384 of the California Penal Code, which specifically requires a written permit either from the owner of the land or from the Forest Service before camp or other fires may be legally started or maintained on areas as defined.

The Forest Service permits are issued free, and require the signature of the applicant agreeing to the certain provisions with respect to the building of campfires, careful use of tobacco in the woods, carrying of shovel and ax, etc. Special circular instructions provide that forest officers or other issuing agencies must require permittees to read the conditions set forth thereon before signing and accepting the permit.

During the 1937 fire season approximately 400 minor fire cases were initiated for prosecution in the State courts. A large proportion of the cases so initiated resulted from violations of the campfire permit provisions.

After the close of the fire season, a representative sample of the people who had been cited for these minor infractions of the fire laws were interviewed at their homes for the purpose of learning, if possible, just what their general and specific reactions were to the prevention methods applied. Much to our satisfaction we learned that in almost every instance the people interviewed were, notwithstanding the penalties assessed, in sympathy with and cognizant of the necessity for strict regulations in connection with the proper and careful handling of campfires designed to prevent disastrous and destructive forest fires.

The most specific unfavorable reactions seemed to center around what in some instances were termed excessive fines for first unintentional offenses. In some cases these fines ran as high as $25 which, when deducted from vacation allotments, necessitated the curtailment of full time vacation periods.

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In most instances where fines of $10 or less were imposed, the principal complaints were to the effect that had the violators known it was unlawful to leave a campfire smouldering while fishing, boating, or hiking for short periods, the violations would not have occurred. This, of course, can be attributed to carelessness from two sources, coupled with possible lack of candor on the part of the permittee:

1. Either the forest officer or other agency issuing the campfire permit neglected to follow instructions requiring the permittee to read the conditions thereon before signing and accepting the permit, thereby overlooking one of the most effective prevention measures within our reach.

2. The permittee was not entirely honest in claiming that he had not read or been required to read the permit before affixing his signature.

The remedy for the first source of carelessness can, of course, be found in the performance record of our own people; while in the second, when we can be reasonably sure that the permittee is not entirely honest, we should have no hesitancy in enforcing the restrictive measures provided.

In all instances, we were advised that the forest officers who visited the camps on their daily patrol or inspection trips were friendly and courteous in every respect, but in many cases it was brought out that they failed to stress the importance of compliance with the provisions of the permits or to inquire if the permittee was thoroughly familiar with the terms thereof. Here, again, if this is true, splendid opportunities for effective prevention work are being dissipated.

Steps are being taken in our prevention campaigns to get the most out of the lessons learned and to benefit from what the violators reported.

STERILIZING SOIL WITH CHEMICALS FOR FIREBREAK MAINTENANCE

H. D. Bruce

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

It is a common belief that chemistry could be drawn upon for important aid to fire control. Experiments starting in 1911, however, have failed to realize very fully on the apparent possibilities of such aid, but in this article there is presented one important and promising development.

A firebreak, after being cleared of trees and brush, soon reseeds to annual vegetation. Although this does not entirely destroy the usefulness of the break, it does reduce its value for quick and strategic backfiring. For this purpose it has become the practice each year to

Spreading dry arsenic trioxide powder upon firebreaks. Two workmen can treat a 5-foot strip previously cleared of vegetation at the rate of 1-1½ miles per hour.

clear a narrow strip through the annual cover. While this can be done rather cheaply where topography permits operation of tractors, on steep breaks expensive hand labor is necessary. In any case, such clearing is only of temporary value and preliminary work must usually be done before breaks can be fired.

Investigations of the possibility of increasing the permanence of backfiring strips by sterilizing the soil have been conducted for several years. Although the effects of a number of industrial chemicals, in various concentrations on various species were studied, only a few were sufficiently effective and at the same time inexpensive enough to warrant their use. Of these, inorganic arsenic is superior. It is relatively cheap, readily available, and extremely toxic.

Arsenite has the remarkable property of becoming almost insoluble in the soil. Even though it be applied in the form of a solution, once it strikes the ground it is absorbed by the soil colloids so that it seldom

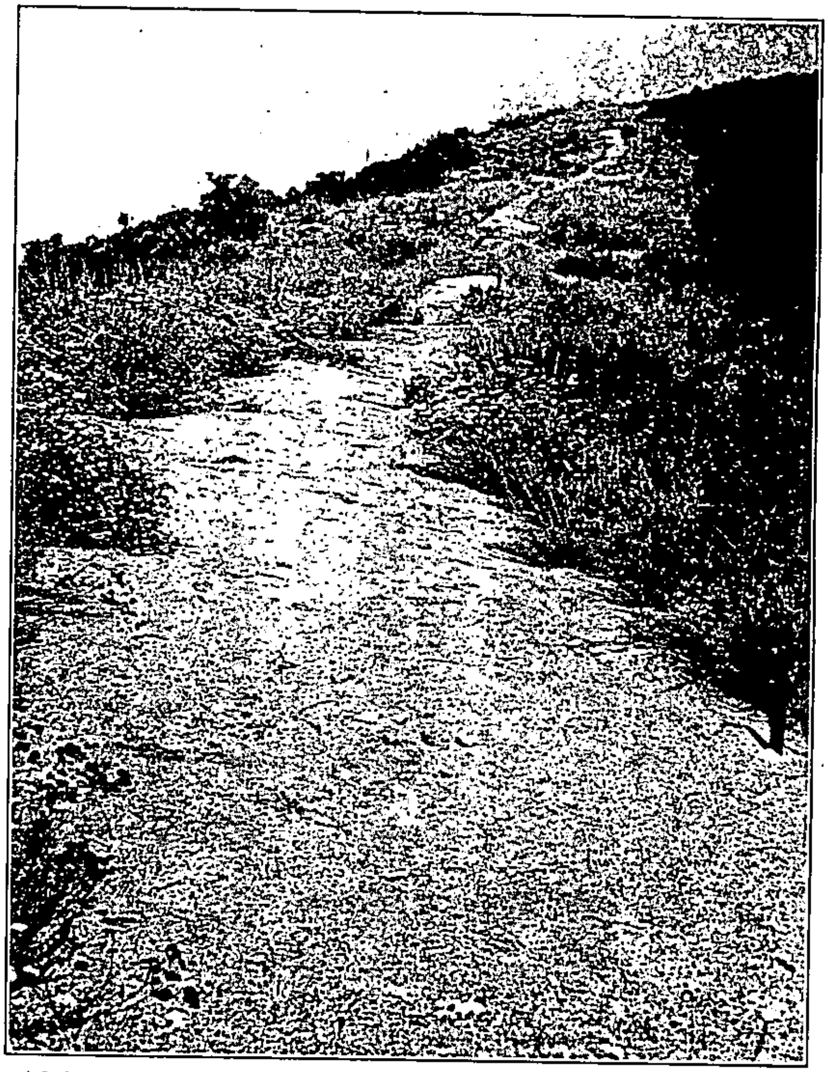
The 5-foot trail of white arsenic left by the applicator. The trail will remain white until the first rain.

reaches deeper than the first inch or two. It is, however, available for imbibition by roots. Shallow roots of grasses and herbs are thus killed and sprouting seeds never develop.

Arsenic is preferably applied in the form of white arsenic trioxide As_2O_3. To spread this as a dry powder, a mechanical applicator has been constructed. It consists of a hopper on wheels, of capacity ample to accommodate 100 pounds of white arsenic. Inside the hopper is a brush, 5 feet long, which rotates as the machine is drawn along, evenly distributing the powder through perforations in the bottom. With this machine, several miles of trail can be treated daily.

For adequate sterilization in the sandy soils of the Sierra Nevada, the optimum spreading rate is about 4 pounds of arsenic trioxide per square rod of surface area. For heavier soils and heavier rainfall, this rate should undoubtedly be increased.

A trail of white arsenic is left in the wake of the applicator. If no maintenance be done on this break in succeeding years, the white

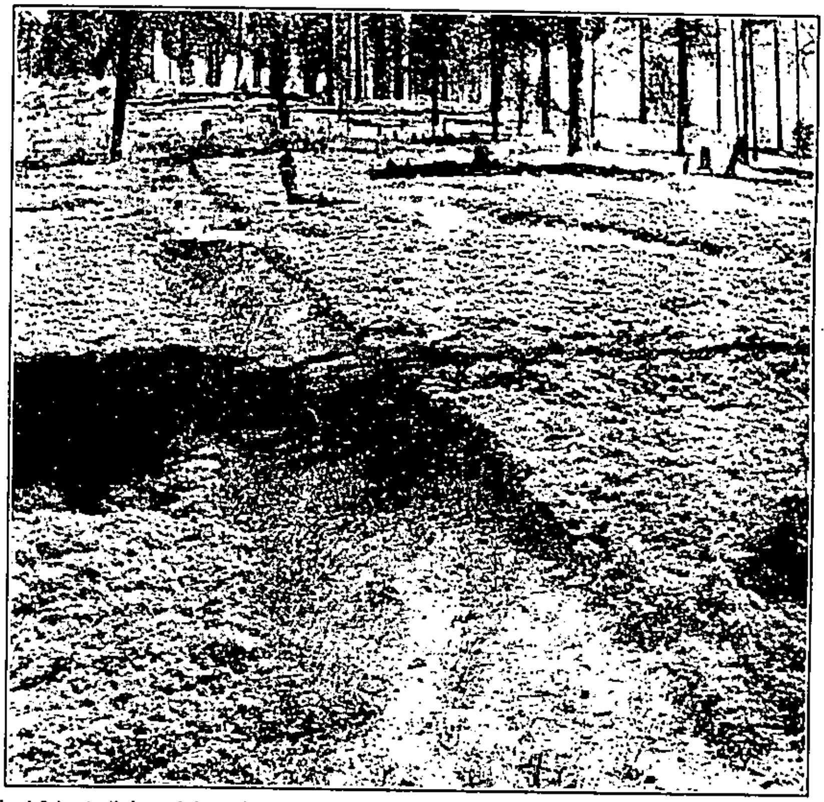


A firebreak trail, sterilized with 4 pounds of white arsenic per square rod, still barren after 3 years.

trail becomes a bare mineral pathway with dense grass and brush on either side.

Arsenic trioxide is only slightly and slowly soluble; hence, it is slow acting. It will not kill grass established at the time of application; therefore, it should be in the soil before the seeds begin to sprout. For this reason the apparent effectiveness of arsenic trioxide as an herbicide is often not as great the first summer as it is the second and succeeding seasons.

Arsenic in its surface-sorbed state will not ordinarily kill deep-rooted perennial species. These should be removed prior to the arsenic treatment. If they cannot be satisfactorily uprooted, as is the case with a sprouting shrub like bear clover, chemicals may be profitably used. Sodium chlorate is excellent for this purpose. Unlike arsenite, chlorate remains soluble in the ground and easily leaches down to the level of deep roots. Sprinkled dry or dissolved, at the rate of 4 pounds per square rod, sodium chlorate in one application will penetrate the roots and kill all the bear clover in the treated area. The first rains completely remove this chemical from the top soil layer, in which seeds may again sprout, and grass and herbs flourish. Accordingly, to



A backfiring trail through bear clover, treated with sodium chlorate and arsenic trioxide, still, quite barren after the third year.

reduce the soil of a stand of bear clover to complete barrenness, both chlorate and arsenite would be used, the former to kill the bear clover, the latter to inhibit the growth of annuals.

A 5-foot backfiring trail through a dense stand of bear clover was treated with 4 pounds of sodium chlorate plus 4 pounds of arsenic trioxide per square rod. Now 3 years after treatment there is neither bear clover nor grass on the treated ground.

The economic value of soil sterilization depends upon its period of effectiveness. Just how long vegetation will be kept from growing on soil treated with 4 pounds of arsenic trioxide per square rod cannot be definitely stated. It depends largely on chance factors, such as wind and water erosion, treading by horses, cattle, and men, and burrowing by ground squirrels, as well as chemical fixation in the soil and leaching by rain water. In light sandy soils the effective period is longer than in heavy loams and clays. Small fenced experimental plots over 5 years old are still sterile. Having lasted 5 years, the sterilization may last 10.

Although the prime purpose of sterilizing soil on firebreaks is the establishment of a backfiring line, another purpose is cheap firebreak maintenance. To distribute 4,000 pounds of arsenic over 1 mile of 50-foot break by hand labor would cost about $170 for men and materials. Assuming a 10-year duration, this means about $17 maintenance cost per year per mile of 50-foot break. This may be compared with maintenance costs in southern California variously estimated at from $120 to $275 per mile.

On some firebreaks, backfiring trails are cut annually with a disc harrow, the cost of which is about $8 per mile. To spread arsenic on the harrowed trail would cost an additional $15. But, if the $23 thus expended would last 10 years, the annual maintenance cost would approximate only $2.30.

It is generally acknowledged that, under some conditions, firebreaks form an essential part of forest-fire-control facilities. In many cases their strategic use can be increased and their cost of maintenance can be diminished by rational use of soil-sterilizing chemicals.

Arsenic is better recognized as a poison to animals than to plants. If animals eat enough arsenic, they die; if arsenic is spread upon grass which is later consumed by cattle or deer, fatalities may result. However, in our use of this poison on firebreaks, the cover is first removed, then the poison is spread on mineral soil. White arsenic is an oxide with little, if any, taste or odor. In these respects it differs from the sodium arsenite which has a salty taste or sodalike odor and which has proved attractive and disastrous to grazing animals. White arsenic has been applied in cow pastures and deer refuges without the animals showing any signs of curiosity or ill effects.

Men working with arsenic powder must avoid breathing its dust and after each working period should clean carefully beneath the fingernails and wash all dust from the hands and face, lest arsenical skin sores develop.

In addition to the poison hazard, there may be other difficulties. One of these is erosion. Removal of the grass cover by burning, rather than by harrowing, scraping, or dragging, the installation of simple erosion dykes, and the studied location of the sterilized trail will do much to lessen the danger of erosion. Other difficulties are wind and runoff. If a strong wind or torrential rain occurs soon after distribution of the arsenic powder, it may be washed or blown away before becoming fixed in the soil. As a precautionary measure, spraying the treated strip with water following the application of the arsenic powder may sometimes be desirable.

TRACTOR USE IN FIRE SUPPRESSION

P. D. Hanson

Fire Control Planning, Region 5, U. S. Forest Service

All our fire-control machines and tools are in ceaseless competition with each other. One such competition is between the tractor-trailbuilder and the tractor-brushbuster. Region 5 adheres to the tractor-trailbuilder, and year by year makes increasing use of this machine. Region 6 uses the tractor-trailbuilder extensively, but, in addition, has developed the tractor-brushbuster, which is designed primarily for clearing brush, young growth, and debris rather than for digging a fire line to mineral soil. Whether both machines will find a permanent place in fire control or whether one will give way to the other remains to be decided by competitive test and experience. The author reports 1937 progress made with the tractor-trailbuilder in his region.

Tractors were first used in fire-line construction in Region 5 in 1926, when machines of the 60 hp. caterpillar type were used to drag churn-butted logs or graders around the perimeter of the fire. In 1931, the development of the trailbuilder attachment resulted in a complete line constructing unit in itself and eliminated the need for using logs, drags, or graders. This attachment on lighter weight machines also helped to solve the transportation problem, as these lighter units could be readily moved about by truck.

Since 1931, there has been a gradual increase in tractor use in fire-line construction on several of the forests in Region 5. In 1936, the Shasta Forest alone built 38.7 miles of fire line, or an average of 4.3 miles on each of the 9 fires on which tractors were used that year.

In 1937, the region felt it was advisable to make available tractor units with trailbuilder attachments solely for fire suppression purposes. Accordingly, 13 units, consisting of 3 Cletrac 55's, 6 Cletrac 35's, and 4 Caterpillar R–5's, with suitable transportation facilities, were stationed at strategic points throughout the region and held in readiness for fire call. One of the Cletrac 35's was equipped with a water tank of 140 gallons capacity, water pump, and hose. These 13 tractors were made available for the period June 1 to October 30, at a total rental cost for tractors and trucks of $4,400.

In addition to the tractors provided solely for fire-suppression purposes, other machines, some of which were rented from private operators and others which were operating on Forest Service improvement projects, were used for constructing fire lines in suppression during the season.

The 1937 fire season was noted for its relatively low percentage of class C fires. Only 73 out of a total of 1,505 fires, or 4.8 percent, were 10 acres in area or over. Consequently, tractors were not called into use to the extent that they would have been in previous seasons had they been available. However, they were used on a sufficient number of fires to warrant a study of their effectiveness and cost.

In addition to their use on actual fire-line construction, these tractors also contributed materially to other fire-suppression activities, some of which were:

Reenforcing and widening hand-made corral lines.

Assisting in mop-up, which included pulling down and removing snags, pushing in burning chunks, ditching, digging out burning stumps, etc.

Opening up and building roads to enable camps to be established nearer the fire or to provide transportation of men by truck nearer to the fire line.

Hauling water on sleds to the fire to supply back pumps.

Opening up or building roads to and around the fire to enable water-tank trucks to reach the fire line and assist in control and mop-up.

Since there was a marked difference in the cost of maintaining tractors for fire use only, compared to the cost of utilizing other machines for suppression work, the accomplishments and costs of each class have been kept separate. Table I shows the use to which the tractors were put and the production in chains per hour, cost, estimates of man hours required to duplicate the work, and other related data.

Table I

Description of tractor use	Private and improvement tractors	Fire stand-by tractors	Total all tractors
1. Number of fires on which tractors were used	12	8	20
2. Total fire perimeters (chains)	2,927	1,978	4,905
3. Fire line constructed by tractors (chains)	727	827	1,554
4. Percentage of total fire line worked by tractor	24.8	41.8	31.7
5. Time to construct fire line (tractor hours)	77.8	92.5	170.3
6. Rate of construction per tractor hour (chains)	9.3	8.9	9.1
7. Cost per tractor unit hour. (All costs including labor and rental prorated against actual working time for season)	$13.22	$35.60	$22.90
8. Cost per chain of fire line constructed	$1.41	$3.99	$2.51
9. Estimates of manpower equivalent chains per man hour (considered optimistic)	.21	.66	.32
10. Estimates of manpower saved (man hours)	11,490	5,770	17,260
11. Number of men equivalent to one tractor unit in line construction	45	14	29
12. Conservative estimates additional burned area prevented (acres)	1,135	1,155	2,290
13. Fire line used as roads. Permitting tank truck mop-up (chains)	156	191	347
14. Other roads constructed (chains)	425	10	435
15. Time to construct these roads (tractor hours)	55	2	57
16. Used other activities (tractor hours)	37	35	72
17. Average number of men in tractor crew	3.2	2.8	3.1

From general descriptions of the fuels in which fire line was constructed, the season's experience indicates what may be expected in line production by machines of different sizes in the resistance-to-control fuel classes as follows:

The larger tractors, such as the Caterpillar RD–8 and RD–7 and the Allis-Chalmers 75, showed a range in line production from 7 chains per hour in extreme resistance fuels to 35 chains per hour in the moderate resistance fuels.

The medium sized tractors, represented chiefly by the Cletrac 55, produced line at the rate of 11 chains per hour in the high resistance fuels and 30 chains per hour in fuels of moderate resistance.

The Cletrac 35 produced line at the rate of 4 chains per hour average in the high resistance fuels and 10 chains per hour in fuels of moderate resistance.

The small Cletrac 15 produced 65 chains of line in low resistance fuels at the rate of 130 chains per hour.

The figures appear to indicate that the larger machines are the more effective in line construction, and appear to contribute more as the resistance class becomes more difficult, if they can be placed on the fire line. The main obstacles to their use are transportation and bridge limits.

Since the degree of slope is an important factor in the effectiveness of tractors in fire-line construction, an effort was made to collect information on the maximum practical limits in slope which various machines can negotiate effectively. Information secured on the Caterpillar Diesel models is included in the following list:

1. Nearly any standard make of track-laying tractors can negotiate slopes up to 35 percent, terrain and vegetation permitting, and up to this limit can work effectively either up or down the hill, quartering up or down the hill, or working across the slope, or parallel with the contour.

2. Caterpillar D-7 and D-8 will climb up a 45 percent slope. Caterpillar D-6 will climb up a 50 percent slope. Caterpillar D-4 will climb up a 55 percent slope.

3. The element of danger enters rapidly in descending slopes approaching 60 percent and over.

4. The wide gage model machines, with track shoes 2 inches wider than the standard furnished, are recommended.

5. The hill-climbing ability of the Caterpillar D-4 tractor is explained by the fact that this machine has less weight per drawbar horsepower than the other machines mentioned. The use of this machine will be experimented with further.

The economy in use of tractors in fire-line construction alone is evident when one compares the cost range, as shown in table 1, with the average regional cost of line construction by hand, which analysis shows exceeds that of the tractor by 200 to 300 percent. Significant, also, is the rate of line construction and the additional contribution of the machines to the efficiency in execution of many other parts of the fire-suppression job.

The relative economy of and justification for more universal use of other Forest Service improvement and privately owned machines is evident. Lack of suitable transportation is the chief reason which limits this use. There is a justifiable need for at least one large fast truck on each of the fire forests.

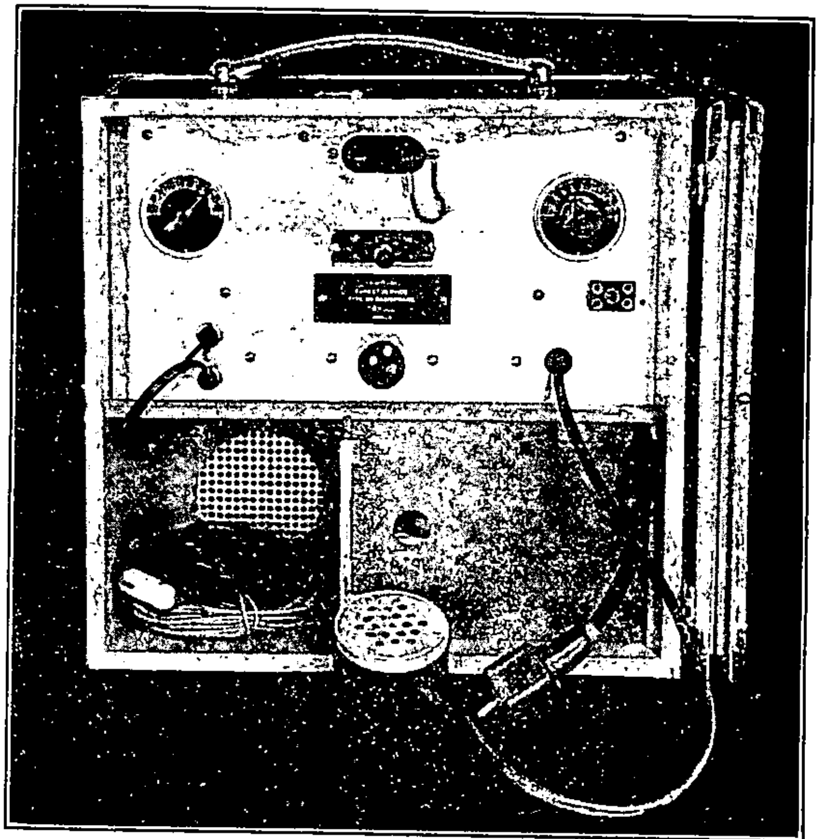
Planning in connection with the use of tractors in fire suppression should be directed toward identification of areas where these machines can be used, and the preparation of maps showing these areas, segregated by slope classes, recognizing the limits between 0 to 35 percent, and 35 to 55 percent. This information, supplemented with maps showing resistance to control-fuel types and the occurrence of C fires, should prove a strong basis for distribution of machines and should be an aid to dispatching action.

RECENT ADDITIONS TO FOREST SERVICE RADIO EQUIPMENT

A. G. Simson

Radio Engineer, Region 6, U. S. Forest Service

Since the various types of Forest Service radio equipment were described in Mr. Simson's article, "Forest Service Radiophone Equipment," page 197, Fire Control Notes, April 1937, two new pieces of apparatus have been developed. The new radiophones are described



Type SV ultra-high frequency radiophone.

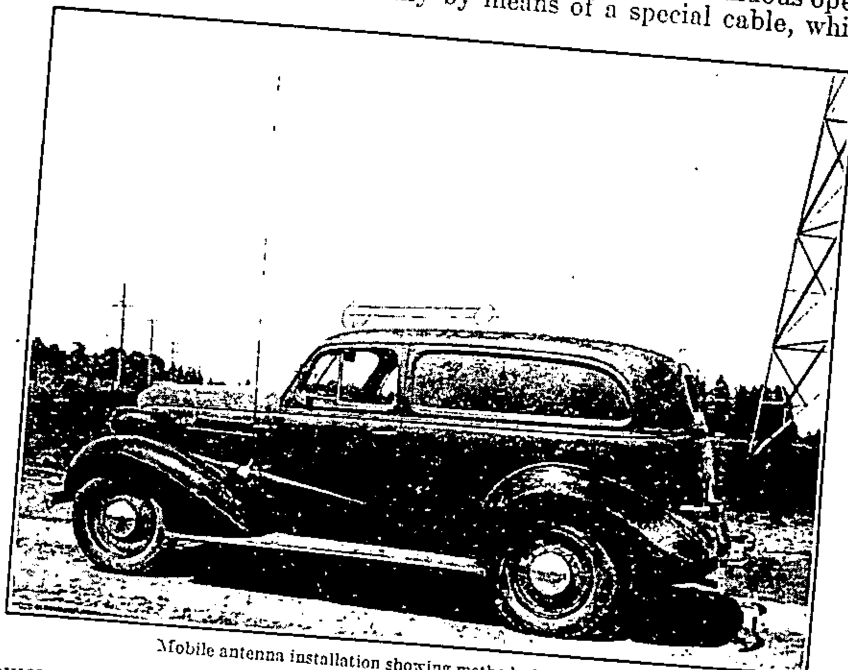
in this article. Requisitions for Forest Service radio equipment and correspondence on technical matters should be addressed to: Regional Forester, Box 4137, Portland, Oreg.

Type SV Radiophone (UHF)

The type SV radiophone is a larger and more powerful adaptation of the type S radiophone. Where the additional weight and bulk do not preclude its use and the extra cost can be borne, it offers several marked advantages over the type S.

The type SV transmits and receives voice only, and is intermediate in power between the types S and T. The estimated working range may vary from 80 miles between mountain lookouts to as little as 3 or 4 miles under certain level-ground conditions. Independent transmitting and receiving sections are mounted on the same chassis, which completely eliminates the frequency shifting between transmit and receive which is necessary in type S. A loudspeaker only is provided on the receiver. The same antenna is used for both transmitting and receiving. A special method of coupling permits a wide variation in the types of antennae employed.

For medium duty or intermittent service all batteries are contained in the set cabinet. Heavy-duty batteries for continuous operation may be attached externally by means of a special cable, which,



Mobile antenna installation showing method of mounting.

however, must be ordered as an accessory item. Weight, complete with medium duty batteries, 18½ pounds.

Type I Radiophone

The type I radiophone is a condensed and simplified unit intended for operation on 6-volt storage battery only, and transmits either voice or cw telegraphy. The power output of the I-type transmitter is intermediate between that of the types SPF and M. Normal output power is approximately 9½ watts.

This device is supplied in individual units—receiver, transmitter, and transmitter power supply. For semiportable operation these units are grouped into a single mounting cabinet.

Type I is primarily designed for mobile installation in cars or trucks, and the various units may be distributed under the dash or in other locations to take advantage of available space. For mobile operation the receiver supplied with the type I is similar in appearance to a conventional automobile radio receiver. It is equipped with a very satisfactory system of push button tuning which may be mounted near the steering column of the vehicle.

When ordering the type I, specify whether for semiportable or mobile installation. If for mobile use, give make and year of car so that a suitable receiver tuning head may be supplied. When supplied for mobile operation a special rod-type antenna will be furnished with the necessary tuning box for mounting on fender or bumper of car. The type I will be supplied to transmit and receive voice only when ordered for mobile service.

The range of the mobile radiophone varies from an estimated 25 miles under unfavorable conditions to as much as several hundred miles under favorable conditions. Probably the range is comparable to that of a type SPF radiophone using kitbag batteries and antenna.

EMERGENCY WIRE REEL

JACK GILMAN

District ranger, Lassen National Forest, U. S. Forest Service

In order to pay out and take up emergency wire without breaking or wearing it out, a reel was constructed back in 1933, which has since been used successfully on numerous fires. One man can reel out or reel in the wire as fast as he can walk.

When paying out wire, the reel is worn on the back, the loose end is secured, and the man simply walks to his destination reeling out the wire as he goes. When taking up the wire, the reel is worn on the chest or stomach, the man travels toward the other end of the wire turning the crank and reeling up the wire as he walks. The wire is not dragged in either operation.

The unit which holds the spool consists of ¾-inch pipe, 90° elbow,

Emergency wire reel in use: (*a*) Back view, (*b*) front view.

and wooden handle. To the shaft are welded three washers, two to prevent side play in the frame and one to support one end of the spool. The spool of wire is placed on the shaft out of the frame. The end of the pipe is threaded to take a ¾-inch floor flange which is used as a lock nut to keep the spool from turning on the shaft.

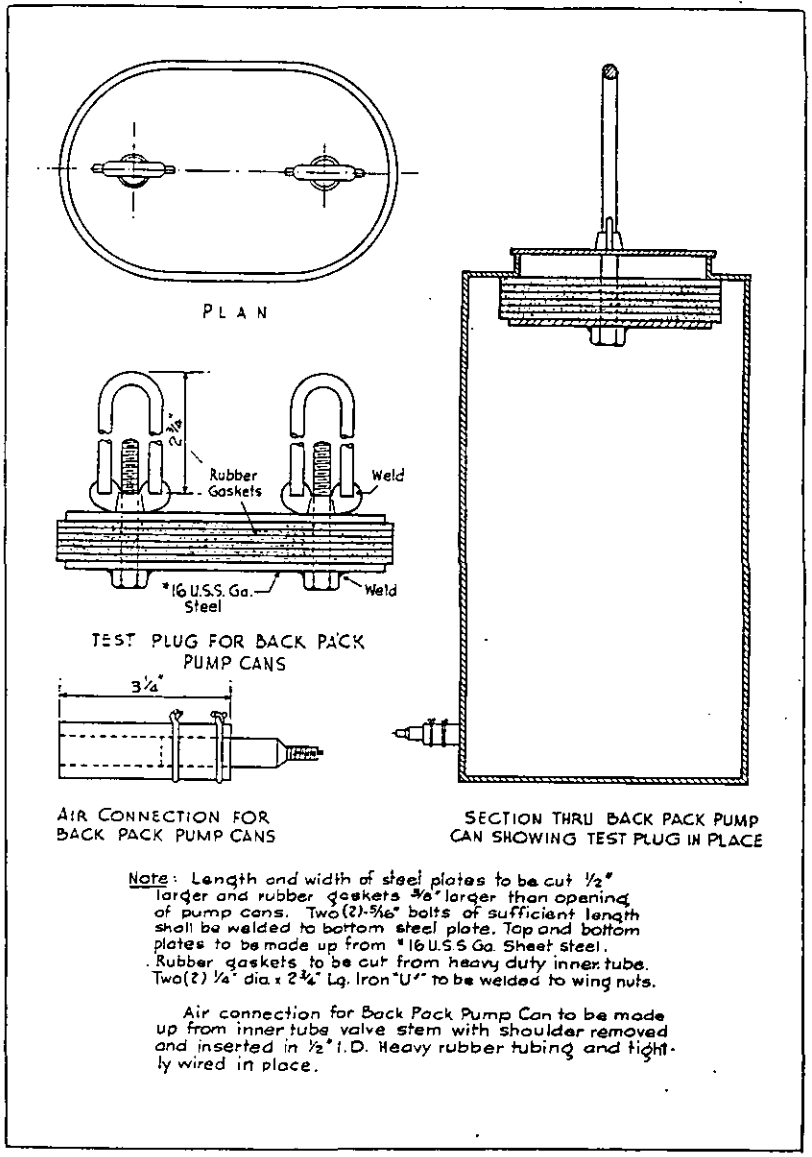
The shaft unit is supported by a wooden A frame attached to a pack board with straps. In one side of the frame there is a hole into which the threaded end of the shaft is placed, and a slot on the other side for the shaft to be secured in place by a pin and iron straps similar to a barrel lock.

TESTING BACK-PACK CANS FOR LEAKS

FOREST PROTECTION DIVISION

Wisconsin Conservation Department

A valve for making the top of the can air tight, and an air valve, such as an auto tire valve, which may be inserted in the can and attached to an ordinary air hose for testing purposes, are the essential



Plans of can leakage tester.

items needed in order to test back-pack cans for leaks. Testing in this way has proved to be very rapid and efficient, particularly where there are large numbers of cans to be overhauled following a large fire or a heavy season's use.

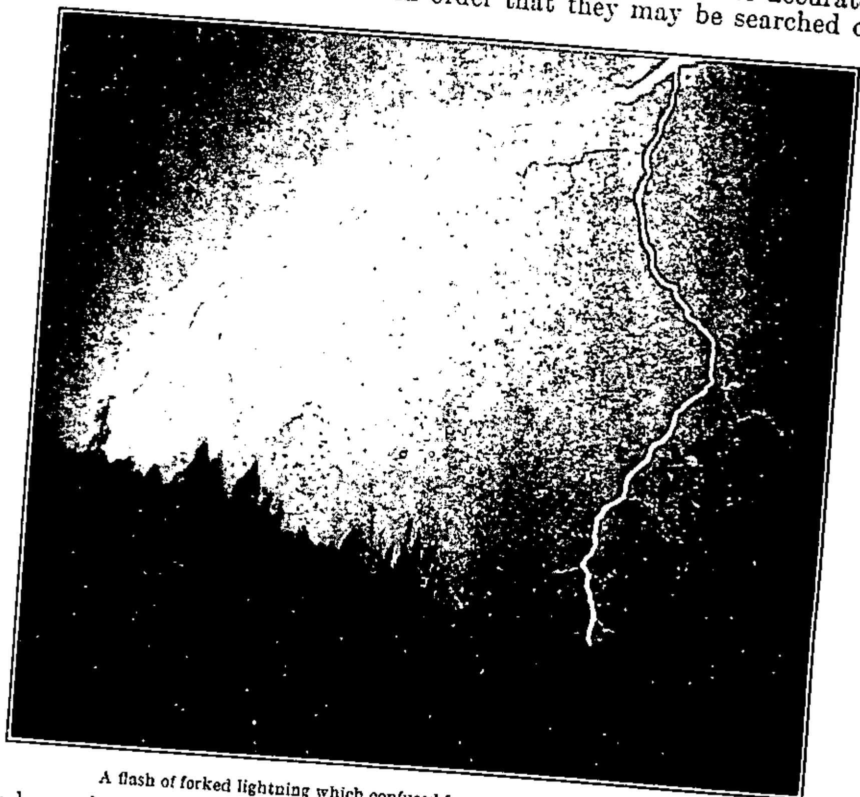
HANG-OVER LIGHTNING FIRES

C. D. Blake
Assistant Forest Supervisor, Flathead National Forest,
U. S. Forest Service

To those who do not know the job, it is a constant wonder that lookout men get azimuth readings on lightning strikes as well as they do, particularly at night. Even so, the average record lacks completeness and precision. Anything that will make for greater accuracy is, therefore, of high importance. The author suggests a device by which lookout men may get a rough but useful measure of the linear distance to such strikes.

The high percentage of hang-over lightning fires, like an unconquered bugaboo, continues persistently from year to year to smirch our fire-control achievement records with unsightly blots.

The main trouble appears to be our inability to locate accurately fire-setting lightning strikes in order that they may be searched out



A flash of forked lightning which confused four experienced fire-control men.

and squelched without the alarming elapsed discovery time which is so common. Even the experienced observer finds that too often the blinding lightning flash prevents accuracy of location. Camera records convince us that too often the human eye detects only a small percentage of simultaneous strikes to ground. Too often the lightning flashes come too thick and fast to permit even the experienced man to record more than a small percentage of the strikes to ground. If this is the case with the experienced observer, is it any wonder that the (probably badly frightened) inexperienced man fails?

I recognize my inability to offer a satisfactory solution to this important problem in fire control. I do know from experience that the old scheme of attempted location of lightning strikes by azimuth triangulations from two or more observation points is very unreliable.

Admittedly, in the following proposed substitute method for lightning-strike location there are possibilities of error because of optical illusions. However, if given a fair trial, I am certain you will discover it has advantages over the old scheme, and may be improved on. At least this plan permits observers to try independently for strike locations. Here it is:

Upon the approach or formation of an electric storm prepare yourself with fire finder or a sight compass. When a lightning strike appears, direct the sights of the instrument on the location and determine the period, in seconds, between the flash and the sound of thunder. Since sound travels a mile in approximately 4.5 seconds, the distance may be determined by dividing the period in seconds by 4.5 or 5.0. (Use 4.5 if wind blows toward you from the strike and 5.0 if it blows away from you.) The strike location may be determined by scaling off on the map the direction and distance. A stop watch is recommended for recording the interval between the flash and the sound of thunder. However, the period may be ascertained in seconds by counting, beginning with 1,001, 1,002, 1,003, etc., then by dividing the last three numerals by 4.5 or 5.0.

REGION 6 FIRE-DANGER BOARD

Donald N. Matthews and J. F. Campbell

U. S. Forest Service, Portland, Oreg.

In each district ranger's office in U. S. Forest Service Region 6 (Washington and Oregon) is a fire-danger board which strikingly

Figure 9.—The Region 6 fire-danger board.

summarizes the variable factors of fire danger and combines them into class-of-day ratings. Although a few experimental boards were on trial in 1936 their regular use was started with the 1937 fire season. The fire-danger boards and the rating system were developed by the Pacific Northwest Forest Experiment Station collaborating with the regional fire-control office.

The fire-danger stations are the source of information used in "posting" the boards which the rangers use in determining presuppression action. These are located at guard stations where fuel-moisture-indicator sticks (called "fuel sticks" for short), wind gage, psychrometer, and herbaceous-stage plots are used to measure fuel-moisture content, wind velocity, relative humidity, and herbaceous stage, respectively. In addition, Byram haze meters are used to measure visibility conditions; i. e., radius of vision, from certain selected lookout points. Ocular estimates are made at other points.

The fire-danger boards are 18 by 24 inches in size, made of metal. Each factor of fire danger used on the board is divided into classes, and each class is assigned a color. Fuel-moisture content, as measured by the fuel-moisture-indicator sticks, for example, is represented by classes and colors as follows: Class 4, 0 to 7 percent, red (this is the most dangerous condition); class 3, 7.1 to 10 percent, orange; class 2, 10.1 to 18 percent, blue; class 1, 18.1 to 25 percent, green; and class 0, above 25 percent, white. Corresponding classes of all factors have the same color; that is, class 4 is always represented by red, class 3 by orange, etc. Large class numerals (4, 3, 2, etc.) in black and the color of the current condition of each factor are displayed through an opening in the board by turning a knob attached to a disk mounted behind the face of the board. A glance at the board may show red, 4 (a large black 4 on a bright red background), fuel moisture; red relative humidity; green, 1, wind velocity; red, 4, herbaceous stage; blue, 2, visibility condition; and orange, 3, risk existing on the district.

All these factors are combined, by means of two simple integration tables on the face of the board, to produce one of seven class-of-day ratings. As a final operation the class-of-day numeral (7, 6, 5, 4, etc.) in black on an appropriate colored background is displayed in a large opening at the top of the board by turning another disk.

Fuel-moisture content, relative humidity, wind velocity, and herbaceous stage have a place on the board because they determine how fires will burn.

Fuel-moisture content is measured by means of fuel-moisture-indicator sticks, used in sets of three. They are one-half by one-half inch ponderosa pine sapwood sticks containing 100 units (grams) of oven-dry wood. Their weight (in grams) indicates their moisture content without any computations. (Simple, low-cost scales have been devised to weigh these sticks.)

The fuel-moisture-indicator sticks are continuously exposed in the open under the same forest-cover conditions as the fuels that are typical of each locality. They indicate the cumulative effect on fuels of the interplay of all weather elements—relative humidity, temperature, wind, rain, etc.

The herbaceous-stage factor is an estimate of the current fire-danger status of the annual growth of vegetation, such as grass, ferns, and weeds, made on plots staked out in representative areas. When the annuals are green and succulent, they do not add to the fire danger, but may be a retardant. As the season passes and they become progressively drier, they add materially to the fire danger. The effect of this vegetation on fires varies greatly at different periods of the fire season and on the same date in different years. The estimates on condition of the herbaceous plots furnish a practical means of weighing this factor in rating current fire danger.

Fuel-moisture content, relative humidity, wind velocity, and herbaceous stage are combined in a single integration table on the face of the board to produce a burning index. This burning index is concerned only with those factors of fire danger which vary markedly during the fire season. For example, although the kind and the quantity of fuel varies from place to place and may be of major importance in determining what a fire will do when burning conditions are dangerous, these factors remain practically constant, except as taken care of in the herbaceous-stage factor on the board, and are not considered among the variable factors combined in the burning index.

Having obtained the burning index from the burning-index table on the board, the next step is to determine the total fire-danger condition in order to decide what action should be taken—how many lookout men, smoke chasers, and patrolmen are needed. In order to get this, visibility conditions (the distance lookout men can be expected to see the smoke from a small fire) and risk (the relative activity of the fire-starting agencies such as man and lightning) also have a place on the board. These two factors of fire danger are combined with the burning index in a second table, and produce one of seven class-of-day ratings that are used to determine the presuppression action that will be taken to meet the fire-danger conditions that produced the rating.

Each district ranger prepares a fire plan at the beginning of the fire season which stipulates in detail the action he will take to meet each class of day. The fire plan is the connecting link between the rating of fire danger and administrative action. Although its striking color scheme makes the board the showy feature, nevertheless the ranger's fire plan is the heart of the system because it gives it life and action. It indicates the specific action the ranger will take to meet each class of danger. For example, his plan will list by name the positions to be manned—lookouts, patrols, etc.—and other action to be taken to cope with each class of day.

The fire plans are localized because they are made for each individual district. They also provide an opportunity to incorporate provisions that action to meet any one class of day may vary somewhat depending on the factor—visibility, risk, etc.—which dominates the situation. Thus somewhat different action may be set up for a class 5 day caused by dry fuels and high winds than for a class 5 day caused by lightning.

The forest supervisor has a special fire-danger board in his office which shows the class of day reported on each ranger district. In the regional forester's fire-control office in Portland there is a master board which shows the class of day on each of the 100 ranger districts in the region. This master board consists of a large map of the region with a colored light at each ranger's headquarters to indicate the class of fire danger on each district.

MISSISSIPPI FIRE TANKS

VICTOR B. MACNAUGHTON

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When the creative development of power-driven and other tools for fire control finally begins to slow down (if it ever does), it is more than probable that the crawler tractor will be playing an important role. In the October 1938 issue of Fire Control Notes, George M. Gowen reported one development in the use of water in California by means of the tractor. Here is testimony on the same point from a Gulf State.

Just as the thrilling cavalry charge in the military battles of 50 years ago is only a memory in the mechanized warfare of today, so the mass attacks of sheer manpower on fires in south Mississippi seems doomed to be replaced by mobile power units backed by small crews.

Twenty years ago at Ypres, the Hindenberg Line got a terrific shock when out of the misty smoke-filled dawn hundreds of British tanks advanced. Twenty years is a long time and it's a far cry from Ypres to the Leaf River battlefields on the DeSoto National Forest; yet, one afternoon in January, Mechanic "Slim" Sheffield rode into the smoke and flames behind the controls of a modern fire tank. The result on the enemy was comparable to that effected by the British tanks. Over logs, crashing through blackjack thickets, down hills, across swampy flats, always on the trail of the spreading fire line went the fire tank. Spewing a driving spray before it, the tank completely conquered flames 20 feet high backed by a 25 m. p. h. wind. Half a mile of line was conquered before it was necessary to refill the tank. Thus a new era of mechanized fire fighting was begun in Mississippi.

This fire tank solves the problem of direct attack on the head of a large grass fire. Heretofore, when backed by a strong wind, the head of the fire traveled until stopped by a backfire or natural barrier. Fire trucks are available on all national forests in Mississippi, and are very effective when they can be placed on the fire line. Their use, however, is limited by the topography, and usually they cannot reach the point where they are needed most.

This initial Mississippi fire tank was built at the Leaf River depot by Shop Foreman Sheffield, after a series of experiments and trials on actual fires. It does not represent the highest degree of possibilities, but its effectiveness on the fire line completely demonstrates the practical value of such a unit.

This first edition was built around a Cletrac A. G. 20 Tractor, on which are mounted two 100-gallon tanks. A power-driven hydraulic pump from a discarded dump truck drives the water under 100 pounds pressure through sprayers in front. The power take-off was made from discarded auto and tractor parts. The speed of this pump is approximately 1,500 revolutions per minute.

A by-pass valve, which is adjusted to the pressure desired, is built in line between the pump and nozzles. The two tanks are hooked together so that the pump draws evenly from both. A three-way valve, coupled in the suction line, permits the operator to refill the tanks in 12 minutes. The take-off that controls the pump so that it may be shifted in and out of gear is located under the driver's seat.

The spray attachment in front consists of a semicircular length of pipe to which are fitted three sprayers. The unit is mounted with brackets near the top of the radiator and close to it. The bumper provides protection to the sprayer from bushes and trees.

A second spray attachment is located directly under the bumper. The water from these nozzles is directed straight down. This spray has separate controls and may be used or not as the occasion demands.

Twenty-five feet of high pressure hose is attached to the rear of the unit. This hose has a pistol-grip nozzle similar to the one used by automobile washers. If, because of some obstacle, it becomes necessary for the tank to veer off the fire line, that portion of the line can be suppressed by the hose operator walking behind the "tank." This hose is also useful to catch burning snags or logs which need immediate quenching. An extra section of hose is carried in case of emergency.

Transportation for the "tank" is provided by a 2-ton International truck. Upon arrival at the fire, heavy oak skids are pulled out and lowered to the ground. A sawhorse placed under the rear end of the body takes up some of the weight as the "tank" is driven down the skids onto the ground.

Conditions on the DeSoto National Forest in south Mississippi are especially favorable to the use of heavy power equipment. The land is gently rolling, offering no steep slopes to be climbed. Almost completely denuded of its mature timber a decade ago, the small blackjack, oaks, and young pine reproduction are easily ridden down by the fire tank. The light, flashy fuel cover of broomsedge grass yields readily to attack by water. A complete system of fine gravel roads insures fast travel to any fire. A number of these tractor units on each DeSoto district would tend to offset the loss in manpower brought about by the recent abandonment of CCC camps.

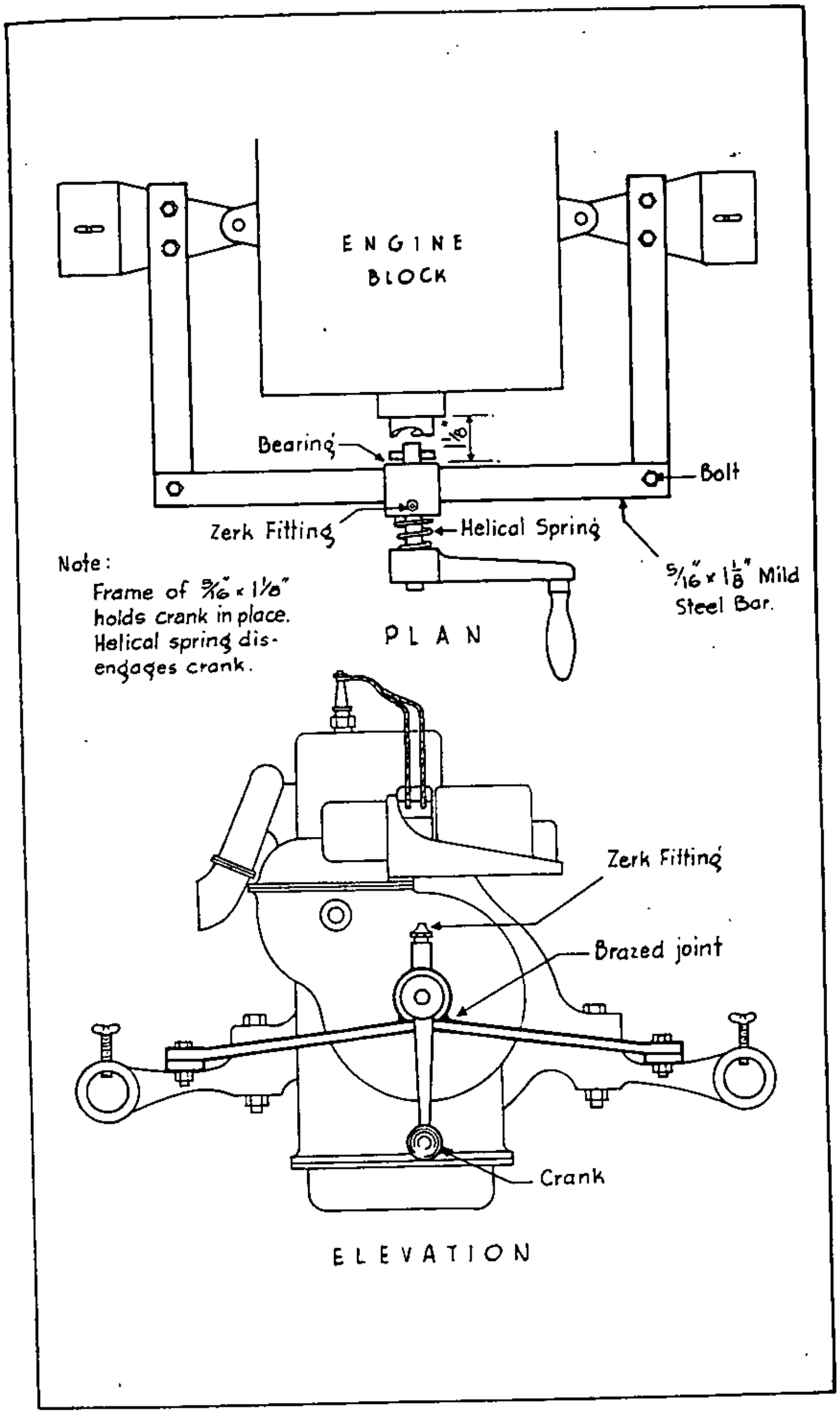
Some improvements planned for future models include more pressure, a more substantial pump, larger water tanks, a starter and lights for the tractor, and the use of mono-ammonium phosphate in the water tanks.

CRANKING DEVICE FOR PACIFIC PUMPER

Chippewa Forest, Region 9, U. S. Forest Service

The device shown in the accompanying sketch was designed for the four-cylinder U-Type Pacific pumper. It makes for easier and safer cranking and keeps the crank always in place.

The frame, made of 5/16 by 1⅛-inch mild steel bar, is bolted to the front carrier supports, and extends around the front of the engine. The cross bar has a slight bend to line up the crank with the crankshaft rachet. The crank bearing is brazed to the frame and a spiral spring is used to keep the crank disengaged. A fitting may be added to facilitate greasing.



Cranking device for 4-cylinder Pacific pumper.

PRE-SEASON GUARD TRAINING ON THE HEBO DISTRICT

ROBERT AUFDERHEIDE

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

Any time that two or more fire-control men gather together the topics of training and morale are sure to come up. The national forest replanning project gives high priority to both subjects, but sometimes it is hard to take hold of them effectively. Here is a district ranger who has tried a simple but excellent way of advancing both morale and training.

On February 20, 1937, while I was returning from the Oregon State Fernhopper banquet with four of the short-term force, one of the guards suggested a program of winter guard-training meetings. It was his idea that a weekly meeting, where the boys could discuss a problem or topic, would shorten the winter months as well as enable each man to prepare himself better for his job. As we discussed the idea, we became enthusiastic, and before we arrived home that night we had decided to give the idea a trial.

A week afterward I was attending the spring rangers' training camp so we did not hold our first meeting until my return. By this time our womenfolk had heard of the idea, and they decided they would also have a meeting—purely social. On April 9 we had our first meeting. The women gathered in the ranger dwelling and we met in the office. After a session of an hour or two, we joined the women and enjoyed refreshments and several hours of cards. We have had these meetings regularly ever since.

The Hebo district normally has 11 guard positions during the summer season. Of this number, two positions are ordinarily filled by forestry school students. One position is usually vacated each season for one reason or another, leaving eight positions filled by returning nonstudent guards. Three of these guards live at some little distance from the ranger station, and it is not very practical for them to be present at the meetings, although one guard frequently attends, traveling 35 miles to do so. Attendance has not at any time been requested or made compulsory in any sense. It is thoroughly understood that a man's standing is in no wise affected by absence from the meetings, and also that attendance in itself has no bearing on his holding his job.

On an average six regular guards and one emergency guard have attended. During spring maintenance several guards from distant stations are on the district, and our attendance is increased by their presence.

In 1937, because of our late start, only 6 sessions were held, but we have had 9 so far in 1938, and shall undoubtedly get in 12. Eighteen hours of additional training for one-half of the regular personnel is well worth while; at least, I have found it so.

One of my problems has been to secure well trained overhead for class B and small class C fires. My approach has been to secure sufficient emergency lookout personnel and train them, so that I could use regular lookouts for overhead positions on the smaller fires. Many evenings have been devoted to subjects pertaining to the efficient handling of these fires—timekeeping, the camp-manager job, compensation, the foreman, tool man, etc.

At one of the meetings it was suggested that a brief reminder list might be of considerable assistance to men filling the overhead positions. We have developed that idea and have prepared a one-page reminder list for each job, arranged in a folder so that the list for each particular job can easily be torn out by the man filling that job. This folder is a part of each 15-man tool cache and is carried in the timekeeping kit.

Other subjects discussed have been the calculation of probabilities, public contact, the one-lick method of fire suppression, the proper preparation of Forms LE–1, fire fighters contract and time slip, a study of information necessary to complete Form 929, and trail and telephone maintenance standards.

The results and advantages have been numerous. From the standpoint of morale alone the meetings have been worth while. I believe that the fellows have a feeling that they are shareholders in the Forest Service; and where previously a guard may have worked only 4 to 6 months of the year, he now works for the Service continually. The spirit of teamwork seems to be more apparent. After several sessions on trail and telephone maintenance I noticed that a better and more efficient job was being done.

A meeting of this sort is a good place to put up a real problem, although it may sometimes be advisable to put it up as a hypothetical case. I've profited from a number of worth while ideas brought up in our sessions.

Several methods of training have been used, and I believe that a variation or a change of gait, so to speak, is very effective in sustaining interest and preventing monotony. We have had informal roundtables with everyone throwing in ideas and taking ideas from the pot. We have employed the conference method with a chart, and have used problems.

On occasions when we have made practical use of some of our acquired knowledge and training, it has been helpful to analyze and criticize our action constructively at our next session. We have even manufactured the occasions. After studying the one-lick method of fire-line construction, we took 30 Farm Security laborers assigned to us for trail work to a trail construction job and practiced the one-lick method with them, giving the guards the third and fourth steps of the four-step method. It was generally agreed that we gained in output of production on trail construction as well as benefited by the training.

The next topic I propose to take up is training instruction, with emphasis on the idea that much of our trouble in supervising a crew of men results from assuming that a man knows how to do some simple yet fundamental thing. If the boys can be taught to recognize this condition, better production on fire control and maintenance work should result.

As a result of the experience gained in conducting these meetings during the past two winter seasons, I expect to give more attention to the following points in planning future meetings:

1. Take sufficient time to prepare adequately instructional material.

2. Limit the subject so that it can be thoroughly covered in not to exceed a 2-hour period.

3. Vary methods of instruction and procedure in conducting meetings.

AUXILIARY RADIATOR COOLING SYSTEM FOR FIRE TRUCKS

W. R. Oakes,

Sequoia National Park, Calif., National Park Service

The simple system described by the author should be a ready means of curing heating troubles in engines which will not cool when being used to discharge a load of water while the truck is standing still.

In Sequoia National Park, where the California sun frequently produces temperatures well over 100° F. and where truck-trail grades run as high as 20 percent, the conventional motor-cooling system of the fire trucks is inadequate.

Several experiments were made with various methods of providing greater circulation of water. The most successful was to supplement the standard system by circulating water from the truck storage tank through the motor block and radiator and returning it to the storage tank by means of a small electric pump. The system is easy to install and no alterations to the truck or its standard equipment are necessary. Anyone handy with tools can do the job. Three-eighths-inch copper tubing was used to carry the water throughout the system.

The pump used to force the water from the storage tank was a Stewart Warner electric (6-volt) fuel pump, Model A-699. It was bolted to the dashboard under the hood, low enough to permit the water to flow by gravity from the storage tank to the intake of the pump as long as the tank was at least half full of water. A push-button switch was installed on the instrument board to control the supplemented cooling system in order to permit the motor to reach an efficient operating temperature, or to cut off the flow when the storage tank is empty. One wire is run from the hot post on the ammeter through the switch to the pump, the latter being grounded to the frame upon installation.

Flexible metal tubing was used to carry the water from the outlet of the pump to the drain plug connection on the radiator, the point where the standard system was cut off.

A spring check valve, ball bearing, was installed between the end of the flexible tubing and the drain cock to prevent the water from the radiator draining back to the tank when the latter is empty, or the loss of water in case of failure of the supply line. A return line of copper tubing was run from the overflow pipe of the radiator back to the storage tank.

Since the fuel pump was not designed to pump water, the flat steel valve springs rusted quickly and were replaced with coiled brass valve springs originally designed for a mechanical fuel pump. (Flat brass springs could be substituted.)

The pump installed as described will deliver approximately 15 gallons of water per hour to the radiator. This has proved adequate for holding the water in the cooling system well below the boiling point.

The cost of the pump, tubing, and miscellaneous parts was approximately $15 for each truck on which the system was installed. The installation can be used on practically any model and make of tank truck.

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